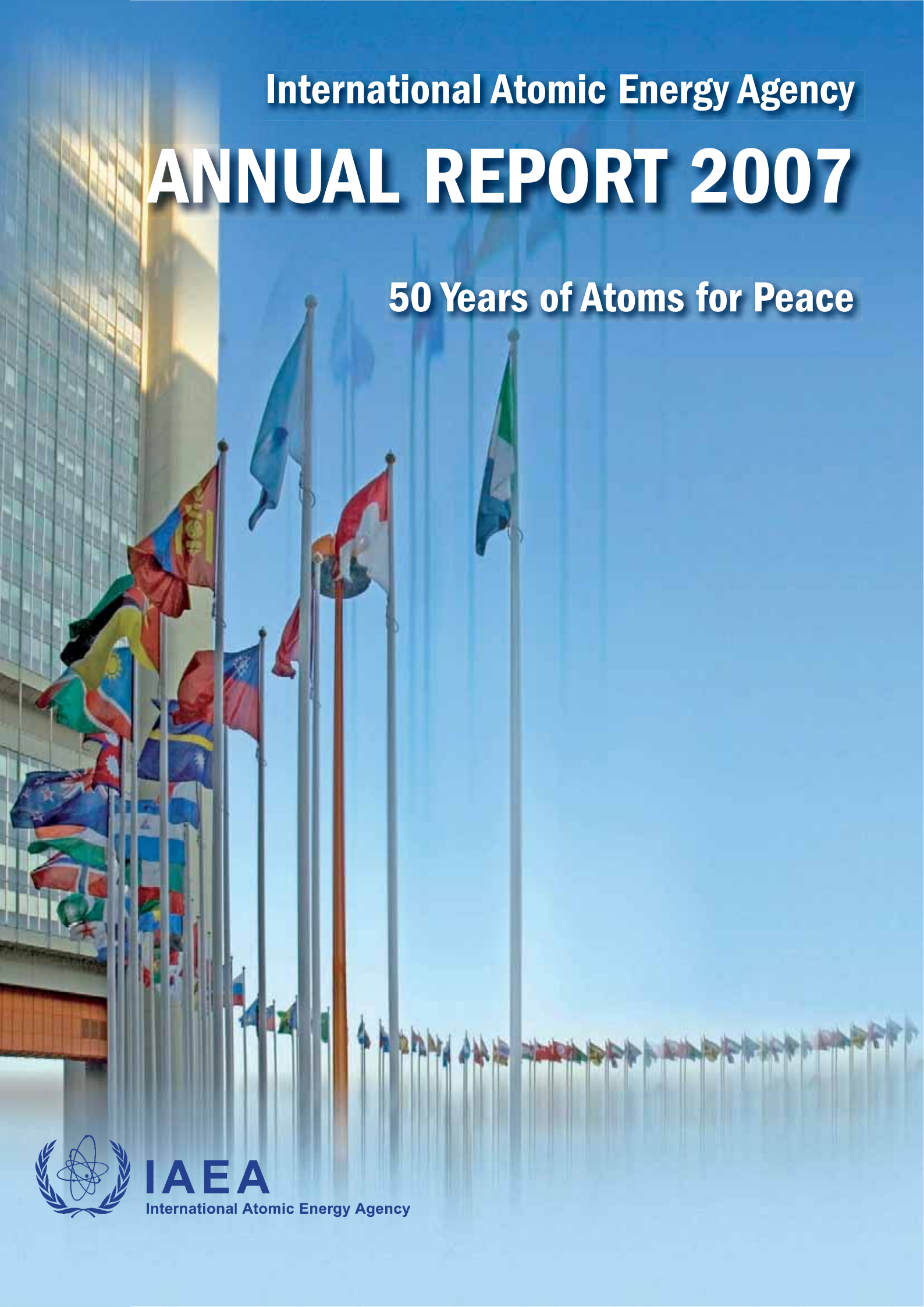
International Atomic Energy Agency

ANNUAL REPORT 2007

50 Years of Atoms for Peace



IAEA
International Atomic Energy Agency

Annual Report 2007

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 2007.

GC(52)/9

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(designation as of 31 December 2007)

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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 located in Vienna. The IAEA's principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

The Agency at a Glance

(as of 31 December 2007)

144 Member States.

64 intergovernmental and non-governmental organizations worldwide invited to observe the Agency's General Conference.

50 years of international service.

2326 professional and support staff.

€268 million total regular budget for 2007, supplemented by extrabudgetary contributions received in 2007 amounting to **€42.2 million.**

$80 million target in 2007 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **3546** expert and lecturer assignments, **4149** meeting participants, **2287** participants in training courses and **1661** fellows and scientific visitors.

2 liaison offices (in New York and Geneva) and 2 safeguards regional offices (in Tokyo and Toronto).

2 international laboratories and research centres.

11 multilateral conventions on nuclear safety, security and liability adopted under the Agency's auspices.

4 regional/cooperative agreements relating to nuclear science and technology.

109 Revised Supplementary Agreements governing the provision of technical assistance by the Agency.

115 active CRPs involving **1538** approved research contracts and agreements. In addition, **80** Research Coordination Meetings were held.

237 safeguards agreements in force in **163** States involving **2122** safeguards inspections performed in 2007. Safeguards expenditures in 2007 amounted to **€110.6 million** in regular budget and **€12.8 million** in extrabudgetary resources.

19 national safeguards support programmes and 1 multinational support programme (European Union).

12 million monthly hits to the Agency's *iaea.org* web site.

2.8 million records in the International Nuclear Information System, the Agency's largest database.

1.2 million documents, technical reports, standards, conference proceedings, journals and books in the IAEA Library available for Member States and **11 300** visitors to the Library in 2007.

177 publications and newsletters issued (in print and electronic formats) in 2007.

The Board of Governors

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

In the area of nuclear technologies, the Board considered the *Nuclear Technology Review 2007* and a Secretariat report on *Considerations to Launch a Nuclear Power Programme*.

In the area of safety and security, the Board considered the *Nuclear Safety Review for 2006* and it established an Agency safety standard on the safety of fuel cycle facilities. It considered the annual report on *Nuclear Security — Measures to Protect Against Nuclear Terrorism* and approved functions specifically assigned to the Agency under the International Convention for the Suppression of Acts of Nuclear Terrorism.

As regards verification, the Board considered the *Safeguards Implementation Report for 2006*. It approved a number of safeguards agreements and additional protocols. The Board kept under its consideration the implementation of the NPT safeguards agreement and relevant provisions of United Nations Security Council resolutions[1] in the Islamic Republic of Iran. With regard to the application of safeguards in the Democratic People's Republic of Korea, the Board authorized the Director General to implement ad hoc monitoring and verification arrangements. The Board considered the Report of the Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute.

The Board considered the *Technical Cooperation Report for 2006* and approved the Agency's technical cooperation programme for 2008.

Composition of the Board of Governors (2007–2008)

Chair: H.E. Mr. Milenko E. SKOKNIC
Ambassador, Governor from Chile

Vice-Chairpersons: H.E. Mr. Mario HORVATIĆ
Ambassador, Governor from Croatia

H.E. Mr. Frank COGAN
Ambassador, Governor from Ireland

Albania
Algeria
Argentina
Australia
Austria
Bolivia
Brazil
Canada
Chile
China
Croatia
Ecuador
Ethiopia
Finland
France
Germany
Ghana
India
Iraq
Ireland
Italy
Japan
Lithuania
Mexico
Morocco
Nigeria
Pakistan
Philippines
Russian Federation
Saudi Arabia
South Africa
Switzerland
Thailand
United Kingdom of Great Britain and Northern Ireland
United States of America

[1] Security Council resolutions 1737 (2006) and 1747 (2007).

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 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 programmes and passes resolutions directing the priorities of the Agency's work.

In 2007, the Conference — upon the recommendation of the Board — approved Bahrain, Burundi, Cape Verde, Congo and Nepal and for membership of the Agency. By the end of 2007, the Agency's membership had risen to 144.

Fiftieth Anniversary of the Agency

To mark half a century of the Agency's founding and its work, there were a number of activities or events in Vienna and in Member States in 2007. Among the more notable were the following.

An illustrated history of the Agency entitled *Atoms for Peace: A Pictorial History of the International Atomic Energy Agency* was published.

An international children's painting competition was organized during 2007, and the winning entries were exhibited at the General Conference.

A photographic exhibition on the Agency's first half century was organized in April 2007 in Geneva. Also in April, the Japan Atomic Industrial Forum devoted a day in its week long meeting in Aomori to the Agency's anniversary. In May, the Government of Hungary organized a celebration meeting in Budapest. In July, the Director General attended a special conference commemorating the fiftieth anniversary hosted by the Republic of Korea in Seoul. A "Jubilee Forum" was organized in Sofia in July by the Bulgarian Government. Finally, the German Government produced a publication on the history of the Agency.

During the 51st regular session of the General Conference in September 2007, the Federal President of Austria, Dr. H. Fischer, the Austrian Government and the City of Vienna honoured the Agency with a formal gala concert and reception at the Vienna Konzerthaus, the historic location of the first General Conference. The photo shows the Austrian Federal Minister for European and International Affairs, Ms. U. Plassnik, delivering her welcome address.

(photo credit: Bernhard J. Holzner © HOPI-MEDIA)

Notes

- The *Annual Report reviews* the results of the Agency's programme according to the three "pillars" of technology, safety and verification. The main part of the report, starting on page 17, generally follows the programme structure as given in The Agency's Programme and Budget 2006–2007 (GC(49)/2).

- The introductory chapter, 'Overview', 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. More detailed information can be found in the latest editions of the Agency's *Nuclear Safety Review, Nuclear Technology Review, Technical Cooperation Report* and the *Safeguards Statement for 2007 and Background to the Safeguards Statement.* For the convenience of readers, these documents are available on the CD-ROM attached to the inside back cover of this report.

- Additional information covering various aspects of the Agency's programme is provided on the attached CD-ROM, and is also available on the Agency's web site at *http://www.iaea.org/Worldatom/Documents/Anrep/Anrep2007/.*

- Except where indicated, 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 Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The term "nuclear weapon State" is as used in the NPT.

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
BWR	Boiling water reactor
CRP	Coordinated research project
ESTRO	European Society for Therapeutic Radiology and Oncology
Euratom	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FORATOM	European Atomic Forum
GEF	Global Environment Facility
IAEA-MEL	IAEA Marine Environment Laboratory
ICRP	International Commission on Radiological Protection
ICTP	Abdus Salam International Centre for Theoretical Physics
INFCIRC	Information Circular (IAEA)
INIS	International Nuclear Information System
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ISO	International Organization for Standardization
LEU	Low enriched uranium
LWR	Light water reactor
NATO	North Atlantic Treaty Organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OECD	Organisation for Economic Co-operation and Development
OECD/NEA	OECD Nuclear Energy Agency
OPEC	Organization of the Petroleum Exporting Countries
PAHO	Pan American Health Organization/WHO
PET	Positron emission tomography

PWR	Pressurized water reactor
SAL	Safeguards Analytical Laboratory
SQ	Significant quantity
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNOPS	United Nations Office for Project Services
UNSC	United Nations Security Council
WHO	World Health Organization
WNA	World Nuclear Association
WMO	World Meteorological Organization
WWER	Water cooled and moderated energy reactor

Overview

The year 2007 marked the fiftieth anniversary of the founding of the International Atomic Energy Agency. The Agency was the concrete expression of the international community's hopes and expectations for the peaceful applications of nuclear science and technology, as articulated in President Dwight D. Eisenhower's 1953 "Atoms for Peace" speech at the United Nations General Assembly. Five decades later, the Agency's activities remain vital in maximizing the use of nuclear technology for economic and social development and preventing its misuse for non-peaceful ends.

This chapter reviews some of the major global developments in 2007 in the areas of the applications of peaceful nuclear *technology*; global nuclear *safety* and the *security* of nuclear and radiological material and facilities; and the *verification* of compliance with nuclear non-proliferation undertakings.

Technology

Continuing population growth and longer human life spans are creating challenges for energy supply, human health, food security, water availability, resource conservation and environmental protection. The Agency, through its nuclear power, nuclear applications and technical cooperation programmes, assists Member States in addressing these challenges.

"Continuing population growth and longer human life spans are creating challenges for energy supply ..."

Nuclear power: Status and trends

Nearly every aspect of development — from reducing poverty to improving health care — requires reliable access to modern energy services. Faced with a growing shortfall of energy and rising fossil fuel prices, many countries are now looking to nuclear power as a way to increase the diversity of their energy supplies. A factor driving the renewed interest in nuclear power is that it emits almost no greenhouse gases.

At the end of 2007, a total of 34 reactors were under construction around the world. There were 439 nuclear power reactors in operation, supplying about 15% of the world's electricity. Three new reactors were connected to the grid — in China, India and Romania — and one laid-up unit was reconnected in the USA. There were no reactor retirements. Construction began on seven new reactors — in China, France, the Republic of Korea and the Russian Federation, while construction resumed at Watts Bar 2 in the USA. The United States Nuclear Regulatory Commission (NRC) received applications for four new nuclear reactors, the first in nearly 30 years.

The Agency revised its medium term projections for global growth in nuclear power upwards in 2007, to 447 gigawatts of electric capacity (GW(e)) and 691 GW(e), respectively, in its low and high projections for 2030. Current expansion, as well as near term and long term growth prospects, remained centred on Asia. Of the 34 reactors under construction, 19 were in Asia, as were 28 of the last 39 new reactors connected to the grid.

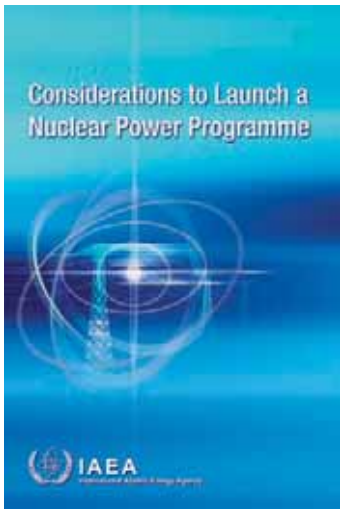
Innovative technologies and approaches

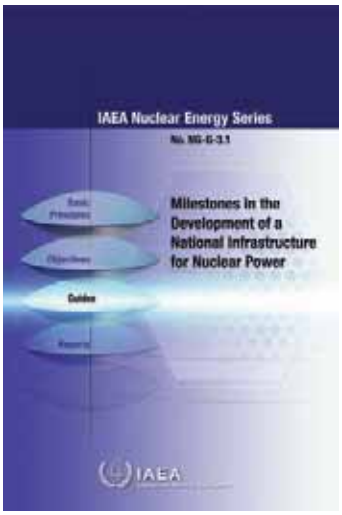
Technological innovation is a key factor in ensuring the long term sustainability of nuclear power. The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)[1] provides a forum for studying innovative nuclear energy systems and associated requirements. Based on assessments of national programmes carried out by INPRO members between 2005 and 2007, the Agency published recommendations on the INPRO methodology for the evaluation of different innovative nuclear energy systems. Comprising seven manuals covering economics, the environment, infrastructure, waste management and proliferation resistance, the methodology is being used in assessments carried out by Member States and by the European Commission, and in a study by several INPRO members of a closed fuel cycle with fast reactors. Phase Two of INPRO will focus on innovative approaches to infrastructure and institu-

[1] Currently, INPRO has 28 members: Argentina, Armenia, Belarus, Brazil, Bulgaria, Canada, Chile, China, the Czech Republic, France, Germany, India, Indonesia, Japan, Kazakhstan, the Republic of Korea, Morocco, the Netherlands, Pakistan, the Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, the USA and the European Commission.

LAUNCHING NUCLEAR POWER PROGRAMMES

In response to increasing interest among Member States in the steps necessary to introduce nuclear power into their energy mix, the Agency published a brochure entitled *Considerations to Launch a Nuclear Power Programme* (GOV/INF/2007/2). It was followed by the publication of *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1), which provides a more detailed description for a technical audience of the complete range of infrastructure issues and the expected levels of achievement, or 'milestones', at the end of each of the three development phases outlined in the publication.





tional development for countries beginning nuclear power programmes, as well as on the establishment of collaborative projects between the members.

Another international initiative on innovative nuclear technologies, the Generation IV International Forum (GIF), coordinates research activities on six next generation nuclear energy systems: gas cooled fast reactors, lead cooled fast reactors, molten salt reactors, sodium cooled fast reactors, supercritical water cooled reactors and very high temperature reactors.[2] In 2007, agreement was reached on R&D projects for sodium cooled fast reactors for work on advanced fuel, component design and the non-reactor parts of the power plant.

For nuclear power to be a feasible option in countries and regions with small electricity grids, the design and production of safe and affordable small and intermediate size reactors (SMRs) will be essential. Although 7 of the 34 reactors under construction at the end of 2007 were smaller than 600 megawatts of electric capacity (MW(e)), and another three were between 600 and 700 MW(e), only one design in the SMR size range was being offered by a major vendor — the 700 MW(e) CANDU-6. Roughly a dozen innovative designs for SMRs are currently under development in various countries, and some could be deployed in the next decade. For example, in the Russian Federation construction of a 70 MW(e) floating nuclear plant using two water cooled reactors began in April; deployment is scheduled for 2010.

Energy assessment services

The prospects for growth in the nuclear power sector were reflected in increased demand for the Agency's assistance for energy assessments that include nuclear power. Algeria, Belarus, Egypt, Nigeria, Sudan, Tunisia and the member countries of the Gulf Cooperation Council, among others, requested assistance. For many Member States that are working with the Agency to build national capabilities for energy systems analysis, nuclear power is not yet a near term option. But of the 77 countries that receive Agency support for such

[2] The members of GIF are: Argentina, Brazil, Canada, China, Euratom, France, Japan, the Republic of Korea, the Russian Federation, South Africa, Switzerland, the United Kingdom and the USA.

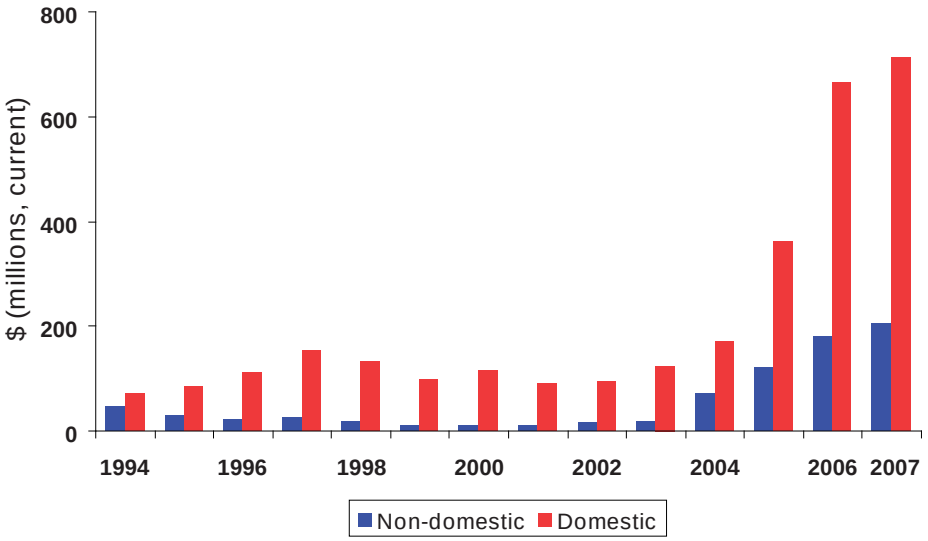


FIG. 1. Trends in reported uranium exploration and development expenditures.

studies, 29 now include an explicit assessment of nuclear power.

The number of people the Agency trained in energy system analysis increased by more than 50% in 2007. In response to still growing demand, the Agency conducted a pilot project using a web based training package. It is expected that such projects will help further expand training services in the future.

Uranium supply issues

Rising expectations for nuclear power and uncertainties about future uranium stocks led to a sharp rise in the uranium spot price in 2007. During the first six months the price almost doubled, from $187 to $351 per kg uranium (kg U). In the second half of the year the price dropped and stabilized at about $230/kg U. The result was a revival of the uranium raw material industry, with significant expansion in exploration, mining and production activities all over the world (see Fig. 1).

The Agency, together with the OECD Nuclear Energy Agency, updated information on the global uranium market for publication in the 2008 edition of the 'Red Book'.[3] 'Identified' uranium resources (with production costs less than $130/kg U) increased by 15% to 5.5 million tonnes from the levels reported in the previous edition. Annual global uranium production in 2007 remained around 40 000 tonnes, similar to the 2005 and 2006 levels, against average annual demand of some 67 000 tonnes. The balance was met by secondary sources such as civil and military stockpiles, by spent fuel reprocessing plants, and by re-enrichment of depleted uranium.

With the expansion of uranium exploration, mining and production activities, as shown in Fig. 1, firms faced shortages of experienced and trained personnel. In addition, many new companies with limited experience became interested in developing uranium resources. Countries with newly discovered uranium reserves were approached to become involved in uranium mining. Many of these countries do not have adequate regulatory or legislative infrastructures, nor do they have sufficient numbers of qualified staff to manage the proposed uranium mining activities. In 2007, the Agency, in partnership with the World Nuclear Association, brought together established regulators and mine operators from the major uranium producing countries to draft a set of best practices for managing radiation, health and safety, waste and the environment, and associated regulatory aspects.

Management of spent fuel

Annual discharges of spent fuel from the world's reactors total about 10 500 tonnes of heavy metal (t HM) per year. China, France, India, Japan and the Russian Federation reprocess most of their spent fuel or store it for future reprocessing. However, for a variety of technical reasons, only about 50% of

[3] The Red Book, known formally as *Uranium 2007: Resources, Production and Demand,* is published by the OECD/NEA on behalf of both organizations.

the world's existing reprocessing capacity is being used. Canada, Finland, Sweden and the USA plan to dispose of their spent fuel directly, although the USA has initiated the Global Nuclear Energy Partnership (GNEP), which includes the development of advanced technologies such as recycling. In 2007, 19 countries signed GNEP's Statement of Principles, which included accelerated development and deployment of advanced fuel cycle technologies.

The Finnish, French, Swedish and US waste repository programmes remained the most developed, although none of these countries is likely to have a repository in operation much before 2020. Construction of the ONKALO underground characterization facility, which could be part of the repository at Olkiluoto in Finland, progressed according to plan. Following the introduction of new legislation, the French repository programme moved to the detailed siting phase, with the goal of applying for a licence in 2015. In Sweden, extensive site investigations resulted in plans for preparation of a licence application for the selected site in 2009. In the USA, preparation of the licence application for a repository at Yucca Mountain was well advanced, with the application planned for mid-2008.

"After more than 50 years of experience with storing spent fuel, there is a high level of technical confidence in both wet and dry storage technologies ..."

Most countries are currently storing spent fuel while keeping abreast of developments associated with reprocessing and direct disposal. After more than 50 years of experience with storing spent fuel, there is a high level of technical confidence in both wet and dry storage technologies and their ability to cope with rising volumes and longer storage periods. A number of Agency studies focused on the technology for spent fuel storage and the long term behaviour of spent fuel and storage components.

Assurances of supply of nuclear fuel

In June, the Director General presented a report to the Board of Governors entitled *Possible New Framework for the Utilization of Nuclear Energy: Options for Assurance of Supply of Nuclear Fuel.* The report provided background information on proposals received by the Secretariat concerning the assurance of supply of nuclear fuel. It made it clear that any framework for the assurance of supply of nuclear fuel and fuel fabrication services, if established under the Agency's auspices, should be open to participation by all Member States on the basis of uniform criteria established in advance by the Board of Governors, and applied in a consistent manner which would not prejudice any State's future fuel cycle options. The report noted that any assurance of supply mechanism would be envisaged solely as a backup to the market in nuclear material, fuels, technologies and services.

Research reactor fuel conversion activities

Nearly 100 civilian facilities around the world — mostly research reactors — operate with small quantities of high enriched uranium (HEU). However, according to many experts, most if not all of these facilities could also operate using low enriched uranium (LEU). The Agency, through its technical cooperation programme, continued to support Member State efforts to convert research reactors from the use of HEU to LEU fuel. In 2007, the Portuguese RPI reactor was fully converted, and the conversion of the Maria reactor in Poland made significant progress.

The Agency also supported Member States participating in international programmes to return research reactor fuel to the country of origin. For example, in the framework of the Russian Research Reactor Fuel Return Programme, and under contracts arranged by the Agency, two shipments totalling 12.7 kg of fresh HEU fuel were made from Poland and Vietnam to the Russian Federation. In addition, the Agency assisted in the shipment to the Russian Federation of 80 kg of irradiated HEU fuel and 280 kg of irradiated LEU fuel of Russian origin from the Řež Nuclear Research Institute in the Czech Republic.

Management of nuclear knowledge

The OECD/NEA's Steering Committee for Nuclear Energy noted in 2007 that because of the decline in nuclear education and training, the nuclear sector risked facing a shortage of qualified staff to ensure the appropriate regulation and operation of existing and planned nuclear facilities, and the European Commission recommended that education and training in nuclear science and engineering be strengthened. The Scientific Forum at the Agency's 2007 General Conference concluded that the Agency is well positioned to play an important role in

expanding the capacity of colleges, universities and nuclear research institutes in these areas.

Following a period of decline, there was a modest increase in the number of university students enrolled in nuclear sciences. Prospective future growth in nuclear power generation, recent initiatives in technology innovation, increased government funding, and acceleration or renewal of nuclear programmes in a number of States attracted new students.

Academic networking and cooperation both expanded in 2007. The European Nuclear Education Network now has 28 members, plus 16 associate members, from 17 countries. The third Summer Institute of the World Nuclear University was held in Taejon in 2007, attracting 102 fellows from 35 countries. The Asian Network for Education in Nuclear Technology has 28 member institutions from 12 countries.

"Millions of people benefit from a wide range of applications of nuclear technology."

Nuclear applications

Millions of people benefit from a wide range of applications of nuclear technology. These include plant breeding for greater food security, the sterile insect technique (SIT) to control insect pests, the effective management of water resources and life saving medical procedures.

Food and agriculture

In 2007, the Agency continued to assist Member States with tools for rapid diagnosis and protocols for animal disease early warning systems, holding regional training courses for technicians from laboratories in over 40 countries in Africa and Asia. The courses enhanced the capabilities of the diagnostic laboratories (established with the Agency's support during the FAO rinderpest campaign), increasing the use of nuclear and nuclear related molecular diagnostic technologies. The impact of such technologies was graphically demonstrated in the Rift Valley fever outbreak in Sudan in August 2007, when veterinary and human diagnostic laboratories played a key role in the diagnosis and control of the disease.

In Citrusdal, South Africa, the false codling moth is the most serious pest affecting the citrus export industry. In response, the citrus industry decided to integrate the use of SIT with other control tactics. A new mass rearing facility was constructed in 2007; Agency support included a technical cooperation project to procure rearing equipment and for the provision of a cobalt-60 source in a cost sharing agreement with Citrus Research International.

The Agency made progress in examining the feasibility of using SIT against the malaria transmitting mosquito *Anopheles arabiensis*. Sufficient information about the insect was collected to allow planning for a production facility and release strategy for control purposes in a selected area in Sudan. An Agency supported programme developed a conventional genetic strain that allows mass elimination of more than 99% of the females. Studies on sterilization and male competitiveness (i.e. sterilized males competing against wild males for wild females) in Sudan and in the Agency's Laboratories, Seibersdorf, demonstrated that good competitiveness can be accomplished using irradiated males. Sterilized marked males were released in Sudan in 2007 so that dispersal and survival could be studied.

In agriculture and food production, the Agency's technical cooperation and coordinated research projects supported more than 60 Member States in 2007 in the use of mutation induction, facilitated by biomolecular technologies, to enhance crops and improve food security. This led to the development of a series of novel mutant strains, such as salt tolerant rice, enhanced quality cassava and high yielding groundnut.

Management of water resources

Lack of freshwater constrains the development efforts of many Member States. Environmental scientists predict further impacts due to climate induced changes in precipitation and river flows. Member States continue to seek the Agency's assistance in using isotope techniques to manage their water resources.

The Agency made progress in its efforts to bring isotope hydrology into the mainstream of national and international water resource related programmes. An international symposium on advances in isotope hydrology, held in May in Vienna, reviewed Agency assisted projects in which isotope techniques were used for water resources management. Another initiative was the publication of an *Atlas of Isotope Hydrology for Africa* to provide Member States with an overview of isotopes in aquifer and river hydrology in 26 countries. In

addition, the Agency trained scientists from ten countries in Asia, Africa and Latin America in the use of a robust, low cost laser spectroscopy instrument for isotope analysis. This instrument, which the Agency helped test and adapt, is being provided to Member States through technical cooperation projects.

Human health

The Agency strengthened its collaboration with WHO, UNICEF and other partners in priority areas in nutrition. For example, WHO was assisted in the planning of a regional consultative meeting in October in Bangkok which provided technical guidance to Member States in the region on incorporating HIV/AIDS treatments into national nutrition policies and programmes.

The IAEA Nobel Peace Prize Cancer and Nutrition Fund 'School for Nutrition' for the Asia–Pacific region focused on interventions to combat undernutrition among infants and small children. Specifically, a 'nutrition school' held in Dhaka in April focused on applications of stable isotope techniques for use by nutritionists and other health professionals.

"Positron emission tomography (PET), ... is safe and non-invasive and is expected to have a ... major impact on understanding disease, ..."

Positron emission tomography (PET), a technology that allows direct observation of molecular interactions in the living body through radiotracer techniques, is safe and non-invasive and is expected to have a major impact on understanding disease, on disease detection and on drug development. At an Agency conference in Bangkok in November, participants were taken to the Chulaborn Cancer Centre's PET facility, where they interacted with leaders in the field and learned about the role of PET in cancer treatment.

Quality assurance programmes, including independent external audits which evaluate the quality of a hospital's radiotherapy treatment system, are important in maintaining the quality of radiotherapy practices. Through its technical cooperation programme, the Agency conducted six Quality Assurance Team for Radiation Oncology missions in 2007. A report was also published entitled *Comprehensive Audits of Radiotherapy Practices: A Tool for Quality Improvement*.

Statistics from WHO project that more than 84 million people will die of cancer over the next ten years, 75% of them in developing countries. With adequate funding and resources, however, more than 40% of all cancers can be prevented and 30% can be cured, if detected early and treated. In close collaboration with WHO and other international and national partners, the Agency continued to implement Model Demonstration Sites to develop multi-disciplinary cancer control capacity in Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen. These projects demonstrate the importance of comprehensive cancer control planning and the advantages of systematic, cross-sector collaboration in cancer care and public health.

By the end of 2007, the Agency's Programme of Action for Cancer Therapy (PACT) had secured donations exceeding $530 000, with additional pledges and pending grants in excess of $440 000, bringing funds raised by PACT since its inception to over $3 million. In December, the OPEC Fund approved a $7.5 million loan to fund cancer projects in Ghana on the basis of an 'imPACT review' — an assessment conducted by the Agency and its partners. Member States continued to support PACT, with more than 20 offering to make available their cancer treatment institutions, hospitals and educational centres for collaborative projects. In addition, the US based National Foundation for Cancer Research established an endowment for PACT to facilitate charitable contributions.

Marine environment

Interest in using nuclear techniques to monitor and preserve the marine environment, and maintain seafood safety, increased in 2007. Studies at the IAEA Marine Environment Laboratory (IAEA-MEL) in Monaco improved understanding of how cadmium, a toxic metal, accumulates in shellfish. Collaborating with FAO and WHO, the Agency used this new information in the international harmonization of standards for acceptable levels of cadmium in seafood to enhance food safety and facilitate international trade.

In cooperation with the Regional Organization for Protection of the Marine Environment, oil pollution, persistent organic pollutants and trace metals were investigated in organisms and sediments from seven countries surrounding the Gulf. A study on the effects of ocean acidification was initiated at IAEA-MEL. This initiative, which employs radioisotopes

of essential elements such as calcium and zinc to assess the effects of acidification on the growth and health of marine organisms, including commercial fish, responds to recommendations from the United Nations Inter-Governmental Panel on Climate Change for greater knowledge of the impacts of climate change on marine biodiversity.

Safety and Security

Global nuclear safety and security trends

The Agency continued to support national and international efforts for the safe and secure use of nuclear technology. Examples in 2007 included the publication of new safety requirements and guides, and the use of safety services to support the wider application of these standards.

While safety and security are primarily national responsibilities, failure can have far reaching consequences beyond national borders. In 2007, the nuclear industry continued to demonstrate a high level of safety and security around the world. There was consensus among States on the need to maintain vigilance in both areas, particularly in light of the renewed interest in nuclear power. The year also saw slow progress in the number of accessions and ratifications to the various safety conventions, which are important in improving safety performance and in raising public confidence.

"In 2007, the nuclear industry continued to demonstrate a high level of safety and security around the world."

The threat of nuclear terrorism remained a matter of concern to the international community. An international nuclear security framework has evolved from existing, strengthened and new international instruments. However, to be effective, more countries need to ratify and implement these instruments, particularly the Amendment to the Convention on the Physical Protection of Nuclear Material.

Agency safety standards and review services

The Commission on Safety Standards and the four Safety Standards Committees were reconstituted after the completion of their terms in 2007. The action plan approved by the Board of Governors in March 2004 was completed and continuous improvement in the quality of safety standards was noted by Member States. The long term vision for the structure of the safety standards is being prepared with the aim of better integration of the nuclear, radiation, waste and transport safety standards. In 2007, one Safety Requirements and ten Safety Guides were approved.

The Agency's safety review services use the safety standards as a reference point, and play an important part in evaluating their effectiveness. In 2007, the Agency received an increasing number of requests from Member States for independent safety and security assessments. In addition to requests for Operational Safety Review Team, International Nuclear Security Advisory Service and International Physical Protection Advisory Service missions, Member States requested other services from the Agency. For example, the Agency began to review new nuclear power plant designs against the safety standards.

During the year, the Agency completed the transition of all its regulatory review services to the Integrated Regulatory Review Service (IRRS). The IRRS is now widely recognized as the international mechanism for sharing regulatory knowledge and experience among senior regulators. In 2007, IRRS missions visited Australia, Japan and Mexico. In addition, limited scope missions to Algeria, Cameroon, Gabon, Kenya, Mauritius, Mongolia, Niger, Uganda and Uzbekistan advised on actions for improving regulatory systems.

At the request of the Government of Japan, the Agency sent an expert mission to the Kashiwazaki-Kariwa nuclear power plant following a strong earthquake there on 16 July 2007. The main findings of the mission and the initial lessons learned were widely shared and used to focus international cooperation in this area.

Control of radioactive sources

Two States made commitments to implement the Code of Conduct on the Safety and Security of Radioactive Sources, increasing the total number from 88 to 90. In June, technical and legal experts met to share their experience in implementing the Code and its supplementary Guidance on the Import and Export of Radioactive Sources. The meeting recognized that differences in the level of implementation of the Code's provisions among Member States were dependent on, inter

alia, facilities and services available to the persons authorized to manage the radioactive sources, training of staff in the regulatory body and law enforcement agencies, legislation and regulations on safety and security of radioactive sources, and financial resources.

Management of radioactive waste and decommissioning

There is growing international interest in the establishment of comprehensive national radioactive waste management policies and implementation strategies, as well as the necessary legal infrastructure, that will ensure that all radioactive waste is appropriately managed and that a safe solution can be found for the disposal of all types of radioactive waste. The concept of a common framework linking radioactive waste types to disposal options in a manner that follows international safety standards, with due regard for local circumstances, has been evolving for a number of years. The Agency completed three projects on the harmonization of safety assessment processes in 2007, focusing on near surface radioactive waste disposal facilities, demonstration of safety during decommissioning of nuclear facilities, and environmental modelling for radiation safety. These projects produced methods and parameters for use by those involved in preparing safety assessments.

Recognizing that the global volume of stored spent fuel and high level radioactive waste continues to increase, and expected storage periods continue to lengthen, the Agency conducted training courses through its Network of Centres of Excellence on Training and Demonstration in Underground Research Facilities on methodologies for the geological disposal of spent fuel and high level waste.

Governments are becoming increasingly aware of the need for early planning, adequate funding and long term strategies for decommissioning. There is now also a need for national and international mechanisms to preserve and maintain operational knowledge and decommissioning experience. Ten power plants around the world have been completely decommissioned, with their sites released for unconditional use, the latest two that were released in 2007 being the Big Rock Point and Yankee Rowe nuclear power plants in the USA. Seventeen plants were partially dismantled and safely enclosed. Thirty-two were being dismantled prior to eventual site release, and thirty-four reactors were undergoing minimum dismantling prior to long term enclosure. The main lessons learned were that proven and available decommissioning technologies are generally preferable to new and innovative technologies, and that flexible and graded approaches to the regulation of decommissioning are necessary and now need further development and support.

In September, the Agency launched a Network of Centres of Excellence for Decommissioning to improve the flow of knowledge and experience among those engaged in decommissioning and to encourage organizations in developed Member States to contribute to the activities of Member States requiring decommissioning assistance. Some 15 Member States expressed their willingness to host training and demonstration events.

Radiation protection of patients

The rapid growth in the number of positron emission tomography, computed tomography and other advanced medical imaging facilities over the past few years has led to an increase in the exposure of patients to radiation. To help Member States reduce unnecessary exposure of patients to radiation, the Agency completed three reports in 2007 on radiation protection measures for these newer medical imaging technologies.

Incident and emergency preparedness and response

Emergency preparedness is the key to mitigating the consequences of any radiation emergency, whether caused by accident or by a malicious act. In 2007, the Agency strengthened global emergency preparedness with new and revised safety standards and guidelines based on lessons learned from past responses. Agency seminars and training courses were held in many Member States. The Agency also conducted three Emergency Preparedness Review missions in 2007.

"Emergency preparedness is the key to mitigating the consequences of any radiation emergency, ..."

The Agency, together with the International Association of Fire and Rescue Services, Pan-American Health Organization and WHO, published a *Manual for First Responders to a Radiological Emergency*. The Agency also strengthened the

Response Assistance Network in 2007, which was set up to assist countries affected by a nuclear or radiological emergency.

Civil liability for nuclear damage

Implementation of the existing international nuclear liability instruments remained limited, mainly because many States are not parties to these instruments. Moreover, the compatibility of the provisions of the instruments and the relationships between them are complex. The International Expert Group on Nuclear Liability (INLEX), established by the Director General in 2003 to help clarify issues regarding these instruments, held its seventh meeting in June 2007. In addition to addressing possible gaps and ambiguities in the existing nuclear liability regime, INLEX reviewed deficiencies in insurance coverage and considered possible ways of increasing the amounts of nuclear liability coverage through voluntary international pooling of operators' funds.

Nuclear security

A number of trafficking and other security related incidents in 2007 served as a forceful reminder of the need for the international community to continue addressing the security of nuclear and other radioactive material. In 2007, the Agency gave high priority to assisting Member States in these efforts, primarily by organizing training courses, workshops and assistance missions.

"In 2007, the Agency supported Brazilian authorities in a project to ensure nuclear security at the Pan-American Games in Rio de Janeiro."

The Agency provided assistance for improved nuclear security arrangements in 19 States, mainly through enhanced physical protection measures and material accounting at facilities or locations, as well as through the movement of radioactive sources to secure locations and, from four States, through repatriation to the original State. Integrated Nuclear Security Support Plans (INSSPs) were initiated or established with 44 States to provide a long term work plan to address nuclear security issues. These plans are also a main vehicle for the Agency to facilitate coordination with bilateral support programmes and other international initiatives.

The capacity of nuclear regulatory authorities in ten countries was strengthened by the provision of inspection related equipment. Fifteen nuclear security missions were conducted in 2007, covering evaluation of national legal nuclear security systems, physical protection, radiation safety, the security of radioactive source infrastructures, and nuclear material accounting and control. The Agency strengthened border control capabilities in 20 States by providing over 850 radiation detection instruments. It also trained more than 1500 people in nuclear security related responsibilities.

Efforts to ensure the effectiveness and sustainability of improvements in nuclear security continued. Guidance collected in IAEA Nuclear Security Series publications served as an important benchmark for Member States. The Agency published two guides in 2007, on the protection of nuclear power plants against acts of sabotage and the identification of radioactive sources and devices.

Support to major public events and cooperation with international partners

In 2007, the Agency supported Brazilian authorities in a project to ensure nuclear security at the Pan-American Games in Rio de Janeiro. Brazilian personnel were trained in detecting hidden, undeclared radioactive material. The Agency donated, or provided on loan, some 200 radiation detection instruments for this purpose. Similar activities started in cooperation with the Government of China for nuclear security at the 2008 Olympic Games in Beijing.

The Agency convened an international conference in November entitled 'Illicit Nuclear Trafficking: Collective Experience and the Way Forward'. Some of the major findings were: that universal adherence to the Amendment to the Convention on the Physical Protection of Nuclear Material and other international legal instruments was essential to enhance nuclear security; advances in nuclear forensics technologies, which can be used to trace the origin of radioactive material, should be available to States that currently do not have access to them; greater sophistication was needed in strategies for implementing detection capabilities, particularly with regard to the risk posed by unguarded borders; and effective communication strategies were needed to avoid unduly adverse public reactions to nuclear or radiological incidents.

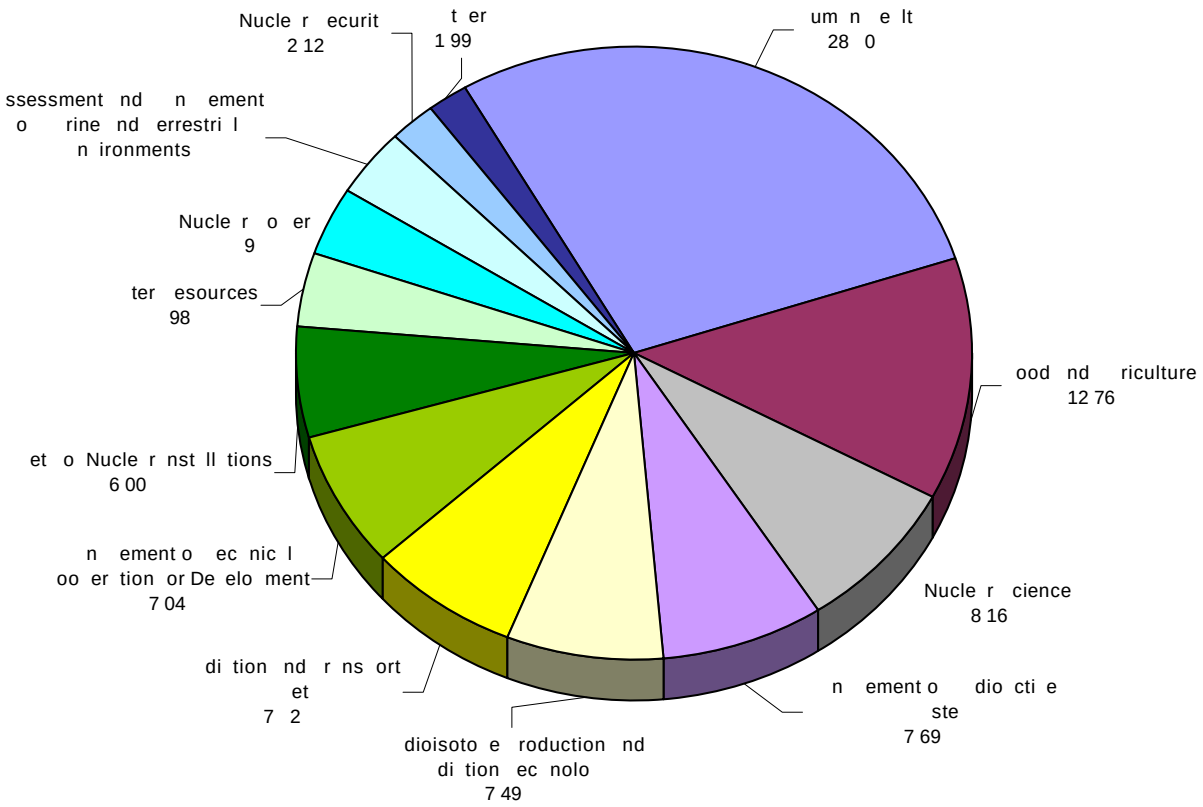


FIG. 2. Distribution of technical cooperation disbursements in 2007 by Agency programme.

Technical Cooperation

The Agency's technical cooperation programme is one of the principal mechanism for implementing the organization's basic mission. Covering all thematic areas of the Agency's activities, and consisting of national, regional and interregional projects, the programme develops human capacity and supports the building of infrastructure to ensure that nuclear technology is used in a safe, secure and peaceful manner.

Technical cooperation projects focus on areas identified by Member States as being of key importance to their development needs. In 2007, human health was the largest single area of the core programme, supporting the use of nuclear techniques for the prevention, diagnosis and treatment of disease, as well as for the improvement of nutrition, particularly of children. The second largest area was food and agriculture, where the objectives were to control insect pests and to improve livestock and crop production, making it more environmentally sustainable. Safety remained a central focus of the programme, with a large number of projects aimed specifically at radiation protection, nuclear installation safety and the safe management of radioactive waste. Water resources, research reactors and environmental protection were other important areas of activity (Fig. 2).

In Africa, for example, the Agency trained energy planning teams in Burkina Faso, Chad, Côte d'Ivoire, Mauritania and Niger in the preparation of national energy demand reports. In the Asia–Pacific region, the Agency assisted Member States in monitoring and assessing marine radioactivity. Up to 4300 data records on radioactivity levels in seawater, sediment and marine organisms were added to the Global Marine Radioactivity Database, which identified large scale oceanographic circulation processes and established benchmarks on radionuclide concentrations in the marine environment. In Latin America, the Agency's assistance covered training for medical physicists working in radiotherapy centres and delivery of specialized equipment. Twenty-four hospitals received equipment for the positioning and immobilization of patients and a number of centres in each of the participating countries were provided with updated reference material and guidance on the physical aspects of radiotherapy. In Europe, the Agency coordinated fuel repatriation and core conversion projects.

The programme is funded by contributions to the Technical Cooperation Fund (TCF), as well

as through other extrabudgetary contributions, government cost sharing and contributions in kind. Overall, new resources reached a total of around $100 million in 2007, with approximately $84 million for the TCF, $13 million in extrabudgetary resources and about $3 million representing in-kind contributions. These resources were applied directly to technical cooperation projects.

In 2007, approximately $94 million was disbursed to over 121 countries. One hundred and sixty training courses were arranged for 2287 participants, 3546 expert missions were organized, 1661 fellows and scientific visitors were trained, and equipment and supplies worth $47 million were provided.

Verification

A major pillar of the Agency's programme provides assurances to the international community regarding the peaceful use of nuclear material and facilities. The Agency's verification programme thus remains at the core of multilateral efforts to curb the proliferation of nuclear weapons.

"A major pillar of the Agency's programme provides assurances to the international community regarding the peaceful use of nuclear material and facilities."

At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force, based upon the evaluation of all information available to it for that year. For a 'broader conclusion' to be drawn that '*all* nuclear material remained in peaceful activities', both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) must be in force, and the Agency must have been able to conduct all necessary verification and evaluation activities. For States that have CSAs in force but no APs, the Agency does not have sufficient tools to draw safeguards conclusions regarding the absence of undeclared nuclear material and activities. For such States, the Agency draws a conclusion, for a given year, with respect to whether *declared* nuclear material remained in peaceful activities.

For those States for which the broader conclusion has been drawn and a State level integrated safeguards approach has been approved, the Secretariat is able to implement integrated safeguards — the optimum combination of all safeguards measures available to the Agency under CSAs and APs to achieve maximum effectiveness and efficiency in meeting the Agency's safeguards obligations.

Safeguards conclusions for 2007

In 2007, safeguards were applied for 163 States with safeguards agreements in force with the Agency.[4] Eighty-two States had both CSAs and APs in force. For 47 of these States,[5] the Agency concluded that *all* nuclear material remained in peaceful activities. For 15 States this conclusion was drawn for the first time. For 35 of the States, the Agency had not yet completed all the necessary evaluations under their APs, and concluded that the *declared* nuclear material remained in peaceful activities. For 72 States with CSAs in force but without APs, the Agency was able to draw the conclusion that declared nuclear material remained in peaceful nuclear activities.[6]

For three States that had item specific safeguards agreements in force in 2007, the Secretariat concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities. Safeguards were also implemented with regard to declared nuclear material in selected facilities in four of the five nuclear weapon States, all of which have voluntary offer safeguards agreements in force. For these four States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities or was withdrawn as provided for in the agreements.

The Secretariat could not draw any safeguards conclusions for 30 NPT non-nuclear weapon States without safeguards agreements in force.

Integrated safeguards were implemented during 2007 in 14 States, while implementation began in another seven States. In addition, integrated safeguards approaches were developed and approved for five States.

[4] The status with regard to the conclusion of safeguards agreements, APs and small quantities protocols is given in Table A6 in the Annex to this document.

[5] And Taiwan, China.

[6] The 72 States do not include the Democratic People's Republic of Korea as the Agency was not able to implement safeguards in that State and, therefore, could not draw any conclusion.

Conclusion of safeguards agreements, additional protocols and small quantities protocols

In 2007, the Secretariat convened an interregional seminar in Vienna for NPT State parties without the required safeguards agreements. Consultations on the amendment of small quantities protocols (SQPs) and the conclusion of APs were held during the year. The Agency also convened regional technical seminars on implementation of APs in Gaborone, Botswana, and in Sydney, Australia.

Additional protocols entered into force for eight States in 2007, bringing the number of States with APs in force to 86. One State concluded a CSA in accordance with its obligation under the NPT. Three States acceded to the safeguards agreement between non-nuclear-weapon States of Euratom, Euratom and the Agency, as well as the AP thereto. A safeguards agreement based on the Tlatelolco Treaty and the protocols thereto entered into force for one State and an item specific safeguards agreement entered into force for another State.

Following a decision by the Board of Governors in 2005, the Agency initiated exchanges of letters with all States having an SQP in order to give effect to the modifications in the standard text and the change in the SQP criteria. During 2007, SQPs were amended to reflect the modified text for four States. An SQP was rescinded and a new safeguards agreement with a modified SQP was concluded. By the end of 2007, there were 69 States with operative SQPs still requiring modification in accordance with the Board's decision.

"Following agreement in the 'Six Party Talks' process, the Agency reached agreement with the Democratic People's Republic of Korea on monitoring and verification arrangements ..."

Verification of nuclear non-proliferation

The issue of nuclear non-proliferation continued to attract the attention of the international community and the media. Following agreement in the 'Six Party Talks' process, the Agency reached agreement with the Democratic People's Republic of Korea on monitoring and verification arrangements related to the shutdown of the Yongbyon nuclear facility and was able to confirm the shutdown status of these installations.

Another verification issue of interest to the international community was the implementation of the NPT safeguards agreement in the Islamic Republic of Iran and relevant provisions of United Nations Security Council resolutions 1737 (2006) and 1747 (2007). The Agency continued to verify the non-diversion of the declared nuclear material in Iran in 2007. However, the Agency was not in a position to provide credible assurance regarding the absence of undeclared nuclear material and activities in Iran. By the end of 2007, the Agency was able to clarify some of the outstanding safeguards issues relating to Iran's past nuclear activities. Contrary to the decisions of the Security Council, Iran did not suspend its uranium enrichment related activities and continued its heavy water related projects.

Strengthening the effectiveness and improving the efficiency of safeguards

In 2007, further progress was made in strengthening the effectiveness and improving the efficiency of Agency safeguards. Enhancements were made to the implementation of integrated safeguards, the development of safeguards approaches, procedures and technology, cooperation with State and regional systems of accounting for and control of nuclear material, training and quality management.

Research and development activities carried out with the assistance of Member State support programmes are essential to meet the safeguards challenges of the future. An R&D programme for 2008–2009, containing 23 projects in areas such as the development of safeguards concepts, information processing, and analysis, verification technologies and training, was prepared. In addition, meetings and workshops were held to identify tools that would be needed by the Agency to carry out its mission in the future.

The Agency continued to expand its remote monitoring capabilities, which resulted in enhanced effectiveness and efficiency of safeguards implementation. Also, new safeguards approaches based on unannounced inspections for verification of spent fuel transfers allowed savings of approximately 30% in the inspection effort involved in such verifications in 2007.

A special Safeguards Analytical Laboratory (SAL) Study Group, established in 2007 by the Director General, recommended that SAL be reconstructed, advance instrumentation for environmental sample analysis be installed, and the Network of

Analytical Laboratories be further utilized. The Board of Governors expressed its support for independent and timely analysis of safeguards samples and encouraged Member States to provide extrabudgetary support.

Committee 25

A committee established by the Board of Governors to consider ways to strengthen the effectiveness and efficiency of the safeguards system presented its report to the Board in June 2007. Member States reaffirmed their commitment to strengthening the effectiveness and efficiency of the Agency's safeguards system as an important tool for meeting nuclear non-proliferation challenges.

Management Issues

In July, the tenth Senior Management Conference took place. These annual two day meetings have given senior Secretariat staff the opportunity to step back and look at the broader, one-house, picture of the Agency's overall programme and operations. The ultimate purpose has been to bring about improvements in the effectiveness of programme delivery to Member States. The 2007 session focused on the interrelated topics of accountability and risk management. Among the practical outcomes from the conference was the planning of a formal 'foresight' or 'vision' process to produce for Member States more firmly based predictions on the future direction of the programme and the corresponding funding requirements. At year's end, the process was well under way.

Technology

Nuclear Power

Objective

To enhance the capability of interested Member States, in a rapidly changing market environment, to improve nuclear power plant operating performance, life cycle management including decommissioning, human performance, quality assurance and technical infrastructure, through good practices and innovative approaches consistent with global objectives on non-proliferation, nuclear safety and security; to enhance the capacity of Member States for the development of evolutionary and innovative nuclear system technology for electricity generation, actinide utilization and transmutation and for non-electric applications, consistent with sustainability goals; and to encourage the improvement of public understanding of nuclear power.

Establishing an Appropriate Infrastructure for Introducing Nuclear Power

In response to growing interest among Member States in the steps necessary to initiate a nuclear power programme, the Agency published a brochure — *Considerations to Launch a Nuclear Power Programme* — that summarized the infrastructure issues associated with the introduction of nuclear power. The brochure was followed by the publication of *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1), which provides a more detailed description of the infrastructure issues to be addressed during each of the three successive phases of the programme's development. Figure 1 lists 19 issues for which the publication describes milestones.

The Agency held a workshop in November in Vienna focusing on the importance of comprehensive infrastructure development to the overall success of a nuclear power programme and its particular impact on reducing investment risks, and on actions that might improve financing prospects. In addition, the Agency conducted several multidisciplinary missions to Member States planning the introduction of nuclear power. These missions have shown that an integrated approach and strong government commitment can help build confidence among the international community in emerging nuclear programmes and can also attract support from others. It is also clear that infrastructure planning must be carried out in the context of a national strategy, taking into account existing institutions, resources and stakeholders. In this regard, under its technical cooperation programme, the Agency provides assistance to Member States which have plans to introduce nuclear power in the preparation of their comprehensive work plans that address issues such as project management, energy planning, safety and legal frameworks, and site evaluation.

Nuclear Power Plant Operating Performance and Life Cycle Management

Three quarters of the world's nuclear power plants are more than 20 years old. Although the typical design life of a nuclear power plant is 30–40 years, it is possible to extend design lives to 60 years, and perhaps longer. Plant life management programmes help operators plan in advance for the challenges of modernization, refurbishment and maintenance. In addition to extending plant life, a number of operators are also uprating the power level at which plants are operated. In this regard, the Agency's second international symposium on 'Nuclear Plant Life Management', held in Shanghai in October, served to exchange information between experts from different countries and organizations dealing with operations and nuclear power plant components. The participants emphasized that the effects of extended operations and power upratings on power plant systems, structures and components must be continually reanalysed for safety and for system optimization. Other issues highlighted were the importance of easy access for inspections, and the need for designs that facilitate easy inspections and component replacement.

"Three quarters of the world's nuclear power plants are more than 20 years old."

Modernization of instrumentation and control (I&C) systems is a major issue for nuclear power plants worldwide. The introduction of digital technologies brings new challenges both in licensing and operation. The Agency held technical meetings on integrating hybrid analogue–digital control rooms, potential common cause failure in digital I&C systems, digital I&C system licensing and I&C

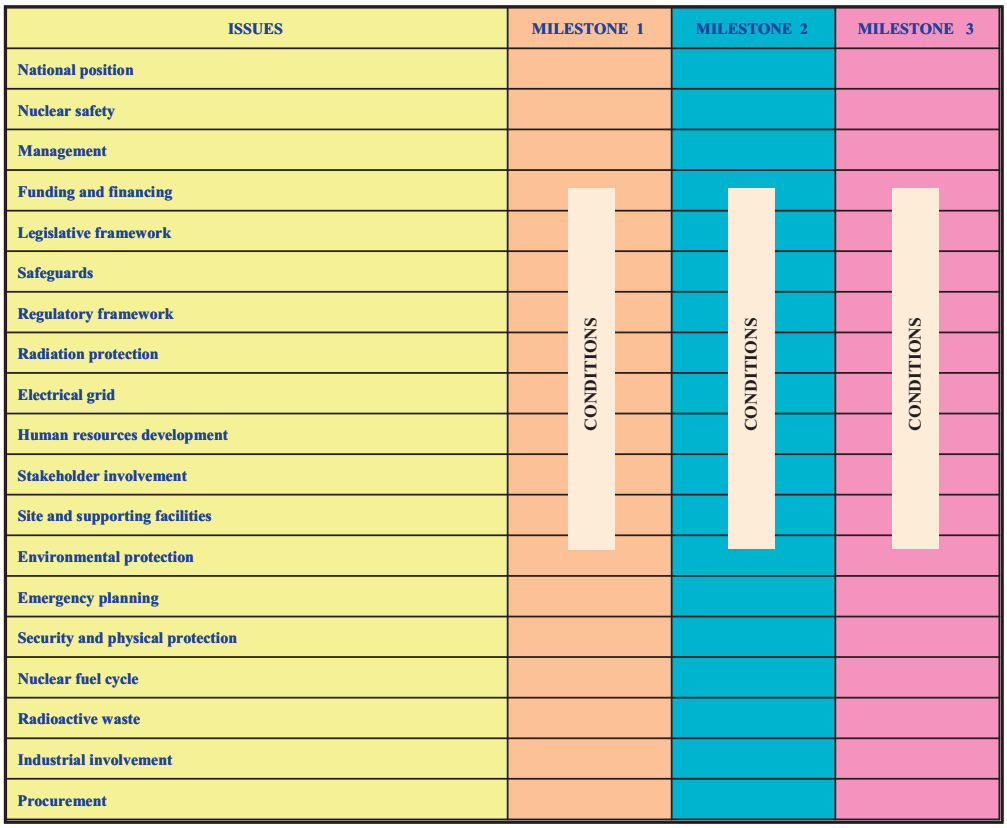


FIG. 1. A diagram from IAEA Nuclear Energy Series No. NG-G-3.1 on the issues and milestones to be considered for the introduction of nuclear power.

modernization for power uprates. Three reports were completed on the role of I&C in power uprating and on-line monitoring for improved performance and component diagnostics. The technical meetings raised awareness of the potential benefits and challenges of using digital I&C systems in functions critical to plant safety, since they significantly improve automation, human–system interfaces, on-line monitoring, nuclear safety, and power production. However, this is a relatively new technology in nuclear power plants, and its application in functions that are critical to plant safety requires significant verification, validation, testing and licensing. The reports detail the benefits of on-line monitoring and offer recommendations on how to take full advantage of these benefits. They also detail, for power uprates, the potentially adverse impacts (e.g. accelerated fatigue, ageing or corrosion effects, or excessive vibration) that need to be analysed in advance and carefully monitored during implementation.

Optimization of nuclear power plant maintenance can lead to improvements in safety, reliability and cost. The results of a CRP involving 13 organizations operating WWER-4400/1000 nuclear power plants were published in *Strategy for Assessment of WWER Steam Generator Tube Integrity* (IAEA-TECDOC-1577). While maintaining high safety levels, the strategy is designed to reduce shutdowns and the number of tubes requiring plugging, improve understanding of tube integrity and speed information sharing. Another maintenance optimization report published in 2007, *Implementation Strategies and Tools for Condition Base Maintenance at Nuclear Power Plants* (IAEA-TECDOC-1551), describes strategies to optimize the scheduling and performance of plant maintenance based on continual monitoring of plant conditions.

The Agency helped enhance equipment reliability in Mexico's Laguna Verde nuclear power plant through a technical cooperation project on modernization of the plant's preventive maintenance programme. As a result of implementing new methods of analysis and preventive maintenance techniques, the plant has seen improvements in safety, reliability and operational costs.

Improving Organizational Performance

A technical meeting was held in March to discuss the new Agency safety standards on management systems and the practical application of integrated management systems. The meeting identified

areas in which the Agency is expected to provide additional support to Member States on how to implement the new set of relevant safety standards. A joint IAEA–FORATOM workshop was organized in November to promote these new standards and to provide information on the transition from a traditional quality assurance approach to an integrated management system.

Technology Development

The Agency's role in technology development is to provide an international forum for the exchange of ideas and information, and to provide training and facilitate technology transfer. These activities are undertaken through technical working groups (TWGs) and CRPs.

The majority of currently operating nuclear power plants are water cooled, and it is anticipated that the near term growth of nuclear power will be based on water cooled reactor technology. The Agency's TWGs on LWRs and HWRs recommended additional work on simulators, and noted progress towards the planning, licensing and construction of evolutionary designs with passive safety features. Innovative systems are under development in several countries. The TWGs also recommended:

— Compilation of information on construction technologies for water cooled reactors;
— Updating of the Agency's status report on advanced LWR designs;
— Preparation of a report on the status of the supply chain for HWRs addressing resources, fuel fabrication, and the supply of heavy water and major equipment.

Following a recommendation of the Technical Working Group on Gas Cooled Reactors, the Agency organized a meeting in Vienna in December to review cost analysis software developed through the Generation IV International Forum (GIF). The meeting concluded that GIF's 'G4Econs' code was the most appropriate software for analysing both electricity generation costs and process heat production costs for HTGRs. As a result, the Agency will: provide training to allow users to perform calculations on a national or regional basis, provide a forum to review the results of those calculations and provide feedback on the lessons learned to the code originators.

"The Agency's role in technology development is to provide an international forum for the exchange of ideas and information, and to provide training and facilitate technology transfer."

The development of the technical rationale for a nuclear power programme, including the level of local industrial participation, fuel cycle policy and site selection, is an important factor in the decision to set up such a programme. The Agency held a workshop on nuclear power plant technology assessment to discuss assessment approaches and economic evaluation methods, and to share experiences and lessons learned in technology selection.

In cooperation with the Japan Atomic Energy Agency and OECD/NEA, the Agency organized an international conference on 'Non-electric Applications of Nuclear Power: Seawater Desalination, Hydrogen Production, District Heating and Other Industrial Applications', which was held in April in Oarai, Japan. The conference reviewed case studies on applications of nuclear heat for desalination, hydrogen production and enhanced use of fossil fuel resources (e.g. coal liquefaction or enhanced oil recovery from tar sands). In addition, two technical documents on desalination case studies were published.

The Agency carries out studies on small and medium size reactors appropriate for smaller grids, including those in developing countries. A new report entitled *Status of Small Reactor Designs without On-site Refuelling: 2007* summarizes the common design objectives and considerations for reactors that have very long lifetime cores. The report provides information on important development trends and objectives for small reactors, on the state of the art concerning their design and technology development, on their design status, and on possible applications.

Owing to its potential in both closing the fuel cycle and making more efficient use of resources, fast reactor technology and fuel cycles continue to be of great interest. The Agency published a technical report entitled *Liquid Metal Cooled Reactors: Experience in Design and Operation* (IAEA-TECDOC-1569) to preserve the knowledge gained over the past five decades in the development, design, operation and decommissioning of these reactors. With regard to fast reactor fuel cycles, the Agency concluded a CRP on advanced reactor technology options for the effective incineration of radioactive waste, in which the transient behaviour of various transmutation systems was studied. The CRP completed benchmarking exercises focusing

on eight innovative transmutation systems with different critical and subcritical concepts, including critical fast reactors, accelerator driven systems and fusion/fission hybrid systems. The CRP included analyses of neutronics and transient behaviour in systems to incinerate minor actinides.

International Project on Innovative Nuclear Reactors and Fuel Cycles

At the end of 2007, the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) had 28 members, and two additional countries had announced their intention to join. Seven volumes of the INPRO *Methodology Manual* were published, providing recommendations on the application of the methodology in such areas as economics, the environment, infrastructure, waste management and proliferation resistance. The methodology is being used in assessments in a number of Member States and by the European Commission. A joint assessment of a closed fuel cycle with fast reactors is being conducted by various Member States. The July 2007 meeting of the INPRO Steering Committee approved 14 collaborative projects on nuclear power for small countries, nuclear fuel cycle issues, environmental impacts, safety issues, proliferation resistance, non-stationary nuclear power plants and the architecture of future innovative nuclear systems.

A workshop held in November in Vienna reviewed common user expectations for nuclear power plants among interested developing countries. It discussed future activities in line with the INPRO objective to be a forum for joint deliberations by technology holders and users. The workshop report addressed the technical and economic characteristics of nuclear plants to be deployed by developing countries, and of associated activities such as fuel cycle options, services and support.

Nuclear Fuel Cycle and Materials Technologies

Objective

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

Uranium Production Cycle and the Environment

Analysis and exchange of information on uranium resources, production and demand in Member States are essential for the steady supply of uranium fuel for nuclear power plants in operation and under construction. Information as of 1 January 2007 shows an increase of 15% over 2004 levels in identified uranium resources (i.e. those resources with production costs of less than $130 per kg U) to 5.5 million tonnes, which is sufficient, at the 2006 consumption rate, for almost 100 years. Total world production remained at a similar level to that reported last year (around 40 000 tonnes; Fig. 1) and accounted for some 60% of the annual uranium demand of 66 500 tonnes. The uranium market remains uncertain in the medium term due to continuing limited information on available secondary supplies and on new uranium production centres. In the second half of the year the spot price for uranium dropped from the peak it reached in June of $135 per lb U_3O_8 ($351 per kg U) and became more stable at around $90 per lb U_3O_8 ($234 per kg U). Exploration activities continued to increase worldwide, stimulated by the strong price increase.

The increasing interest in uranium production pushed up demand for skilled labour and for information exchange, and produced a large increase in related technical cooperation proposals to the Agency for implementation in 2009–2011. In 2007, these proposals were reviewed and ten were selected for implementation in Africa, Latin America and Asia. Also in 2007, the Agency organized two training meetings in Vienna covering special mining and milling technologies and recent developments in uranium exploration. A third training meeting was held in Swakopmund, Namibia, at which issues related to the uranium production cycle, for example mining technology and environmental control, were discussed for the benefit

"The increasing interest in uranium production pushed up demand for skilled labour and for information exchange,..."

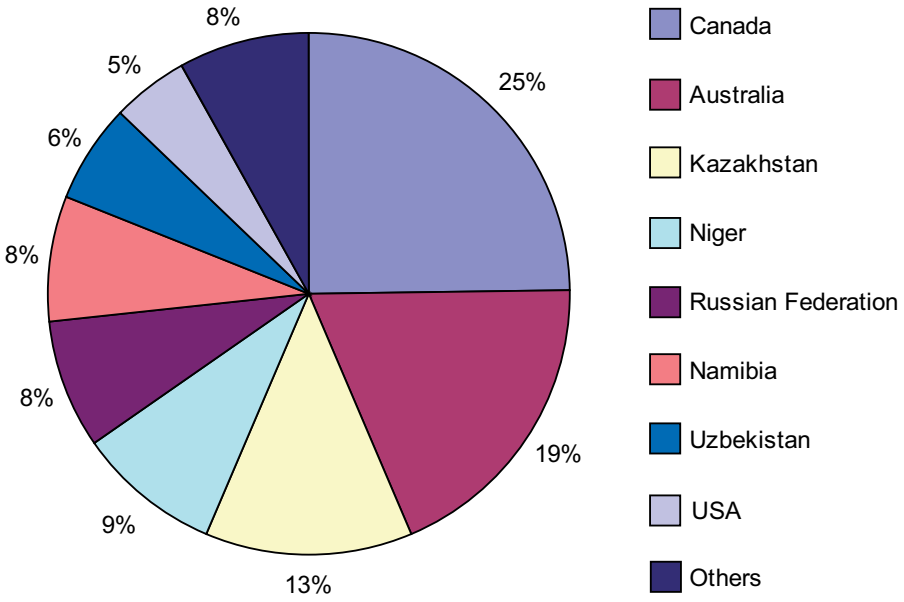


FIG. 1. Uranium production by country in 2006 (total 39 600 t U).

FIG. 2. Participants at a technical meeting in Halden examining fuel rod instrumentation.

of African Member States. Through the technical cooperation programme, the Agency also provided China and Egypt with advice on methods for uranium exploration.

Nuclear Power Reactor Fuel Engineering

Several Agency activities during the year addressed fuel performance. A technical meeting held in Halden, Norway, in September considered techniques for fuel research and highlighted the methods and instrumentation used to obtain fuel performance data during reactor operation (Fig. 2). Such data were used in a CRP on fuel modelling at extended burnup (FUMEX-II), which was completed in 2007. The results show that modern fuel performance codes generally perform well at burnups up to around 70 GW·d/t U, and there are satisfactory predictions of fission gas release from most codes.

Initial results in 2007 from a CRP on fuel and water chemistry (FUWAC) have clarified the causes and conditions for crud formation on fuel in WWER and LWR systems, and of boron deposition in such crud. This will help operators better manage water chemistry in their reactors, since changes in water chemistry influence both fuel oxidation rates and the migration of corrosion products from steam generators to the fuel, where they can accumulate and lead to fuel failures.

Spent Fuel Management

Annually, some 10 500 tonnes of heavy metal in the form of spent nuclear fuel is discharged from operating nuclear power reactors. The management of this spent fuel is an important factor influencing the future of nuclear energy, and deals with issues related to long term interim storage and spent fuel treatment. Less than 20% is currently reprocessed, and no final repositories are scheduled to open much before 2020 — and then only in a very few countries. As the amount of spent fuel in storage climbs steadily, so does the need for efficient management of all issues related to the long term interim storage of spent fuel. Five Agency reports issued in 2007 provide insights and advice on such storage issues.

'Burnup credit' refers to a refinement of the traditional assumption in criticality safety analyses that spent fuel has the same reactivity as fresh fuel. Spent fuel in fact has less reactivity, depending on its burnup. Taking burnup into account reduces unnecessary over-design. The reports published in 2007 present methods for incorporating burnup credit in analyses, identify areas where international cooperation would be especially valuable in improving methods and make the case for developing international guidelines.

The reports also present methods for choosing, in any given situation, the best long term and near term strategies, the best casks for storage and transport, the best storage options and the best approach to contract management. They also present design approaches to improve cask performance while recognizing that different designs are needed in different situations. They emphasize the increasing value of fuel data so that fuel can be managed most efficiently at all steps of its life cycle, for example through zoned cask loading where cooler spent fuel is positioned to shield hotter fuel.

Topical Advanced Nuclear Fuel Cycle Issues

In 2007, activities covered the fuel and fuel cycle issues of fast reactors and high temperature gas cooled reactors (HTGRs), partitioning and transmutation, burning plutonium and minor actinides in fast reactors, reuse options of reprocessed uranium, thorium utilization and issues related to proliferation resistance in the nuclear fuel cycle. Assistance was provided on fuel cycle issues through the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles.

Technical reports were compiled in cooperation with experts from Member States in the areas of fast reactor fuel technology, the back end of the fast reactor fuel cycle and the current status of and future trends in minor actinides. The reports cover state of the art information on plutonium and minor actinide bearing oxide, carbide, nitride and metallic fuels for fast reactors, their fabrication, properties and irradiation behaviour and aqueous and pyroelecrolytic routes for partitioning of spent fast reactor fuels. The reuse options of the increasing quantities of reprocessed uranium were summarized in *Management of Reprocessed Uranium: Current Status and Future Trends* (IAEA-TECDOC-1529), which was published in February.

In the area of HTGR research, the Agency, in collaboration with the European Commission and the ReActor for Process heat, Hydrogen And ELectricity generation (RAPHAEL) group, conducted a course in December on coated particles in Petten, the Netherlands. The course trained graduate students and young researchers in fuel design, fabrication, characterization techniques, irradiation and post-irradiation examination, and waste processing and storage, for coated particle fuel used in high temperature reactors.

Member State interest in using thorium based fuels is increasing, and a technical meeting on thorium fuel cycle options for PHWRs, LWRs and HTGRs was held in October at the Çekmece Nuclear Research and Training Centre, Istanbul. Information was exchanged on thorium availability, processing thorium ores, manufacturing, and proliferation resistance issues of the thorium fuel cycle.

"Member State interest in using thorium based fuels is increasing, ..."

Integrated Nuclear Fuel Cycle Information System

Interest in the Agency's databases and simulation systems in the area of the nuclear fuel cycle continues to increase. Registered users increased in 2007 by some 25%. The databases that provide information on worldwide nuclear fuel cycle activities include the Nuclear Fuel Cycle Information Systems, World Distribution of Uranium Deposits, Post-irradiation Examination Facilities Database, Minor Actinide Property Database and Nuclear Fuel Cycle Simulation System (formerly known as VISTA). A web based application has been developed for using NFCSS through the Internet. All databases and NFCSS applications are available at *http://www-nfcis.iaea.org/*.

Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development

Objective

To enhance the capacity of Member States to perform their own analyses of electricity and energy system development, energy investment planning and energy–environment policy formulation and their economic implications; to sustain and effectively manage nuclear knowledge and expertise; and to enhance information and knowledge resources on the peaceful uses of nuclear science and technology serving the needs of Member States and the Secretariat.

Energy Modelling, Databanks and Capacity Building

The rising expectations for the future contribution of nuclear power were reflected in the Agency's 2007 projections for nuclear power development in the world. Table 1 shows the low and high estimates of nuclear power capacity for various regions. The low estimates include only firm plans by governments and power utilities for construction of new nuclear power units and life extensions of existing units, adjusted for the planned retirements of units. According to these low estimates, the global nuclear power capacity will increase to 447 GW(e) in 2030, compared with 370 GW(e) at the end of 2006. In the high estimates, which include additional nuclear power units suggested by the long term plans of governments or utilities, global nuclear power capacity is expected to reach 691 GW(e) in 2030. The largest increase is estimated for the Far East region, where even in the low case about 55 GW(e) of new nuclear power capacity is expected. In the high case, this additional capacity would be over 100 GW(e).

In 2007, steps were taken by Member States interested in making use of nuclear power for meeting their future needs. The Agency received national and regional requests, involving more than 70 countries, for technical assistance in conducting energy planning studies. Currently, through the technical cooperation programme, such studies are being supported in 77 countries, of which 29 are evaluating the nuclear power option.

The Agency develops and transfers to interested Member States analytical tools for energy assessments, with emphasis on building local capabilities for the application of these tools in national energy studies. During 2007, 22 regional and national training events were organized through which 429 energy analysts and professionals received training (see Fig. 1). Ten fellows were also hosted at the Agency.

A pilot project was successfully completed in 2007 for a new distance learning service that features an Internet training package. This included an e-training course using the Asian Network for Education in Nuclear Technology (ANENT) platform. Based on this experience, distance learning will be expanded

TABLE 1. NUCLEAR POWER CAPACITY PROJECTIONS: LOW AND HIGH ESTIMATES

Country group	2006	2010		2020		2030	
		Low	High	Low	High	Low	High
North America	112	114	115	125	132	129	168
Latin America	4	4	5	8	8	9	19
Western Europe	123	121	122	91	131	71	149
Eastern Europe	47	48	49	70	85	81	111
Africa	2	2	2	3	5	3	12
Middle East and South Asia	4	10	11	16	27	21	46
South East Asia and the Pacific					1	1	7
Far East	78	79	82	112	136	133	179
World total	370	378	386	425	525	447	691

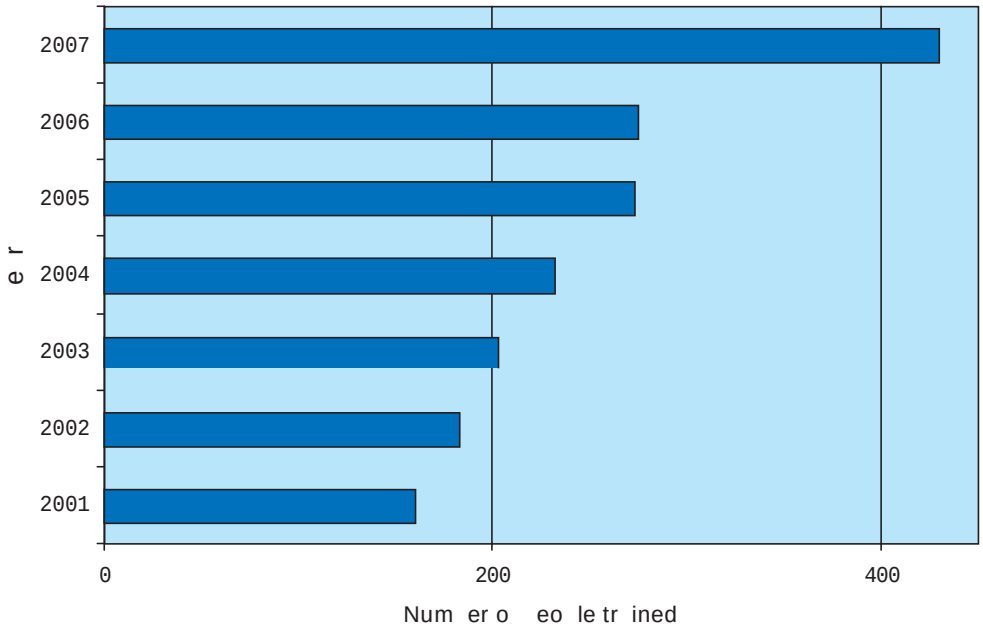


FIG. 1. Agency training of professionals in Member States in energy system planning and analysis and in the use of its models (2001–2007).

to reach more energy analysts and professionals in Member States.

Energy Economy Environment (3E) Analysis

The year 2007 saw new scientific and policy developments that facilitated a better understanding of global climate change, with crucial implications for nuclear power. In the scientific area, for example, the Intergovernmental Panel on Climate Change completed its Fourth Assessment Report, to which the Agency contributed as a member of several working groups. These groups: confirmed the increasing anthropogenic influence on the climate system due to the emission of greenhouse gases (GHGs), the bulk of which originate from the burning of fossil fuels; presented discernible impacts of climate change, particularly in sensitive ecological systems; analysed the vulnerability of societies and ecosystems to changing climatic conditions; identified adaptation options and their limitations; and concluded that beyond certain magnitudes of climate change adaptation possibilities become exceedingly expensive or vanish altogether. This calls for a drastic reduction of GHG emissions (about 50% globally by 2050), and greatly increases the importance of low carbon energy technologies such as nuclear power. The groups also found that in the power sector, over the time horizon to 2030, nuclear energy has the largest mitigation potential in terms of emissions avoided at the lowest average social cost globally. A comprehensive survey of technological assessment studies concluded that nuclear power (together with hydro and wind power) generates the lowest lifetime GHG emissions per unit of electricity generated.

"A comprehensive survey of technological assessment studies concluded that nuclear power (together with hydro and wind power) generates the lowest lifetime GHG emissions per unit of electricity generated."

On the policy side, parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Bali Action Plan at the 13th Conference of the Parties (COP-13) in December. This document frames a two year process to finalize and adopt a post-2012 global climate agreement, including GHG emission reduction arrangements. The Agency arranged a side event at COP-13 to provide information about the potential role of nuclear power in GHG mitigation and about its services to interested Member States for analysing the nuclear option as part of their national energy planning. The Agency also assisted the UNFCCC Secretariat in preparing background documents for the negotiators.

At the 15th session of the Commission on Sustainable Development (CSD-15), focusing principally on energy, three publications were released for which the Agency was an author jointly

with other international organizations (i.e. UNDESA, UN-Energy and the World Bank). The first, *Assessing Policy Options for Increasing the Use of Renewable Energy for Sustainable Development: Modelling Energy Scenarios for Sichuan, China*, presents results using the Agency's energy analysis models. The second was *Energy Indicators for Sustainable Development: Country Studies on Brazil, Cuba, Lithuania, Mexico, Russian Federation, Slovakia and Thailand*, while the third was entitled *Energy for Sustainable Development: Policy Options for Africa*.

Nuclear Knowledge Management

In June, the Agency hosted an international conference in Vienna on 'Knowledge Management in Nuclear Facilities'. The main areas covered were the role of knowledge management in the safe operation of nuclear power plants, knowledge management's contribution to gains in operating economics and performance, the preservation of existing knowledge and its use in relation to future innovations, and the smooth and effective transfer of knowledge to the next generation. The main conclusions were the importance of the human factor in knowledge management for issues relating to nuclear safety and security, and the need for nuclear knowledge management to be an integral part of all nuclear activities at the project, corporate and national levels.

Providing training in nuclear knowledge management methodology continued to be a high priority. The annual school of nuclear knowledge management at the Abdus Salam ICTP in Trieste provided 34 participants with an overview and basic understanding of the tools, mechanisms and challenges of nuclear knowledge management. In addition, the Agency supported the 2007 World Nuclear University Summer Institute by funding the participation of 24 candidates from developing countries. Regional workshops on nuclear knowledge management were also hosted by Germany, Japan and the Russian Federation.

In order to enhance the methodology and guidance for nuclear knowledge management, the Agency completed a report on *Web Harvesting for Nuclear Knowledge Preservation*. In addition, special publications on *The World Nuclear University: New Partnership in Nuclear Education* and *Asian Network for Education in Nuclear Technology (ANENT): IAEA Activities and International Coordination* were issued.

The methodologies developed by the Agency were applied through knowledge management assistance visits to the Darlington and Bruce nuclear power plants in Canada, and to the Ignalina nuclear power plant in Lithuania. An important element of the visits was the guided self-assessment, through discussions with the Agency expert team, of the risks involved when knowledge is lost.

The Agency's services to Member States in the area of knowledge management were channelled through ongoing technical cooperation projects. For example, Kazakhstan received assistance in the development of a national concept on nuclear knowledge management. A regional technical cooperation project for Europe on strengthening capabilities for nuclear knowledge preservation supported an expert meeting on the development of a knowledge portal for nuclear power plants and the conceptualization of a guidance document on conducting knowledge management assistance visits. A meeting of national coordinators for a regional project in support of ANENT, held in Goa, India, assisted in the development of the ANENT cyber education platform and planned future activities.

International Nuclear Information System

INIS continues to play an important role in nuclear information management and preservation and remains the single source of nuclear information for some Member States. The addition of Seychelles in 2007 brought the INIS membership to 141 (118 countries and 23 international organizations).

As with other knowledge management activities, the Agency supported INIS Member States through its technical cooperation programme. In 2007, several national INIS centres were established or reactivated. New national centres were launched in Burkina Faso, Kenya, Niger and Uzbekistan. Assistance was provided to Qatar to reactivate its national INIS centre, and a national training course on INIS was conducted in Ghana. Also, a multilingual thesaurus was completed in 2007 and distributed among Member States in seven languages — the six official Agency languages and German.

The Agency continued efforts to expand free access to the INIS database for universities. In 2007, a total of 354 universities in 63 Member States were granted free access to INIS bibliographic and full text information through the Internet.

Nuclear Science

Objective

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

Atomic and Nuclear Data

The Agency maintains an extensive collection of nuclear, atomic and molecular databases that are available to all Member States through both on-line and traditional services. In this connection, four new CRPs were initiated in 2007. The first one is on establishing a recommended numerical database for processes important for modelling heavy elements in nuclear fusion reactor plasmas. The second one focuses on generating data relevant to erosion processes in fusion devices, with the goal of understanding how plasma constituents interact with the solid wall materials of fusion devices, leading to erosion and re-deposition of these materials. Such understanding and control are crucial for achieving fusion energy. The third CRP has the goal of assembling and evaluating neutron cross-section data for important minor actinides. These data are of great value for innovative reactor design. The fourth CRP is on improving the quality of heavy charged particle interaction data for patient dose delivery calculations in radiotherapy.

The Agency's Reference Input Parameter Library (RIPL), which has become a standard source of input data for nuclear reaction modelling, was extended in 2007 to encompass energy and non-energy applications. The methodology of this library has been adopted by the US nuclear application library (ENDF/B-VII), and RIPL technical documents are being frequently cited by users worldwide. The Agency convened a workshop on the medical applications of nuclear data for science and technology, which helped scientists and engineers obtain extensive training in the use of nuclear data in therapy and diagnostics. This will enable the 40 participants, including 35 from developing countries, to work with greater understanding and confidence in medical uses of radiation and radioisotopes.

Research Reactors

The Agency promotes regional collaboration to improve the utilization of small and medium size research reactors. In 2007, the Agency organized a workshop on strategic planning for research reactor utilization in the Mediterranean region and a technical meeting on the utilization of small and medium size research reactors. The presentations and discussion at both meetings reflected increasing networking and collaboration among the participants, one of the Agency's goals for this activity.

A new initiative was launched by the Agency to promote research reactor coalitions to serve as international user centres that would enable countries that do not have research reactors, or that are considering closing an old reactor, to use nearby facilities with modern technical capabilities. Efforts in 2007 created a number of potential research reactor coalitions. The need for such coalitions was strongly supported in the final report of the Agency's international conference on 'Research Reactors: Safe Management and Effective Utilization', held in Sydney.

The Agency promotes materials studies for the energy sector using research reactors. The use of research reactors and complementary techniques, such as positron annihilation, for such studies is summarized in a new publication, *Characterization and Testing of Materials for Nuclear Reactors* (IAEA-TECDOC-1545).

Innovation and research reactor operation

Rising expectations for nuclear power have increased interest in research on new generation fuels and materials that pose challenges for existing research reactors. Limited government funding and the increased importance of revenue from, for example, commercial isotope production add further management challenges for sustainability. To facilitate the exchange of ideas and experience in this more competitive environment for selecting, designing and operating various devices in research reactors, the Agency published in 2007 a *Compendium on Utilization Related Design Features of Research Reactors* (Technical Reports Series No. 455), which collected worldwide experience in these areas.

The Agency started an assessment of the use of aqueous homogeneous reactors (AHRs) for radioisotope production. A group of experts reviewed the state of the art of AHRs, including

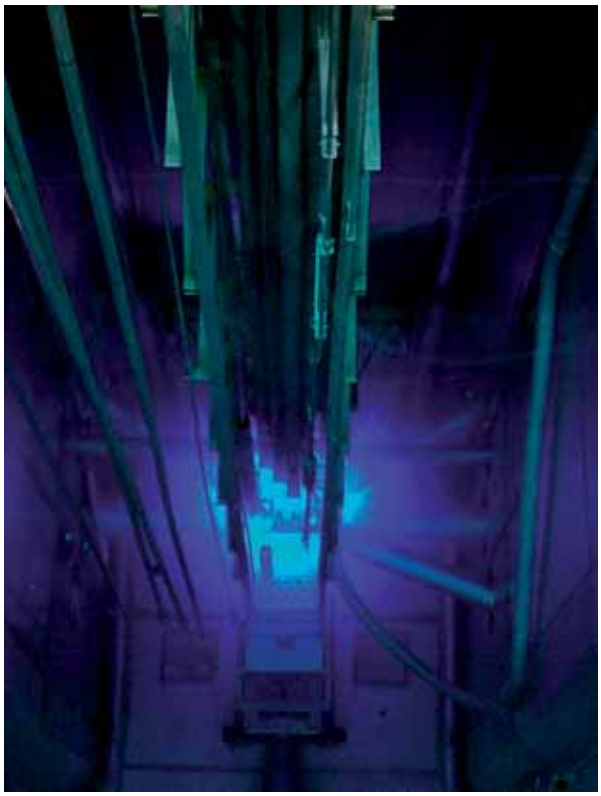


FIG. 1. New LEU core in operation at the Portuguese RPI reactor.

historical and ongoing activities in China, France, the Russian Federation and the USA, and identified specific opportunities and challenges with respect to the recovery of different isotopes of importance for medical use. The Agency also organized a training course in Ljubljana, Slovenia, on good practices in water quality management for research reactors and research reactor spent fuel storage facilities.

An international conference entitled 'Research Reactors: Safe Management and Effective Utilization', held in Sydney in November, was the latest in a series of Agency conferences on these subjects. It recommended continued support for: international coalitions and shared regional facilities; feasibility studies for future research reactors; applying the Code of Conduct on the Safety of Research Reactors; periodic safety reviews of research reactors; and efforts to reduce proliferation risk, including minimizing the use of HEU.

Research reactor fuel

Through the technical cooperation programme, the Agency worked with the Government of Portugal to convert the Portuguese RPI reactor from the use of HEU to LEU (Fig. 1). To support an ongoing CRP on the conversion of miniature neutron source research reactors from the use of HEU to LEU, a workshop organized by the Agency reviewed core conversion calculations and experimental data and agreed on the path forward to select a single candidate LEU fuel.

The Agency continued to support Member States participating in international programmes to return research reactor fuel to the country of origin. As part of the Russian Research Reactor Fuel Return Programme (RRRFR), two shipments of fresh HEU fuel were sent from Poland and Vietnam to the Russian Federation under contracts arranged by the Agency. The Agency also assisted in the shipment of irradiated Russian origin research reactor fuel from the Řež Nuclear Research Institute in the Czech Republic. This was the first research reactor spent fuel shipment for which the high capacity casks purchased by the Agency for the RRRFR in 2006 were used (Fig. 2).

The Agency's technical cooperation project to help remove irradiated Russian research reactor spent fuel from the Vinča Institute in Serbia completed prerequisite work within the spent fuel pools. The preliminary safety analysis and transport safety reports were also completed and submitted to the Serbian regulatory authority for review.

Utilization of Accelerators and Nuclear Instrumentation

In 2007, the Agency organized a worldwide proficiency test for X ray fluorescence (XRF) laboratories that confirmed the high level of analytical reliability of environmental material analyses in most of these laboratories. A portable XRF spectrometer that was developed at the Agency's Laboratories, Seibersdorf, was used extensively in 2007 to study and characterize precious cultural heritage objects and biological materials in museum collections in Vienna. It is available to all interested Member States for similar investigations.

"The Agency continued to support Member States participating in international programmes to return research reactor fuel to the country of origin."

Three workshops were held in cooperation with the Abdus Salam ICTP in Trieste to strengthen the use of nuclear methods using accelerators and X rays in Member States. Also, the Agency, together with the American Nuclear Society, organized an international conference in Pocatello, USA, on

FIG. 2. High capacity cask used in the shipment of spent fuel from Řež, Czech Republic.

the application and use of accelerators. Through the workshops and conference, a broad range of international experts and researchers from developing countries enhanced their technical knowledge of accelerator based techniques and their potential applications in their countries.

Two CRPs were concluded in 2007. One, on the development of new techniques and applications of accelerator mass spectrometry (AMS), looked at previously inaccessible research areas opened up by the ultra-trace sensitivity of AMS (as low as 10^{-15}) and at possible new applications in environmental monitoring and nuclear security. The CRP both improved existing methods and developed new procedures that are easily adapted in developing countries without access to modern dedicated accelerator facilities. The second CRP, on ion beam modification of insulators, helped to develop a new type of doped silicon carbide, a very promising material surpassed only by diamond in its performance in high power microelectronic devices. Ion beam synthesis of a new carbide is hence of great value in microelectronics.

Through its technical cooperation programme, the Agency conducted 13 training courses at both the Agency's Laboratories, Seibersdorf, and in developing Member States on the methods and applications of X ray emission techniques. Training focused on the study and protection of cultural heritage objects, air pollution monitoring, training and teaching materials based on information and communication technology, and quality control and quality assurance in nuclear analytical techniques and nuclear instrumentation. These training modules are available to all Member State laboratories.

Nuclear Fusion Research

On 24 October, a milestone in nuclear fusion research was achieved with the entry into force of the Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the International Thermonuclear Experimental Reactor (ITER) Project. In his capacity as the Depositary of that Agreement, the Director General convened the first session of the ITER Council in Cadarache, France, in November 2007.

The main emphasis of the Agency's fusion programme is on increasing international cooperation and support for science and technology for fusion power. Nine technical meetings were held in 2007 on fusion power plant reliability and topics of relevance to the operation of ITER. In connection with the challenges and application of plasmas that meet the requirements of a real power plant, a specialist meeting involving both fission and fusion experts was convened to discuss materials research using neutrons.

To encourage the exchange of expertise between Member States, the Agency co-organized an experiment in the tokamak in Lisbon and a plasma school at the Abdus Salam ICTP in Trieste, both of which exposed participants to mainstream fusion research.

In conjunction with the 'Fifth Inertial Fusion Sciences and Applications' conference, organized by Osaka University and held in Kobe, the Agency conducted a technical meeting on the physics and technology of inertial fusion energy targets and chambers to enhance international cooperation in developing alternative fusion concepts. The convening of these meetings in Kobe helped to strengthen collaboration between scientists from emerging economies and the major groups in fusion research, and enhanced the prospects of developing human resources for fusion research.

Food and Agriculture

Objective

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

Sustainable Intensification of Crop Production Systems

Plant mutation breeding has been thoroughly modernized by the advent of high throughput technologies using molecular genetics, of which mutation induction represents the leading technology. Characterized by a maximum of mutant plants in a minimum of time, the use of this technology enables the production of improved and higher yielding crops that are hardier in harsh environments and have enhanced nutritional value, which helps mitigate micronutrient malnutrition.

There has been significant progress in plant mutation breeding worldwide, fostered by the application of novel molecular biology tools. In 2007, an Agency technical cooperation project in Asia developed and facilitated the exchange of more than 20 new food crop mutant varieties among participating countries. In the tsunami affected areas of Sri Lanka, farmers began growing a high yielding, salinity tolerant mung bean variety (VC2917A) originally developed by Chinese breeders. Excellent field trial results have also been reported in Thailand for soybean varieties from Vietnam and the Republic of Korea, in Sri Lanka for groundnuts from Indonesia and Bangladesh, and in the Philippines for mung beans from Pakistan. Under the same project, Indian breeders developed 12 mutant groundnut varieties, which are estimated to cover about 45% of the groundnut growing area in India.

Mutation breeding clearly is the methodology of choice for Vietnam's farmers, as some 50% of rice and soybean varieties under cultivation in Vietnam were developed using mutation techniques and biotechnologies enhancing efficiency. Long term Agency support enabled Vietnamese breeders in 2007 to improve crop production in both lowland and highland areas, with consequent enhancements in food security and farmers' incomes.

Molecular techniques for screening crop genetic material continued to be incorporated into Agency activities in 2007. This screening reduces both costs and the time invested in evaluating up to maturity large mutant populations in the field. In 2007, the Agency made significant progress in the development of protocols and the use of low cost options in the application of reverse genetics technologies — such as targeting induced local lesions in genomes (TILLING) — to tropical crops such as tef, finger millet, yam, plantains, bananas, roots and tubers, which are known as orphan crops. Of great value for the economies of developing countries, orphan crops are often both commodity and cash crops, and help mitigate food scarcity.

The Agency's training activities in 2007 emphasized the acquisition of skills in these areas. At the end of May 2007, 20 trainees from 20 Member States attended the 7th FAO/IAEA Interregional Training Course on Mutant Germplasm Characterization Using Molecular Markers at the Agency's Laboratories, Seibersdorf.

Tackling Soil Degradation

With only 11% of the Earth's surface currently cultivated, and about 24% (3900 megahectares) potentially arable, it is crucial to develop technology packages to minimize soil degradation and to sustain crop production in tropical acid soils. In 2007, the Agency supported technical cooperation projects using nuclear and isotopic techniques for soil management in Benin, Brazil, Burkina Faso, Cuba, Mexico, Nigeria and Venezuela. These techniques revealed genotypic differences in nitrogen and phosphorus use efficiency in cereals and legume crops. Studies in Brazil and Mexico also showed that the inclusion of multipurpose legume species as cover crops/green manures in the cropping system contributed a higher level of nitrogen to soils, with good potential to reduce fertilizer inputs without reducing yield in subsequent cereal crops. The isotopic techniques were proven to be essential tools in collecting quantitative information related to nitrogen and carbon cycling and dynamics in tropical acid soils, as influenced by zero tillage and other soil conservation measures which greatly enhance soil organic matter accumulation and soil carbon stocks.

An updated and improved web based database on standardized phosphate rock (PR) solubility measurements provided greater accessibility

of information to a larger audience, including researchers, rural educators (agriculture extension workers), farm managers, farmers, policy makers and fertilizer companies. It also enabled users to make better informed decisions on the direct application of PR as compared with commercial water soluble phosphorus fertilizers.

Improving agricultural water management is a high priority given that the agricultural sector accounts for 75% of freshwater consumption. In 2007, the Agency developed guidelines providing water resource managers, land holders, agriculture extension workers and researchers with information on how to obtain the best performance from a variety of soil moisture monitoring equipment. The guidelines provided two important conclusions. The first was that the field calibrated neutron moisture meter (NMM) remains the most accurate and precise method for soil profile water content determination in the field. Moreover, it is the only indirect method capable of providing accurate soil water balance data for studies of crop water use, water use efficiency, irrigation efficiency and irrigation water use efficiency with a minimal number of access tubes. The second was that electromagnetic sensors (i.e. capacitance sensors) exhibit much more variability in the field than either the NMM or direct soil water measurements.

Based on these conclusions, an interregional training course on the use of nuclear and related techniques to measure storage, flows and the balance of water in cropping systems was held at the Agency's Laboratories, Seibersdorf, in October. The course provided the participants from 21 Member States with the tools to separate plant transpiration (the beneficial use of water for plant growth) from evapotranspiration using the combined isotopes of water (oxygen-18 and deuterium) and carbon (carbon-13) (Fig. 1). The course also provided new estimates for refining input parameters and validating/testing of the FAO crop water productivity model in the development of better irrigation strategies.

Sustainable Intensification of Livestock Production Systems

The use of rapid and sensitive nuclear and nuclear related diagnostic technologies for the detection and control of emerging transboundary animal and zoonotic diseases has received special attention from Member States to counter outbreaks of animal diseases. In response, two expert meetings and six national and regional training courses were held at which more than 140 animal production technicians and health diagnosticians were trained.

"Improving agricultural water management is a high priority given that the agricultural sector accounts for 75% of freshwater consumption."

Agency collaboration with FAO and WHO provided technologies, diagnostic support and training in response to the emergence of Rift Valley fever (RVF) in the Horn of Africa, which in January 2007 left at least 200 people dead in northern

FIG. 1. A participant in a training course on air, plant and soil sampling to determine oxygen-18 and deuterium for separating evaporation and transpiration components from evapotranspiration.

Kenya. These efforts included an epidemiological study to help the disease risk assessment currently being undertaken by CRP participants at the Kenya Agricultural Research Institute in Nairobi, through the collection of sera from 47 farms in six provinces known to have the mosquitoes that transmit RVF. Control efforts are also being revolutionized through the evaluation of isothermal polymerase chain reactions as highly sensitive tools to rapidly diagnose high risk diseases and deliver immediate results.

The Agency provided support to Member States through training and the supply of equipment and reagents for the measurement of progesterone levels using nuclear based techniques to identify non-pregnancy three weeks after an attempt at breeding. These techniques provide much higher rates of precision, especially when compared with conventional 60 day methods. Artificial insemination is a well established technology to improve breeding quality through the introduction of more beneficial characteristics, and in this regard Agency assistance provided farmers in Bangladesh, Cameroon, Honduras, Mongolia, Niger and the United Republic of Tanzania with the technology to improve the quality of their stock and to increase milk sales by 37% through the use of artificial insemination.

The Agency collaborated with the International Livestock Research Institute and the US Department of Agriculture in using gene based nuclear technologies to understand the genetics of economically important traits in small ruminants. Genetic markers were developed within these genes for use in testing animal populations to select animals with superior traits; from the 800 genes screened, 149 were involved in animal immunity. These CRP results, as well as the Agency's genetic resource database containing 726 blood and DNA samples from 12 countries derived from 32 small ruminant breeds for genetic mapping, will greatly benefit Member States and help the Agency to target technical assistance programmes.

Sustainable Control of Major Insect Pests using the Sterile Insect Technique (SIT)

Continental Europe's first large scale Mediterranean fruit fly (medfly) mass rearing facility was inaugurated in Valencia, Spain, in April 2007 under a cooperative agreement with the Agency, which provided the design, technology and training for the centre. This, the world's second largest 'insect factory', has the capacity to produce 500–600 million sterile male flies per week, and provides the means in the Valencia region to suppress destructive medfly populations in an environmentally friendly manner. The investment marks a major step forward in area-wide pest control for a region that accounts for 80% of the country's citrus exports, while at the same time reducing the use of insecticides and strengthening Spain's position as one of the world's top exporters of citrus fruit.

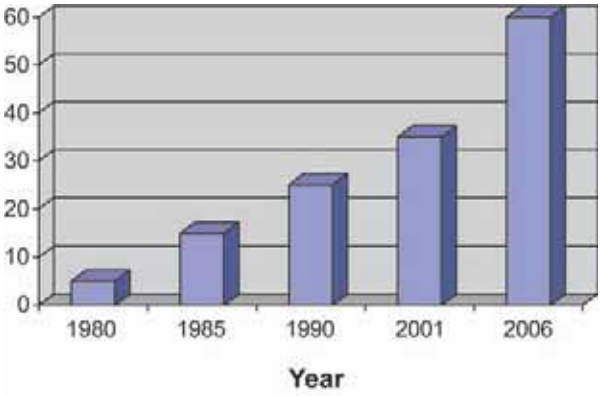


FIG. 2. Country approvals of food irradiation.

In Addis Ababa, Ethiopia, the Tsetse Mass Rearing and Irradiation Centre of the Southern Tsetse Eradication Project (STEP) was officially inaugurated on 3 February 2007 by the Deputy Prime Minister of Ethiopia in a ceremony held in conjunction with an African Union/African Development Bank donors' meeting in support of the project. The STEP project applies SIT as part of an integrated pest management approach to eventually create a tsetse fly free zone for two species (*Glossina pallidipes* and *G. f. fuscipes*) in a 25 000 km^2 area of fertile, under-used agricultural land, and to foster sustainable agriculture and rural development in the Ethiopian Southern Rift Valley.

"Continental Europe's first large scale Mediterranean fruit fly (medfly) mass rearing facility was inaugurated in Valencia, Spain, ..."

In the past year, increased and improved detection methods have been put in place and expert advice and training were provided through an Agency project for control of the cactus moth, *Cactoblastis cactorum*, which attacks prickly pear cacti (Opuntia). The moth was first detected in 1989 in the south-eastern USA and has since

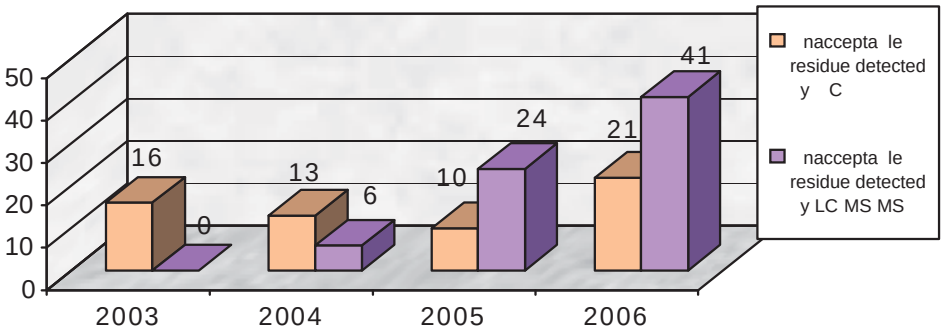


FIG. 3. Liquid chromatography tandem mass spectrometry enhances the capability to analyse pesticide residues (GC: gas chromatography; LC-MS/MS: liquid chromatography–mass spectrometry/mass spectrometry.

advanced westwards along the Gulf of Mexico. Results in 2007 indicate that the sterile moth release pilot programme has been successful, as the pest has not been detected west of Dauphin Island, Alabama, where it has been since 2004. In Mexico, an effective trap monitoring network allowed the early detection of an outbreak of cactus moth on the island of Mujeres in the Yucatan Peninsula. After intensive eradication activities the pest has not been found on the island.

Improving Food Quality and Safety

The approval and commercial application of irradiation as a quarantine treatment for agricultural commodities is gaining acceptance worldwide (Fig. 2). In recognition of the importance and potential use of irradiation on a commercial scale, some 75 specialists attended an FAO/IAEA regional workshop in Mexico City in 2007. An important result of the workshop was a recommendation to strengthen activities at the regional level, including the implementation of a programme on the use of irradiation as a phytosanitary measure through the FAO Regional Office for Latin America and the Caribbean.

"The approval and commercial application of irradiation as a quarantine treatment for agricultural commodities is gaining acceptance worldwide."

Laboratory capacity is necessary to enable countries to provide feedback on the implementation of sound production practices and to meet food quality requirements for enhanced consumer protection and increased international trade. In 2007, results were collated from a five year CRP on the development of strategies for the effective monitoring of veterinary drug residues in livestock products in developing countries. The project involved 16 countries and resulted in the development of capabilities to produce in-house reagents and test kits for immunoassay screening of important antibiotic residues in laboratories in Africa, Asia and Latin America. Guidelines on the validation of screening methods were developed and adopted by the project partners and confirmatory mass spectrometric methods were developed and validated in laboratories in Asia and Latin America.

Related activities included an interregional training workshop in September at the FAO/IAEA Training and Reference Centre for Food and Pesticide Control at the Agency's Laboratories, Seibersdorf. Scientists from 20 Member States were trained on methodologies for veterinary drug residue analysis. Several analytical methods were developed or adapted and validated at the laboratories, and presented at international conferences, published in the scientific press and used in training courses. Support was also provided for technical cooperation projects in nine countries on residues of veterinary drugs in foods.

The use of effective pesticide management practices will also be facilitated through the application of the results of a CRP, completed in 2007, on testing the efficiency and uncertainty of sample processing for the analysis of food contaminants. The CRP resulted in the collation of studies on the behaviour of pesticide residues under different sample preparation conditions and variables (Fig. 3). This information will help food control laboratories to take account of variabilities related to sample preparation procedures in the evaluation of analytical results so as to ensure a realistic estimation of the overall sampling

uncertainty and to avoid trade disputes over maximum residue limits for pesticides.

Agency efforts in the areas of consumer protection and international trade are expected to be enhanced by the IAEA Collaborating Centre for eLearning and Accelerated Capacity Building for Food and Environmental Protection (EACB), inaugurated in 2007 at the Centro de Investigación en Contaminación Ambiental (CICA) of the University of Costa Rica. CICA was designated as the lead institution, or 'Collaborating Centre', acting in cooperation with the Advanced Radiation Technology Institute of the Korea Atomic Energy Research Institute and the Food Science and Technology Programme of the National University of Singapore.

Human Health

Objective

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

Nuclear Techniques in Nutrition

During 2007, the Agency strengthened its collaboration with WHO, UNICEF and other partners in priority areas in nutrition, with special emphasis on nutrition and HIV/AIDS. The Agency hosted a steering committee meeting for a regional consultative meeting in October in Bangkok aimed at providing technical guidance to incorporate HIV/AIDS into national nutrition policies and programmes.

The complex interactions between poor nutrition and infectious diseases are highlighted by a new regional technical cooperation project in West Africa on the effect of improved micronutrient nutrition (vitamin A and zinc) on malaria in young children. Capacity building and training in the use of nuclear techniques in nutrition are major components of this project. In this regard, the Agency's contribution to capacity building in nutrition in Africa was recognized during the first meeting of the Federation of the African Nutrition Societies, held in May in Morocco.

Infants and young children are particularly vulnerable to the devastating effects of poor nutrition, as demonstrated by recent estimates that 99% of all child deaths occur in low and middle income countries, with poor nutrition being a significant factor in more than half of these deaths. A major aim of the IAEA Nobel Peace Prize Cancer and Nutrition Fund 'School for Nutrition', held in April in Dhaka, Bangladesh, was to discuss with nutritionists and other health professionals in the Asia–Pacific region the usefulness of stable isotope techniques in the development of effective interventions to combat undernutrition in infants and young children.

Stable isotope techniques were also part of new national technical cooperation projects focusing on infant and young child nutrition. For instance, the Agency supported projects to assess human milk intake in breastfed infants over a period of several years. Highlighting significant progress in this important area, the Agency held a technical meeting in November to review available data and to identify priority areas for future applications in the development and/or evaluation of nutritional interventions.

Nuclear Medicine and Diagnostic Imaging

New nuclear medicine procedures have been developed that can diagnose diseases non-invasively — providing information that cannot be acquired with other imaging technologies — and can deliver targeted treatments. Overall, the use of nuclear medicine procedures is expanding rapidly, especially as new imaging technologies, such as positron emission tomography/computed tomography (PET/CT) and single photon emission computed tomography/computed tomography (SPECT/CT) continue to improve the accuracy of detection, localization and characterization of disease.

"Overall, the use of nuclear medicine procedures is expanding rapidly, ..."

The Agency's first international conference on clinical PET and molecular nuclear medicine, which was held in Bangkok in November, drew nearly 400 delegates from 82 Member States. This event focused on the dynamics and recent advances in the area of PET tracers and their clinical applications. The short half-lives of most radioisotopes used in PET make it essential that the process is automated, from irradiation to the dispensing stage, so that the final radiopharmaceuticals are in compliance with the approved guidelines of good manufacturing practices. The participants of the conference reaffirmed the need to evolve appropriate guidelines for short shelf-life radiopharmaceuticals. The issue of expanding PET/CT to the developing world was also raised as one of the priorities, further reinforcing the need to promote nuclear medicine in public health care systems, and establishing human resources capacity. The conference reflected a growing trend within the medical community to find integrated global solutions to health related challenges.

The Agency facilitated research in 2007 into childhood cancers through a CRP on improvements in the treatment of acute lymphoblast leukaemia (ALL). As part of the CRP, 241 children from India, Myanmar, Pakistan and Sudan were tested, and four common specific fusion genes were identified, adding weight to the hypothesis that 'good prognosis' leukaemia is associated with delayed infection exposure in childhood. Good prognosis refers to the patterns of genetic activity in this cancer, which can predict the long term survival of a patient. This points to public health measures that can be realistically put into place to ease the scourge of the most common cancer among children

"The Agency facilitated research in 2007 into childhood cancers ..."

Radiation Oncology and Cancer Treatment

An important result of the European Union Network for Information on Cancer (EUNICE) steering committee meeting in Lyon in January 2007 was that 90% of the European data in the Agency's Directory of Radiotherapy Centres (DIRAC) was updated. The Agency continued to strengthen its collaboration with ESTRO, supporting 75 participants from central and eastern Europe at ESTRO training courses in 2007. Another noteworthy initiative was the decision by the Ministers of Health of Central America — Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama — at their 2007 annual meeting to approve a subregional cancer control programme with the assistance of the Agency, PAHO and WHO.

A prospective randomized trial comparing high dose rate (HDR) brachytherapy alone versus HDR brachytherapy with external radiotherapy for the palliation of dysphagia in advanced oesophageal cancer was completed. The results of this Agency study showed that there was an advantage to using the combined modality treatment in terms of dysphagia relief and quality of life. The results of this study were presented at the meeting of the European Cancer Organization in Barcelona and at the American Society for Therapeutic Radiology and Oncology Annual Meeting in Los Angeles.

The Agency, through a number of technical cooperation projects in Latin America, supported the introduction of new technologies such as PET in radiotherapy, mainly by training local staff and by expert missions. A highlight was the assistance provided to Nicaragua to adopt HDR brachytherapy for improving cancer care, to continue to improve radiotherapy with the support of the Programme of Action for Cancer Therapy (PACT) (Fig. 1) and to develop nuclear medicine services.

FIG. 1. PACT support for radiotherapy in Nicaragua.

Quality Assurance and Metrology in Radiation Medicine

A new International Code of Practice, *Dosimetry in Diagnostic Radiology* (Technical Reports Series No. 457), was published in 2007. The report emphasizes the practical aspects of calibration at the IAEA/WHO secondary standard, dosimetry laboratories and during measurements in clinical practice. The code of practice will help to achieve and maintain a high level of quality in diagnostic radiology dosimetry, to improve the implementation of traceable standards at the national level, and to ensure better control of radiation dose in X ray medical imaging worldwide.

"Through a regional technical cooperation project in Latin America, 24 hospitals received equipment for the positioning and immobilization of patients, ..."

At the Agency's Laboratories, Seibersdorf, a new gamma camera laboratory was inaugurated in May. In a training course held in June, medical physicists received hands-on training in gamma camera acceptance and other quality control tests. A regional dosimetry comparison exercise was held in May with the participation of five representatives of national calibration laboratories in Africa. The exercise identified the main reasons for important deviations detected during a dosimetry comparison in Africa carried out in 2003.

Upgrading of the dosimetry laboratory facilities included the commissioning of a new cobalt-60 unit and the installation of a new diagnostic X ray irradiator in 2007. As a result of these upgrades, the capacity of the Agency's Laboratories for dosimetry services to Member States was enhanced. In particular, standardization of radiation dosimetry in diagnostic radiology was strengthened with the new equipment that complies with the new international code of practice for dosimetry in X ray diagnostic radiology.

Health services in Mexico were strengthened through a national technical cooperation project that focused on medical physics resources. Laboratory equipment, together with expert advice provided through the project, supported the medical physics

SECURING ADEQUATE FUNDING FOR PACT

By the end of 2007, PACT had secured donations exceeding $530 000, with additional pledges and pending grants in excess of $440 000, bringing funds raised by PACT since its inception to over $3 million. Meanwhile, the establishment of an endowment fund — the 'PACT Fund at NFCR' — by the National Foundation for Cancer Research will facilitate the support of PACT initiatives by US based individual and institutional donors. In this connection, a fund raising effort was launched with a reception at United Nations Headquarters in New York in October, which was attended by more than 80 leading cancer experts, activists and philanthropists.

The Director General addressing the PACT Fund at the NFCR reception in New York.

graduate programme of the Universidad Nacional Autónoma de México, resulting in new and better equipped practical activities for students. During the two year project that ended in 2007, 16 students completed their advanced degree. Twelve of these graduates now work as clinical medical physicists in Mexican radiotherapy, nuclear medicine and magnetic resonance health services, and two are pursuing doctoral degrees in a related field.

Through a regional technical cooperation project in Latin America, 24 hospitals received equipment for the positioning and immobilization of patients, and in each of the participating countries some centres have been provided with updated reference material and guidance on the physics aspects of radiotherapy. The project focused on quality assurance in radiation therapy, machine calibration and the calculation of patient dose.

Programme of Action for Cancer Therapy

During 2007, Agency collaboration with the International Agency for Research on Cancer (IARC), the International Network for Cancer Treatment and Research (INCTR), the International Union against Cancer (UICC), WHO and national cancer institutes and centres in Algeria, Argentina, Brazil, Egypt, France, India, Morocco, the Philippines, South Africa, Thailand and the USA expanded through 'imPACT' reviews, the development of PACT Model Demonstration Sites (PMDSs), regional initiatives and events.

The Agency formalized relationships with several key international partners, signing 'PACT Practical Arrangements' with UICC, INCTR and the US health consultancy Axios. More than 20 Member States offered to collaborate with PACT, with cancer treatment institutions making their hospitals and educational centres available to support PACT initiatives. This will assist the PMDSs as well as regional training and mentoring projects. PACT worked with steering committees established by health ministries in the six PMDSs (Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen) to finalize national cancer control strategies and develop national action plans for the future implementation of comprehensive cancer control programmes. In addition, follow-up imPACT missions to five PMDS countries were conducted in 2007.

Training modules on comprehensive cancer control, radiation oncology, emerging techniques in radiotherapy planning and delivery, research, education and training were conducted in Buenos Aires in April, during the third IAEA Nobel Peace Prize Cancer and Nutrition Fund Special Event on Cancer. The Nobel Fund also supported training on quality assurance in radiotherapy for 16 participants from Africa at the Argonne National Laboratory in the USA.

Through PACT, the Agency supported the following training activities in 2007 for PMDSs and other Member State health professionals: the US National Cancer Institute (cancer prevention); the IARC (cancer registration and epidemiology); and the INCTR (assessing national cancer care needs and developing thematic strategies on palliative care). Through donations and in-kind assistance, PACT obtained support for individual training in radiation oncology, medical physics and radiation therapy technology in Canada and South Africa.

Water Resources

Objective

To improve the sustainable and integrated management of water resources by Member States through the use of isotope applications.

Meeting Common Water Challenges

The Agency recorded a number of significant achievements in its efforts to bring isotope hydrology into the mainstream of national and international water related programmes in 2007. For example, the 12th symposium on 'Advances in Isotope Hydrology and its Role in Water Resources Management' was held in Vienna in May. More than 200 participants from 59 countries conducted an extensive review of isotope techniques and their applications in characterizing surface water and groundwater resources, as well as of advances in related analytical instrumentation. Roundtable discussions at the symposium indicated that recent Agency initiatives, particularly on river–groundwater interactions, were important for ongoing water management efforts and for assessing the impacts of climate change. In addition, participants emphasized the continuing role of international organizations in capacity building for isotope hydrology. The proceedings of the symposium were published by the Agency in December.[1]

"Efforts continue to be made by the Agency to assist Member States in becoming more self-reliant in the use of isotope techniques in hydrology."

Groundwater with high arsenic concentrations from naturally occurring sources is the primary source of drinking water for millions of people in Bangladesh. Exposure to elevated arsenic concentrations has resulted in a major public health crisis. Following successful IAEA–World Bank cooperation over the past seven years, the Bangladesh Atomic Energy Commission, under the Agency's guidance, signed a memorandum of understanding to facilitate the use of isotopes in World Bank projects for mitigating the effects of arsenic poisoning of aquifers used for drinking water supply.

The Agency participated in the second International Joint Danube Survey held in August and September and organized by the International Commission for the Protection of the Danube River. The main objective of the survey was to provide an assessment of the water quality and hydrological and ecological status of the 2400 km long Danube River, from its headwaters in Germany to its mouth at the Black Sea. The Agency coordinated sampling and analysis for stable isotopes of water, tritium, nitrogen isotopes and radon. This was the first time isotopes were used in the Danube survey. The results of this survey support EU Water Framework goals in identifying pollutant sources and improving understanding of groundwater and tributary inputs to the Danube River. It was also an opportunity to conduct a pilot test of a new approach based on radon-222 for identifying locations where groundwater enters rivers.

Efforts continue to be made by the Agency to assist Member States in becoming more self-reliant in the use of isotope techniques in hydrology. For example, the Agency helped to adapt a new instrument for isotope analysis that uses a laser spectroscopy technique. This instrument will cost about 75% less than existing mass spectrometers, and will perform equivalent analyses with very low operation and maintenance costs. Two training courses were held at Agency Headquarters on the use of this instrument, in which participants from ten Member States were trained on the procedure for the operation of the instrument and on evaluation of the results and quality control procedures.

Dissemination of technical information to and within Member States was made easier through a set of Internet based data management tools, which offer possibilities for presenting and analysing worldwide georeferenced isotope and hydrochemical data and will enable Member States to improve their ability to use and integrate isotope hydrology. In addition, a video on sampling techniques for isotopes and related field measurements was developed to aid practitioners in enhanced data collection for groundwater assessment in Member States.

Addressing Water Resources Issues

The Agency, in collaboration with the Global Environment Facility (GEF) and the US Geological

[1] See *http://www-pub.iaea.org/MTCD/publications/PDF/p1310_start.pdf.*

Survey, organized an international study tour for members of three aquifer management teams: the Guarani in Latin America, and the Northwest Sahara and the Illumeden, both in Africa. The objective of the study tour was to enhance the management of transboundary aquifers by sharing knowledge, experience and best practices. The study tour provided the basis for building a network of professionals active in GEF supported groundwater projects and to integrate isotope techniques in these projects.

As part of its efforts to assist Member States in strengthening their capacity in the area of isotope hydrology:

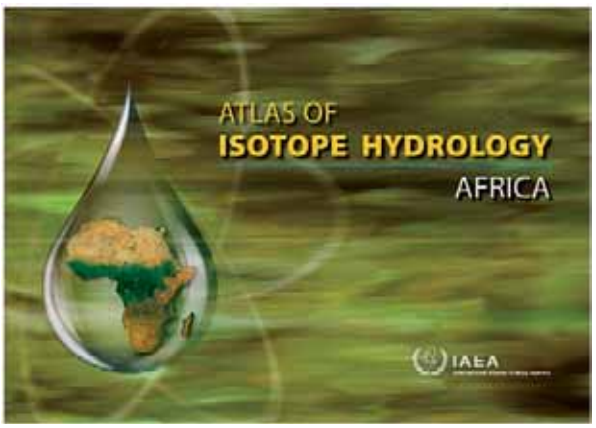
— Three technical cooperation regional training programmes on field techniques, data interpretation, application of isotope and geochemical techniques, and quality assurance for chemical analyses were held in El Salvador, Uruguay and Venezuela.
— A regional training course was organized in collaboration with the Centre for Ecotoxicological Research of Montenegro for 22 trainees to study the application of isotope techniques in hydrology. The course was offered as part of the Agency's technical cooperation programme to address country specific water resource management issues.
— Three scientists from Ethiopia, Sudan and Uganda were supported by the Agency, within the framework of the IAEA–UNESCO/Joint International Isotopes in Hydrology Programme, in the completion of MSc programmes in isotope hydrology at UNESCO's Infrastructural, Hydraulic and Environmental Engineering Institute for Water Education in Delft, the Netherlands.

Nutrient pollution (nitrates and phosphates) from agricultural use is a priority issue for water quality management in river basins. The Agency convened a technical meeting to review relevant isotope methodologies and to produce a guidebook on isotope techniques for river basin managers. This guidebook will facilitate the integration of isotope techniques in river basin management.

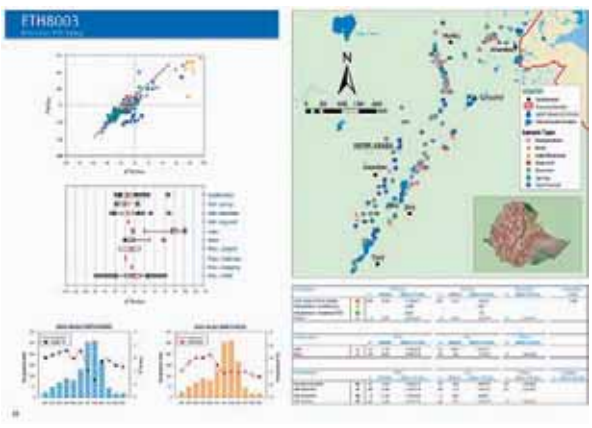
Two demonstration projects in Austria were completed on the use of the tritium/helium-3 isotope methodology — one to determine groundwater

NEW ISOTOPE HYDROLOGY ATLAS

Environmental isotopes are important in regional studies of water resources to obtain temporally and spatially integrated characteristics of groundwater systems. Isotope data were collected from 1973 to 2007 for 26 African countries. This information was used to prepare a special publication entitled *Atlas of Isotope Hydrology — Africa*. Intended for use by scientists, practitioners and policy makers engaged in the field of hydrology, the atlas features data from nearly 10 500 isotope records gathered from about 80 Agency projects. For each country, a digital elevation map showing project areas, major water bodies and locations of stations in the IAEA–WMO Global Network of Isotopes in Precipitation is presented. Summary pages for each project include a higher resolution map of the study area showing sample types and locations as well as isotope data tables and plots. The information presented in the atlas can be downloaded through the on-line application WISER from *http://www.iaea.org/water*.



Cover page of the atlas.



Example of a project page in the atlas.

age in a nitrate contaminated aquifer and the other to determine the sustainability of aquifers and rivers under conditions of increased water use and climate change. The results of these projects will allow the Agency to assist more Member States in the use of this isotope technique for river basin and groundwater management.

Two new reference materials were produced for stable oxygen and hydrogen isotope measurements of water samples to replace the material that had been in use for the past 30 years. These new standards, Vienna Standard Mean Ocean Water 2 (VSMOW2) and Standard Light Antarctic Precipitation 2 (SLAP2), ensure the continued consistency of measurements performed in isotope laboratories worldwide.

Assessment and Management of Marine and Terrestrial Environments

Objective

To enhance the capability of Member States in the identification and mitigation of environmental problems caused by radioactive and non-radioactive pollutants using nuclear techniques.

From Measurements to Environmental Impact Assessments

Developing and implementing a regulatory regime requires that information be collected and interpreted. This can involve a complex set of actions, such as collection of samples, carrying out measurements in the field and laboratory, data evaluation and environmental modelling. To address these issues, the Agency organized a conference in April on 'Environmental Radioactivity: From Measurements and Assessments to Regulation', which brought together experts involved in assessments for both routine and accident situations.

As a part of its activities to provide Member States with recommended methods for the measurement of radionuclides, the Agency published a comprehensive review of methods for the measurement of polonium-210 (Po-210) in the journal *Applied Radiation and Isotopes*. The Agency also organized a proficiency test on the rapid measurement of Po-210 in water samples, primarily for member laboratories of the network of Analytical Laboratories for the Measurement of Environmental Radioactivity, which is coordinated by the Agency. In November, the second worldwide open proficiency test for radionuclides in environmental samples was undertaken.

Nuclear Techniques to Study Air Pollution

The Agency helped Mexico, through the technical cooperation programme, to identify the main sources of air pollution in Mexico City. The Mexican capital is located in a valley and has a population in excess of 20 million, besides a number of industries located within the city's limits, and is visited each day by some 3.5 million vehicles. Together, these factors contribute to deterioration of the air quality, making

FIG. 1. New facility to study the impacts of ocean acidification on the larvae of commercial fish.

it one of the most polluted urban centres in the world. With Agency assistance, air sampling using state of the art air particulate filters was conducted: the particulate matter obtained was analysed using the proton induced X ray emission technique, resulting in a more thorough identification of air pollution sources.

Impacts of Climate Change on Marine Biodiversity

A new facility to study the effects of ocean acidification on the early life stages of commercial fish and polar molluscs was established in the IAEA Marine Environment Laboratories, Monaco (IAEA-MEL), in November (Fig. 1). In response to calls for more knowledge of climate change impacts on marine biodiversity, radiotracers will be used in this experimental facility to examine the metabolism of essential elements and contaminants in these marine biota under different future climate scenarios for ocean acidity.

"A new facility to study the effects of ocean acidification on the early life stages of commercial fish and polar molluscs was established in ... IAEA-MEL ..."

Environmental Contaminants, Seafood and International Trade

Determination of the physical and chemical state of an element is fundamental to understanding the behaviour of pollutants in any given environment. In October, IAEA-MEL co-hosted a radionuclide speciation workshop in Jackson Hole, Wyoming, in the USA, at which the latest developments in this discipline were revised and discussed. The rapid development of new technologies enables scientists to obtain more reliable and precise data on the way radionuclides disperse in the environment.

A new CRP on applications of radiotracer and radioassay technologies to seafood safety assessment was initiated. The major objective of the CRP is to promote international trade in seafood, particularly from developing countries, through better knowledge of background contaminant levels and bioaccumulation processes that are relevant for aquaculture farms. The research is focused on the biotoxins paralytic shellfish poison and ciguatoxin, and also on cadmium in seafood such as scallops, oysters and squid, for which there is inadequate information to establish international standards for trade.

Proficiency tests of organic pollutants and trace metals in sediment and biota reference materials were carried out for marine laboratories in the Yellow Sea region. Five laboratories each from China and the Republic of Korea participated in the proficiency tests organized by IAEA-MEL.

Radioisotope Production and Radiation Technology

Objective

To contribute to improved health care, better industrial performance as well as effective quality control processes and a cleaner environment, by supporting technology to strengthen national capabilities in Member States for producing radioisotope products and applying/adapting radiation technologies for socioeconomic benefit.

Radioisotopes and Radiopharmaceuticals in Medicine

Globally, the number of medical procedures involving the use of radioisotopes is growing, with an increasing emphasis on radionuclide therapy using radiopharmaceuticals labelled with particle emitting radioisotopes for the treatment of cancer. A new CRP initiated in 2007 on the development of therapeutic radiopharmaceuticals based on lutetium-177 for radionuclide therapy has helped accelerate the production of this radioisotope in Member States. This CRP is intended to complement another new CRP in the human health area on the clinical evaluation of a lutetium-177 radiopharmaceutical called ^{177}Lu-EDTMP (a phosphonate complex of lutetium) for bone pain palliation in metastatic prostate cancer. The goal of these two CRPs is to help develop products up to the clinical use stage.

"Globally, the number of medical procedures involving the use of radioisotopes is growing, ..."

A CRP on the development of technologies for generator produced therapeutic radionuclides was completed, resulting in the development of two generator systems for yttrium-90 used for the treatment of cancer and other diseases and a new technique for quality control testing. The electrochemical generator system developed will facilitate the wider availability of yttrium-90, while the ultra-sensitive new method of assaying the radionuclidic purity of yttrium-90 will help improve the safety of its use for therapy.

Radioguided sentinel lymph node (SLN) biopsy is a widely used procedure for the management of early breast cancer and melanoma to assess the risk for metastasis. A new CRP designed to complement a CRP in the human health area has as its focus the development of a specific radiopharmaceutical for SLN detection (SLND). The SLN biopsy is used to guide surgical management in breast cancer patients, while in the early stages of melanoma SLND can improve staging of the disease and dictate patient management.

The regular production of fluorine-18 (the most used PET tracer) in an operating accelerator in South Africa and preparation of fluorine-18–fluorodeoxyglucose (FDG) for clinical use in cancer patients were the main achievements of a technical cooperation project completed in 2007. The project's main feature was the investment by South Africa in the equipment and facilities, while the Agency facilitated the transfer of know-how and training.

Radiation Processing Technology

Radiation processing is an important technique in the sterilization of medical products and the decontamination of spices and medicinal herbs, while its use in processing natural and synthetic polymeric materials is growing. Radiation induced grafting is a powerful technique for the preparation of novel materials based on easily available and low cost synthetic and natural polymers. There is growing interest in developing materials as special adsorbents and membranes for use in environmental and industrial applications. A new CRP initiated in 2007 seeks to use gamma rays, electron beams and heavy ions for the grafting of various monomers onto natural and synthetic polymers in order to develop novel adsorbents and membranes. These adsorbents can be used for the efficient removal of heavy metal ions from contaminated water and wastewater and for the collection and recovery of significant metal ions from sea water.

Enhancing the utility of natural polymers is an area of growing interest in Member States. In recognition of the potential benefits that radiation technology can offer for the processing of natural polymers into such products as hydrogel wound dressings, adsorbents of toxins, non-bedsore mats, and antibiotic, antioxidant and plant growth promoters, the Agency initiated a new CRP focused

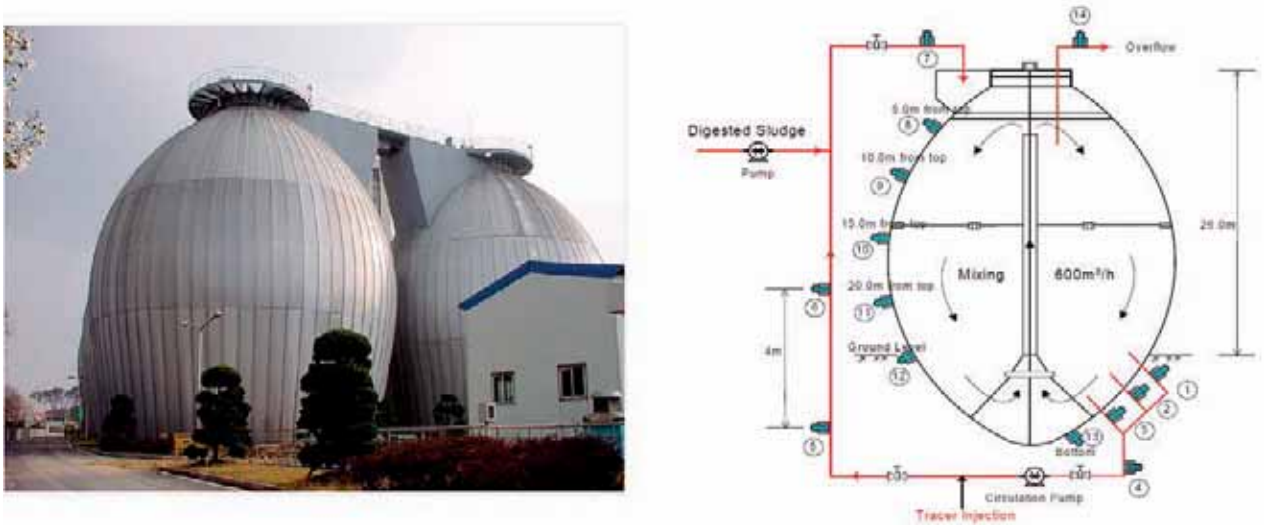


FIG. 1. Investigation of sludge digesters in a wastewater treatment plant in the Republic of Korea using scandium-46 as a tracer.

on the development of radiation processed products of natural polymers for application in agriculture, health care, industry and the environment. The main objective is to facilitate the wide use of radiation processed natural polymers and to bring together radiation technology specialists and end users.

Industrial Applications of Radioisotopes and Radiation Technology

Short lived radiotracers are used by industry to diagnose complex problems and obtain reliable and quick results. Radionuclide generators can help in overcoming the difficulties faced by users in obtaining such radiotracers. A new CRP seeks to investigate the potential of radionuclide generators for industrial radiotracer applications. The results of the CRP are expected to improve the availability of industrial radiotracers and radiotracer services, especially in developing Member States that do not possess radioisotope production facilities.

Through a regional technical cooperation project, the Agency is assisting Member States in Africa to maximize the commercial application of radiotracer and sealed source technologies for solving specific technology problems in priority industrial sectors such as the petroleum and petrochemical industries, and in mineral ore mining and processing. The application of these technologies increases productivity and safety and reduces environmental impacts. Other related technologies are also being promoted for specific applications, such as nucleonic gauges for calibration and repair purposes and in training courses for personnel. In 2007, Agency assistance focused on human capacity building in key radioisotope technologies, and on the conversion of conventional training material into information and communications technology based training/learning material.

"..., the Agency is assisting Member States in Africa to maximize the commercial application of radiotracer and sealed source technologies ..."

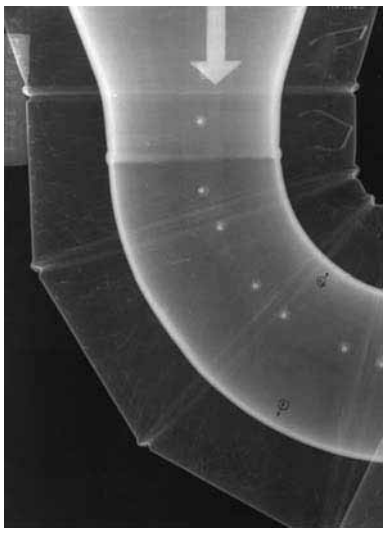


FIG. 2. Gamma radiography of a pipe without removing the insulation reveals internal flaws that are not reliably identifiable by non-nuclear methods.

Wastewater treatment plants (WWTPs) are the final barrier against possible contamination of

downstream surface waters such as rivers, lakes and the sea. Therefore, it is very important to maintain effective operating conditions of the plants to eliminate or reduce the risk of environmental pollution. Radiotracer techniques can be used to study the plants with the aim of improving their design features and optimizing performance. With the assistance of the Agency, the Korea Atomic Energy Research Institute developed a technology which was certified by the Ministry of the Environment for the in-service measurement of the effective volume of anaerobic digesters in WWTPs using scandium-46 as a radiotracer (Fig. 1). Through the injection of the isotope into the digester, the size and location of immobile layers can be found without disturbing the plant's operation. Through this technique, the operational efficiency of sewage facilities can be enhanced, additional environmental pollution prevented and operating costs reduced.

Digital industrial radiography (DIR) has considerable advantages over the film based techniques currently used in most Member States (Fig. 2). The industrial requirements of increased accuracy and ease of analysis and interpretation of data are more readily available from DIR, and hence a new CRP was initiated in this area in 2007. The objective is to design, develop, test and validate simple and low cost digital radiography techniques, in particular by optimizing the X ray detector and detector–source configuration.

Safety and Security

Incident and Emergency Preparedness and Response

Objective

To have in place effective and compatible national and international arrangements for early warning, for responding to actual and potential nuclear/radiological incidents and emergencies independently of their cause, and for feedback and continuous improvement.

Early Notification and Assistance Conventions and the International Action Plan

In 2007, the Agency organized the fourth meeting of the competent authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Early Notification and Assistance Conventions, respectively). The meeting reviewed progress in the area of international emergency preparedness and response, including the activities of the Agency's Incident and Emergency Centre (IEC). With the endorsement of many of the recommendations of the Working Groups on International Communications and International Assistance, work under the Action Plan for Strengthening International Preparedness and the Response System for Nuclear and Radiological Emergencies has now entered an implementation phase, which will build on these recommendations. In particular, the meeting endorsed recommendations relating to the development of an Agency system for incident and emergency communications.

Preparedness for Response to Incidents and Emergencies

To assist Member States in developing an adequate level of preparedness and response capabilities and arrangements, the Agency issues guidance, organizes training events and exercises, and provides reviews of national emergency systems. In 2007, the Agency, in cooperation with several international organizations,[1] published *Arrangements for Preparedness for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-G-2.1). To assist Member States in applying this guidance, the Agency conducted a number of training courses, workshops and exercises at the national and regional levels covering topics such as emergency planning, first response, radiological monitoring, medical response and biodosimetry, and emergency communications (Fig. 1).

The Agency offers its Emergency Preparedness Review (EPREV) service upon request to provide an independent assessment of a Member State's emergency preparedness and response programme and its conformance with the Agency safety standard *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2). In 2007, the Agency conducted EPREV missions to Egypt, the Russian Federation and Tajikistan. The results of these missions were the country specific EPREV Mission Reports, which contain specific recommendations based on identified weaknesses and shortcomings, as well as strengths and good practices, in the countries' emergency preparedness and response programmes. The aim is to improve their national, regional and local capabilities to respond to a nuclear or radiological emergency.

Emergency Exercises

Being well prepared is the basis for an effective and efficient response to incidents and emergencies. The Agency conducts regular exercises — referred to as Convention Exercises or ConvEx — of varying scope with the contact points and international organizations identified under the Early Notification and Assistance Conventions. Small scale ConvEx exercises to test the reliability and responsiveness of communications were conducted throughout 2007. In addition, the Agency participated in a number of national exercises.

[1] Specifically, FAO, the International Labour Office, PAHO, the United Nations Office for the Coordination of Humanitarian Affairs and WHO.

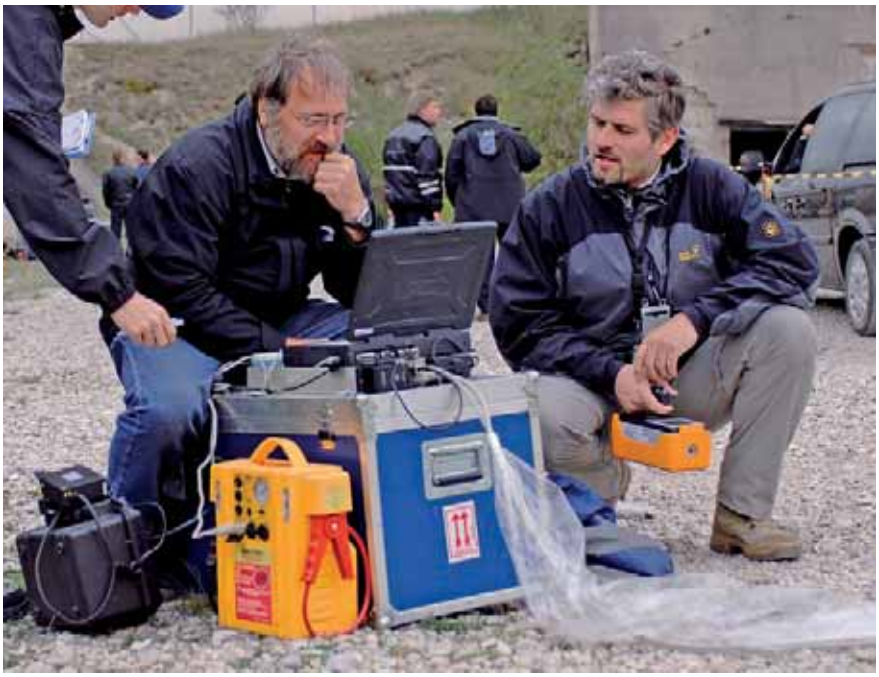


FIG. 1. Participants in an international intercomparison exercise for emergency assessment in the field.

Response Assistance Network (RANET)

The Agency's ability to render assistance to a country affected by a nuclear or radiological emergency relies on Member States making known the national assistance capabilities they could make available to a requesting country. In 2007, the Director General followed up on the 2006 launch of RANET — a registry of national assistance capabilities that can be called upon on request under the Assistance Convention — by sending a letter to all Parties to the Convention encouraging their registration in the network. In addition, within the framework of the Asian Nuclear Safety Network, a roster of experts with many competences that are foreseen in RANET was established to support the implementation of the Assistance Convention.

Reporting and Response to Incidents and Emergencies

In 2007, the Agency's IEC was informed or became aware of 140 events involving or suspected to involve ionizing radiation. In 25 cases the Agency, in accordance with established arrangements for response to incidents and emergencies, facilitated the provision of official information to Member States or coordinated international assistance. For example, in November the Agency, at the request of the authorities of Honduras, arranged for regional assistance from the USA to recover radioactive sources detected in a scrap metal shipment container. During the year, the Agency also received a number of requests for official information on events at nuclear facilities and facilitated the provision of authoritative information to concerned Member States and the public.

"In 2007, the Agency's IEC was informed or became aware of 140 events involving or suspected to involve ionizing radiation."

The International Nuclear Event Scale (INES) serves as a tool for communicating to the public the safety significance of events and covers a broad range of events related to nuclear facilities, radiation sources and the transport of radioactive material. In 2007, the Agency conducted two regional training seminars within the framework of the Asian Nuclear Safety Network in China and the Philippines. The seminars had the goal of supporting countries in the broader application of the scale.

Safety of Nuclear Installations

Objective

To achieve and maintain appropriate levels of safety in nuclear installations during their design, construction and total life cycle through promulgating safety standards for all types of nuclear installations; and to assess the application of these safety standards throughout the world.

Expert Mission to the Kashiwazaki-Kariwa Nuclear Power Plant

Over the years, the seismic safety of nuclear installations has received increasing attention from the Agency in light of the number of severe earthquakes that have affected nuclear installations. A major extrabudgetary programme on the seismic safety of existing nuclear power plants was formally established and initiated in September 2007.

"... the seismic safety of nuclear installations has received increasing attention from the Agency in light of the number of severe earthquakes that have affected nuclear installations."

In the aftermath of the earthquake in Niigataken Chuetsu-oki, Japan, on 16 July 2007, and upon a request from the Government of Japan, the Agency conducted an Engineering Safety Review Service mission to the Kashiwazaki-Kariwa nuclear power plant (Fig. 1) in August 2007. The objective was to gather information and identify the lessons that might have implications for nuclear safety, and share them with the international nuclear community. Although the earthquake significantly exceeded the level of the seismic input considered in its original design, the installation remained safe during and after the earthquake. In particular, the automatic shutdown of Units 3, 4 and 7, which were operating at full power, and Unit 2, which was in the start-up state, was performed successfully. Safety related structures, systems and components seemed to be in a much better general condition than might be expected, with no visible significant damage. This is certainly due to the safety margins introduced at different stages of the design process. However, many important components, such as the reactor vessels, the core internals and the fuel elements, which could not be examined during the mission, will warrant further assessments.

To address the complex multidisciplinary issues involved in a major seismic event, and to take into consideration the experience gained and lessons learned from the expert mission to the Kashiwazaki-Kariwa nuclear power plant, the Agency initiated

FIG. 1. The Kashiwazaki-Kariwa nuclear power plant.

work on establishing an International Seismic Safety Centre to consolidate past efforts and achievements and share this information with the international community. The centre will be the focal point on:

— Enhancement of the seismic safety of nuclear installations worldwide, utilizing the knowledge and expertise of specialists in all relevant scientific fields;
— Support to Member States by providing assistance in relation to seismic hazard, seismic design and seismic re-evaluation issues for existing and new nuclear installations, with particular emphasis on assistance to those with little experience in the subject;
— Sharing of experience and lessons learned with the international nuclear community in order to mitigate the consequences of such extreme natural events and to reflect the latest knowledge in the safety standards at the national and international level.

Learning the Lessons from Events

In response to an event at Forsmark Unit 1 on 25 July 2006, the Agency, in cooperation with the Swedish Nuclear Power Inspectorate and the OECD/NEA, held an international workshop on defence in depth aspects in electrical systems of importance to safety. At the meeting, held in Stockholm in September, regulators, operators, technical support organizations, international organizations and nuclear industry vendors discussed the lessons learned from the Forsmark and similar events. Recommendations from the workshop will be taken into account during the updating of the IAEA safety standards. Moreover, the Agency was requested to evaluate the operational safety of all Swedish nuclear power plants, starting with Forsmark in February 2008, Oskarshamn in 2009 and Ringhals in 2010.

Weaknesses in the sharing of information on events affecting the safe performance of reactivity control systems during power change and shutdown in nuclear power plants have recently been identified. Events have taken place in several Member States, and in the light of the complex and profound implications of these events for both regulators and operators, the Agency organized a technical meeting in Tokyo in October to exchange the lessons learned and identify possible further corrective actions and the necessary technical support. Participants recommended that the Agency encourage Member States to report and use operating experience, revise Agency publications related to reactivity management, develop accident analyses for nuclear power plants with BWRs, GCRs and FBRs, review the Agency's Operational Safety Review Team guidelines on reactivity management, and build on existing best international practices, such as those identified by the World Association of Nuclear Operators and the Institute of Nuclear Power Operations, when revising the IAEA safety standards.

Integrated Management System

The Agency supported a new project in China using the safety culture attributes defined in *Application of the Management System for Facilities and Activities* (IAEA Safety Standards Series No. GS-G-3.1). These attributes were used as a framework to identify and define the content of a safety culture learning exchange between a new Chinese operating company that is building a power plant and a US company having experience in operating the same type of facility. The Agency also conducted a Safety Culture Assessment Review Team (SCART) mission, the first to a nuclear power plant, to the Santa María de Garona nuclear power plant in Spain.

Research Reactor Safety Enhancement

A technical cooperation regional workshop on the Promotion of Safety Culture in Research Reactor Operating Organizations of the South East Asia, Pacific and Far East Countries was held in China in October. The workshop provided decision makers with practical information on developing, enhancing and assessing safety culture. Lessons learned from incidents and from deficiencies in safety management and safety culture were discussed. The participating countries were assisted to develop a realistic action plan to enhance safety culture in their organizations and were provided with guidance on safety culture assessment through the use of SCART missions.

An international conference on 'Research Reactors: Safe Management and Effective Utilization' was held by the Agency in Sydney in November. The conference addressed issues related to safety, utilization and fuel management. Among the results of the conference are that international exchanges and regional networking appear to be key elements for enhancing the safety of research reactors worldwide, through sharing of best practices

and lessons learned from their operation. The recommendations of the conference support actions launched by the Agency, in particular the promotion of the application of the Code of Conduct on the Safety of Research Reactors, and pointed the way to further action in this area.

A technical meeting on safety management and verification for research reactor safety committees, held in Vienna in December, provided a forum for senior members of the safety committees in 25 Member States to discuss their national practices on the safety management of research reactors and to exchange experience and information on issues of common interest.

Generic Review of New Reactor Safety against Agency Safety Assessment Requirements

As a response to renewed interest in the development of nuclear energy capacity worldwide, vendors are designing new reactors to meet the growing demand for safer and more economical nuclear power generation, and governmental regulatory bodies have initiated evaluations of these designs to support licensing decisions. To support Member State activities in this area, the Agency has developed a tailored project framework on early harmonized appraisal of safety cases made by vendors. This review of a new nuclear power plant safety case against the Agency's safety standards offers interested Member States an opportunity to assess the scope of the safety case made by vendors and highlights issues important to safety by identifying potential gaps or weaknesses in documentation. It provides a focus and foundation for the subsequent, more detailed, evaluation or licensing process of the concerned Member States. Such safety evaluations provide for early screening of safety cases and contribute to a better focus for subsequent licensing activities, as well as to a more harmonized approach to safety worldwide. In 2007, the Agency reviewed four new reactor designs at the request of the United Kingdom regulatory body.

"... the Agency has developed a tailored project framework on early harmonized appraisal of safety cases made by vendors."

Radiation and Transport Safety

Objective

To achieve global harmonization of radiation and transport safety standards and standards for the safety and security of radiation sources and thereby to raise the levels of protection of people, including Agency staff, against radiation exposure.

Revision of the Basic Safety Standards

The Agency, in cooperation with the co-sponsoring and potential co-sponsoring organizations, initiated the revision of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (the BSS) in 2007 at a technical meeting in July that involved more than 130 participants. The meeting made recommendations on the revision of the BSS, including one that the revised edition should follow the 2007 recommendations of the ICRP to the extent possible. Progress reports on the revision of the BSS were made to the Commission on Safety Standards and the various Safety Standards Committees at their meetings in 2007. The committees endorsed the change in the structure of the BSS, based on ICRP exposure situations, and provided detailed guidance on how education and training, reference levels, existing exposure situations and terminology should be treated.

"Comprehensive radiation and waste safety infrastructure profiles have now been developed and are being maintained for 107 Member States."

Application of the Agency's Safety Standards

In response to a request of the Government of Chile, the Agency conducted an appraisal of the operational aspects of the radiation protection of workers and the public within the major facilities of the Chilean Nuclear Energy Commission (Fig. 1). This was the first combined appraisal for occupational and public protection performed on an operational organization. The appraisal resulted in recommendations and suggestions on where improvements were necessary or desirable to further strengthen national activities. A number of good practices were also identified for dissemination to other Member States.

In 2007, the Agency participated in gamma spectrometry and dose rate measurements in an emergency situation intercomparison exercise in Austria (Fig. 2). This exercise — which was organized by the Austrian Research Centers in cooperation with the Agency and the Austrian

FIG. 1. Radioisotope production facility visited during the appraisal of the Chilean Nuclear Energy Commission.

FIG. 2. High resolution gamma spectroscopy systems being tested under field conditions at the in situ intercomparison scenario exercise in Austria.

Nuclear, Biological and Chemical Defence School — tested preparedness in the event of contamination after an accident and emergency situation, including malicious acts or as a legacy from past activities.

Assisting Member States to Improve their Safety Infrastructure

Comprehensive radiation and waste safety infrastructure profiles have now been developed and are being maintained for 107 Member States. Each profile is based on six thematic safety areas (TSAs) that cover: national regulatory infrastructure; occupational protection; medical exposure, including patient protection; public and environmental protection; emergency preparedness and response; and education and training. The information in the profile is derived from numerous sources, including mission reports, country reports at regional coordination meetings and self-assessment questionnaires. These profiles provide the basis for an analysis of each State's regulatory infrastructure relative to the safety and security of radiation sources, resulting in the development of country specific action plans that identify both the priorities and the actions to be taken by the Member State, and the assistance to be provided by the Agency. This coordinated assistance facilitates Member State progress towards the application of international safety standards.

Strengthening Radiation Protection: Education and Training in Radiation, Transport and Waste Safety

The General Conference welcomed the Secretariat's efforts to ensure the wide participation of developing countries in the forthcoming XII Congress of the International Radiation Protection Association.

In 2007, the Agency held postgraduate educational courses on radiation protection and the safety of radiation sources in Argentina (in Spanish), Malaysia (in English), Morocco (in French), South Africa (in English) and the Syrian Arab Republic (in Arabic). In addition, the Agency completed a number of teaching aids for radiation protection officer training courses. Also during the year, the Agency conducted an education and training appraisal mission in Morocco. In addition to noting several good practices, the mission identified areas for improvement.

Other assistance to Member States in 2007 included training courses in the radiation protection of health professionals. The range of training material available to Member States was expanded with the release of a new package on the prevention of accidental exposure in radiotherapy.

Code of Conduct on the Safety and Security of Radioactive Sources

In June, technical and legal experts met in Vienna on the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary Guidance on the Import and Export of Radioactive Sources. Information was exchanged and a variety of topics were discussed, including: infrastructure for regulatory control; facilities and services available to the persons authorized to manage radioactive sources; training of staff in the regulatory body, law enforcement agencies and emergency service organizations; experience in establishing a national register of radioactive sources; and national strategies for gaining or regaining control over orphan sources. The meeting confirmed that there was widespread international support for the Code of Conduct and the Guidance. The meeting recognized that implementation of the provisions of the Code of Conduct was uneven among Member States due to, inter alia, facilities and services available to the persons authorized to manage the radioactive sources, training of staff in the regulatory body, law enforcement agencies and emergency services, legislation and regulations on safety and security of radioactive sources, national strategies for gaining or regaining control over orphan sources, and financial resources.

Radiological Protection of Patients

In line with the recommendations of the International Action Plan on the Radiological Protection of Patients, activities were begun to provide information to health professionals. Building on the success of the dedicated web site on the radiological protection of patients (*http://rpop.iaea.org*), the site was enhanced with information on the radiation protection of paediatric patients, since children are a subgroup of the population at greater risk from radiation exposure.

In a project initiated under a regional cooperation agreement for Asia and the Pacific, the Asian Network of Cardiologists in Radiation Protection was established in 2007. The Agency is coordinating the activities of the network by organizing and supporting an annual meeting with network members, providing technical coordination and monitoring the action plans developed during the annual meeting.

Safe Transport of Radioactive Material

As part of the implementation of the Action Plan of the International Steering Committee on Denials of Shipment of Radioactive Material established in 2006, the Agency convened a two day regional workshop in Montevideo in July to discuss the reasons for denials of shipment, the role of the Agency and the Transport Regulations in alleviating denials, and the effect of denials on industry. Participants also made presentations on the instances and effects of denials of shipment in their countries. The main outcomes of the workshop included a regional plan of action to address instances of denials and a regional network to ensure that communication is facilitated and is ongoing. These resulted in additional actions being proposed, and feedback has been received on how the workshop participants implemented actions in their countries.

Ionizing Radiation Warning — Supplementary Symbol

A new radiation warning symbol (Fig. 3) was published by the ISO as Standard No. 21482: Ionizing-Radiation Warning — Supplementary Symbol. The introduction of the new symbol is a result of the Agency's efforts to develop a universal radiation warning symbol. The new symbol is intended to supplement rather than replace the trefoil sign for ionizing radiation on Category 1, 2 and 3 sources, which are defined as dangerous sources capable of causing death or serious injury if accessed by unauthorized persons. The Agency will assist Member States in the appropriate use of the new symbol.

FIG. 3. The new radiation warning symbol to supplement the existing trefoil sign.

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 human habitats against potential health effects attributable to actual or potential exposure to radioactive waste.

A Common Framework for Radioactive Waste Management

The concept of a common framework linking radioactive waste types to disposal options in a manner that respects international safety standards and that takes into account local circumstances has been evolving for a number of years. In 2007, an Agency workshop in Cape Town considered the concept and came to a number of important conclusions. There was consensus that international standards on radioactive waste classification should encompass all waste types, including those containing naturally occurring radionuclides and disused sealed sources, and should essentially be based on long term management. There was also agreement that defining radioactive waste with minimal amounts of radioactive content as very low level waste was a legitimate and useful concept and should be part of the classification scheme. It was also recognized that certain types of radioactive waste are not suitable for near surface disposal but do not warrant the degree of isolation and containment provided by geological disposal. For such material, disposal at intermediate depths (i.e. between a few tens of metres and several hundred metres) in a suitable geoclinal environment was considered appropriate. While classifying radioactive waste on the basis of disposal options was considered to offer many benefits, the workshop recognized that the safety of any particular disposal facility had to be demonstrated. The conclusions from the workshop will be used in the development of new safety standards publications.

"The concept of a common framework linking radioactive waste types to disposal options ... has been evolving for a number of years."

Completion of the ASAM Project

The five year Application of Safety Assessment Methodologies (ASAM) Project concluded in 2007. Five working groups, comprised of representatives from waste producers, disposers, regulators and others in over 30 countries, explored the application of the safety assessment methodology to a range of proposed and existing near surface radioactive waste disposal facilities. The groups also developed advice to assist regulators, operators and specialists in reviewing safety assessments. The ASAM Project confirmed that earlier methodologies provided a good framework for conducting safety assessments and that, in principle, they were also suitable for addressing the impacts of non-radioactive contaminants. The project formulated advice on several important safety assessment issues for mining, heterogeneous waste and re-assessment of existing facilities, and for disruptive events, engineered barrier performance, conservatism and realism in assessments.

Remediation Strategies and Long Term Management of Radioactive Waste after Accidental Radioactive Releases to the Environment

Twenty years after the Goiânia accident in Brazil, in September 1987, an international workshop in Santos, Brazil, considered the concepts and ideas that form the basis for the long term planning and management of the consequences of accidental releases of radioactivity to the environment. The participants worked on developing an internationally harmonized basis for remediation strategies and radioactive waste management policies that ensure long term safety.

Completion of the EMRAS Exercise

The Agency's Environmental Modelling for Radiation Safety (EMRAS) exercise ran from 2003 to 2007. It continued some of the work of previous international exercises in the field of radioecological modelling and focused on areas where uncertainties remain in the predictive capability of environmental models. Around 100 specialists from 30 Member States participated in EMRAS projects on the assessment of radioactive releases, the restoration of sites with radioactive residues, and protection of

the environment. The exercise created or validated a number of models and resulted in the revision of an Agency publication, *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments* (Technical Reports Series No. 364).

Evaluation and the DeSA Project

In response to Member State requests for recommendations for ensuring safety during decommissioning, over 50 experts from 30 Member States have been taking part in the Demonstration of Safety Assessment during Decommissioning of Nuclear Facilities (DeSA) project. Running from 2005 to its conclusion in 2007, this project demonstrated the use of the methodology for a nuclear power plant, research reactor and nuclear laboratory. It also developed: (i) a harmonized safety assessment methodology for decommissioning; (ii) guidance on the application of a graded approach to safety assessment; and (iii) a model for a standardized regulatory review procedure. Finally, the project established a forum and network of operators, regulators and other technical specialists involved in evaluation and demonstration or regulation of safety during the decommissioning of various types of facilities.

Increase in Uranium Mining Activities

The recent increase in the uranium mining industry has resulted in the creation of a number of new and smaller companies interested in exploring for and developing uranium resources, many of which have little or limited experience of uranium resource development. In addition, many countries new to the uranium business — including those with few or no regulations, legislation or qualified staff to manage the proposed uranium mining activities — are being targeted for uranium exploration. The Agency, in partnership with WNA, convened a meeting in Vienna to bring together established regulators and mine operators from the major uranium producing countries. The participants agreed that a code of best practices for the uranium mining industry was needed to assist new players to operate in an appropriate manner from the first stages of development.

Development of a Mobile Hot Cell for High Activity Source Conditioning

While securing radioactive sources remains a declared priority for Member States, the actual conditions for doing so in the field look rather different. The procedure to secure spent sources, or indeed any other radioactive material, often requires the use of expensive, specialized facilities that are not widely available. In response, the Agency conceived the concept of a mobile unit for the conditioning of spent high activity radioactive sources. This concept consists of a mobile hot cell and storage container for the recovery, conditioning and packaging of high activity sources. The unit will allow engineers and technicians to condition sources where they were last used. In 2007, the first mobile hot cell was

FIG. 1. The Langer Heinrich uranium mine in Namibia.

FIG. 2. Active demonstration test of the mobile hot cell in South Africa in March 2007.

manufactured and tested by the Nuclear Energy Corporation of South Africa (NECSA) (Fig. 2). The technical demonstration established that the NECSA team is fully qualified to safely perform the required operations with the conditioning installation.

International Decommissioning Network

In September 2007, the Agency launched the International Decommissioning Network to provide a forum for the sharing of practical decommissioning experience among Member States. This was in response to the wish expressed at the International Conference on Lessons Learned from the Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities, held in Athens in 2006. This network will bring together existing decommissioning initiatives both inside and outside the Agency. Organizations with a demonstrated record of excellence in a wide range of areas, with facilities suitable for demonstration or training and a willingness to share their experience, will be recognized under the network's Centres of Excellence in Decommissioning scheme. An initial programme for the network was developed at a technical meeting held in Vienna in 2007. Priorities for hands-on training and demonstrations were developed.

Nuclear Security

Objective

To improve worldwide security of nuclear material, other radioactive materials and their associated nuclear facilities, in use, locations and transports, through support and assistance to Member States for the establishment of effective national nuclear security regimes.

Nuclear Security Assessments

To provide effective and comprehensive assistance and coordination, the Agency expanded the use of Integrated Nuclear Security Support Plans (INSSPs). These plans are intended to serve as a reference and framework for implementing nuclear security activities and improvements in States. At the end of 2007, 44 INSSPs were in varying stages of development and completion.

With the aim of assessing the status of technical and administrative arrangements, the Agency continued to offer nuclear security advisory missions, fact finding missions and technical visits. Fifteen nuclear security advisory missions were carried out in 2007, including: International Physical Protection Advisory Service (IPPAS) missions; International Team of Experts (ITE) missions to advise States on their adherence to or implementation of international instruments relevant to enhancing protection against nuclear terrorism; IAEA SSAC Advisory Service (ISSAS) missions to evaluate States' regulatory, legislative, administrative and technical components of the respective State systems for accounting and control of nuclear material at both the national and facility levels; and Radiation Safety and Security of Radioactive Sources Appraisal (RaSSIA) missions.

Illicit Trafficking Database

Established in 1995, the Agency's Illicit Trafficking Database (ITDB) benefits from the voluntary participation of 98 IAEA Member States and one non-Member State. As of 31 December 2007, States had reported or otherwise confirmed 1340 incidents to the ITDB. Of these, 303 incidents involved the seizure of nuclear material or radioactive sources from persons who possessed them illegally and, in some cases, attempted to sell them or smuggle them across borders.

Of particular concern are those incidents involving the unauthorized possession of high enriched uranium and plutonium. From 1993 to 2007, 15 such incidents were reported to the ITDB. Some of these cases involved an attempt to sell material or smuggle it across national borders.

In 389 of the confirmed cases, the material was reported stolen or lost. A total of 571 incidents involved other unauthorized activities, such as detection of material disposed of in unauthorized ways, discovery of uncontrolled, or orphan, material, and other incidents that appear to be inadvertent in nature. In 77 cases, the nature of the incident is unknown. Expanded reporting to the ITDB of events in countries from all regions of the world demonstrates a clear need for further improvement in measures to control and secure nuclear and other radioactive material, wherever used or located.

The Agency developed subregional workshops on illicit nuclear trafficking information management and coordination with the goal of strengthening Member State capacities to cooperate in preventing and combating illicit nuclear trafficking. Two workshops took place in Singapore in July 2007 and South Africa in August 2007. The Agency also adopted a more proactive information collection strategy, including information collection visits to States. The results of such visits provided more comprehensive and complete information to the ITDB and contributed to the Agency's assessment of countries' nuclear security needs. ITDB analytical products were used in awareness briefings at various national, regional and international training activities, at international conferences and seminars, and to support Agency nuclear security activities, such as missions, needs assessments and the development of documents.

International Conference on Illicit Nuclear Trafficking

In November, the Agency organized an international conference entitled 'Illicit Nuclear Trafficking: Collective Experience and the Way Forward'. Held in Edinburgh, the conference objectives were to: take stock of achievements in recent years; examine the challenges in combating illicit nuclear trafficking; and explore avenues for future action. The findings of the conference — discussed in greater detail in the Overview chapter

of this document — included a range of actions through which international efforts to deal with the challenge of illicit trafficking could be strengthened.

New Cooperation Arrangements with Member States

In June, the Agency signed a cooperation arrangement with Qatar for Agency assistance in enhancing the effectiveness and efficiency of Qatar's nuclear security. In addition, work continued under a partnership programme between the Agency and the Pakistan Nuclear Regulatory Authority, which included training courses, on the job training and the provision and procurement of detection equipment.

Capacity Building

Supporting the development of nuclear security education mechanisms continued to be a priority for the Agency in 2007. For example, educational programmes at the Sevastopol National University of Nuclear Energy and Technology in Ukraine and at the Interdepartmental Special Training Centre in Obninsk, Russian Federation, received Agency support. In May, the Agency provided Saudi Arabia's Naif Arab University for Security Sciences with a set of arrangements for enhancing cooperation between the university and the Agency. These arrangements promote institutional visits, facilitate the exchange of information, and help organize symposia, meetings and training on nuclear security issues.

The Agency continued to provide nuclear security training to improve and expand the practical nuclear security skills of technical and non-technical personnel in States. More than 950 participants from 87 countries participated in nuclear security training in 69 courses held during the year. Regional and national training courses in the areas of physical protection and of combating illicit trafficking constituted the majority of these activities. A peer to peer meeting on the management and coordination of illicit trafficking information was conducted for one national and two regional groups. In April, the Agency inaugurated a Nuclear Security Support Centre (NSSC) in Islamabad, Pakistan. The Agency also procured equipment for the establishment of an NSSC in Ghana and conducted initial discussions with Brazilian and Malaysian authorities on establishing NSSCs in those States.

Risk Reduction

The removal and repatriation of vulnerable radioactive sources continued to be priorities for the Agency. In 2007, 127 sources were repatriated to the USA from a country in Latin America. The majority of the sources were transuranic neutron sources, but also included transuranic gamma, caesium-137 and radium-226/beryllium sources. Two high activity disused sources were recovered in Africa and were conditioned and repatriated to Canada. In addition, one very large disused source, one disused Russian teletherapy source and one disused brachytherapy machine were removed from their respective locations and consolidated in a secure facility.

"The removal and repatriation of vulnerable radioactive sources continued to be priorities for the Agency."

Guidance on Nuclear Security for Member States

In 2007, the Agency published *Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage* (IAEA Nuclear Security Series No. 4), which provides methods for evaluating and proposing corrective actions aimed at reducing the risk related to any malicious act directed at a nuclear power plant that could endanger human health and safety and the environment through radiation exposure or the release of radioactive substances. Another publication in this series, *Identification of Radioactive Sources and Devices* (IAEA Nuclear Security Series No. 5), serves as an aid to non-specialist individuals and organizations in initially identifying radioactive sources, devices and packages with which they may come into contact in performing their duties. It also provides information on precautionary actions to be taken if a suspected uncontrolled source or device is found. This publication complements the Agency's International Catalogue of Sealed Radioactive Sources and Devices database.

Nuclear Security Equipment Laboratory

The Nuclear Security Equipment Laboratory (NSEL) continued to provide technical support to Member States. In 2007, the NSEL organized 25 training courses and technical missions to Member

States, conducted acceptance tests of 915 portable and 4 fixed installed pieces of radiation detection equipment, and evaluated eight new instruments for nuclear security and safeguards applications.

Security at Major Public Events

Following the successful implementation of previous projects that assist Member States in ensuring the nuclear security of major public events, the Agency established projects with Brazil and China in preparation for the 2007 Pan-American Games (Fig. 1) and the 2008 Summer Olympic Games. The Agency's assistance to Brazil included supplying radiation detection equipment, providing up to date information on illicit trafficking activity and conducting national workshops on illicit trafficking awareness, on response to criminal or unauthorized acts involving nuclear or other radioactive material, and on nuclear security awareness for security officers and mobile expert support teams. To enhance China's capabilities for ensuring the nuclear security of the 2008 Olympic Games, the Agency initiated a training programme that to date has trained more than 150 participants.

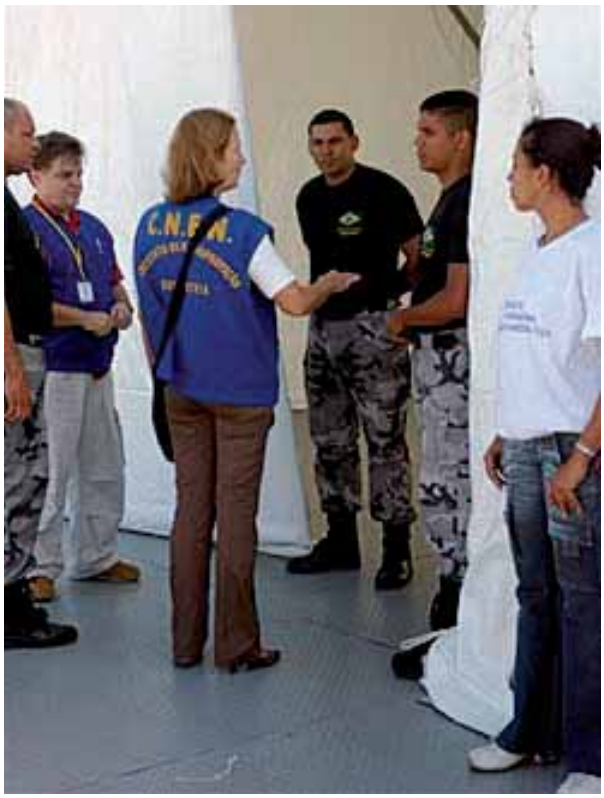


FIG.1. Assistance for nuclear security was given by the Agency to the Pan-American Games.

Financial Support to the NSF

The implementation of the Agency's nuclear security programme continued to depend largely on the donation of extrabudgetary funds by Member States and others to the Nuclear Security Fund (NSF). In 2007, financial and in-kind contributions with a cumulative value in excess of $20 million were received from more than a dozen Member States and the European Union. This was the largest amount received in a single year since the programme was set up, equal to more than 40% of all funding received prior to 2007. In part, this was due to the contribution in 2007 of over €7 million by the European Union, the single largest contribution ever made to the NSF. Increased emphasis on programme delivery resulted in expenditures of nearly $19 million during the year, which considerably exceeded the previous year's expenditures of approximately $15.5 million.

"... the Agency established projects with Brazil and China in preparation for the 2007 Pan-American Games and the 2008 Summer Olympic Games."

The NSF continued to rely on relatively few donors. Coordination with these donors and other multilateral initiatives continued to reduce duplication. The Agency also provided assistance to individual State efforts to improve nuclear security by bringing together representatives of other national and multilateral assistance programmes carrying out activities in that particular State.

Verification

Safeguards

Objective

To provide credible assurance to the international community that nuclear material and other items placed under safeguards are not diverted or misused; for States with comprehensive safeguards agreements, to provide credible assurance that all nuclear material remains in peaceful activities; and to support the efforts of the international community in connection with nuclear disarmament.

Safeguards Conclusion for 2007

At the end of each year, the Agency draws a *safeguards conclusion* for each State with a safeguards agreement in force, based upon the evaluation of all information available to it for that year. With regard to States with comprehensive safeguards agreements (CSAs), the Agency seeks to conclude that all nuclear material remained in peaceful activities. To draw such a conclusion, the Secretariat must conclude: (i) that there is no indication of diversion of declared nuclear material from peaceful activities (including no misuse of declared facilities or other locations to produce undeclared nuclear material); and (ii) that there is no indication of undeclared nuclear material and activities for the State as a whole.

In order to conclude that there is no indication of undeclared nuclear material and activities for the State as a whole, and ultimately to be able to draw the broader conclusion that all nuclear material remained in peaceful activities, the Secretariat considers the results of its verification activities under CSAs *and* the results of its evaluation and verification activities under additional protocols (APs). Therefore, for the Agency to draw such a broader conclusion, both a CSA and an AP must be in force, *and* the Agency must have been able to conduct all necessary verification and evaluation activities. For States that have CSAs in force but no APs, the Agency does not have sufficient tools to provide credible assurance regarding the absence of undeclared nuclear material and activities for the State as a whole, and therefore only draws a conclusion for a given year with respect to whether *declared* nuclear material remained in peaceful activities.

In 2007, safeguards were applied for 163 States with safeguards agreements in force with the Agency. Eighty-two States had both CSAs and APs in force. For 47 of these States,[1] the Agency concluded that all nuclear material remained in peaceful activities. For 35 of the States, the Agency had not yet completed all the necessary evaluations and could therefore only conclude that the declared nuclear material remained in peaceful activities. Similarly, for 72 States with CSAs in force but without APs, the Agency was only able to draw that conclusion.[2]

Three States had in force item specific safeguards agreements which require the application of safeguards to specified nuclear material, facilities and other items or material. For these States, the Secretariat concluded that nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities.

Five nuclear weapon States had voluntary offer safeguards agreements in force. Safeguards were implemented with regard to declared nuclear material in selected facilities in four of the five States. For these four States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities or was withdrawn as provided for in the agreements.

"In 2007, safeguards were applied for 163 States with safeguards agreements in force with the Agency."

As of 31 December 2007, 30 non-nuclear-weapon States party to the NPT had yet to bring CSAs into force pursuant to the Treaty. For these States, the Secretariat could not draw any safeguards conclusions.

A broader conclusion was drawn for the first time for Armenia, Belgium, Cuba, Denmark, Estonia, Finland, Italy, Malta, the Netherlands, Palau, the Republic of Korea, Slovakia, Spain, Sweden and Uruguay, and was reaffirmed for 32 States.

[1] And for Taiwan, China.

[2] The 72 States do not include the Democratic People's Republic of Korea as the Agency was not able to implement safeguards in that State and, therefore, could not draw any conclusion.

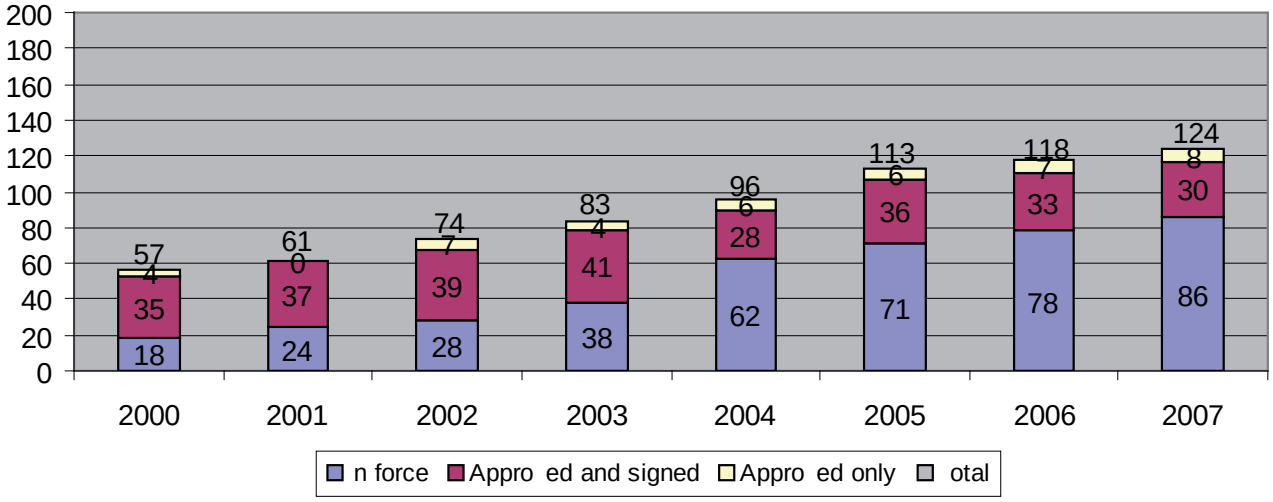


FIG. 1. Number of APs in force and approved by the Board of Governors at the end of 2007.

Conclusion of Safeguards Agreements and APs

The Agency continued to facilitate the conclusion of safeguards agreements and APs. As a result of these and other activities, the number of States party to the NPT that had yet to conclude CSAs decreased from 31 to 30. APs entered into force for eight States during 2007, so that by the end of 2007, 86 States had APs in force (Fig. 1). Five States signed APs in 2007, and seven States had APs approved by the Board of Governors.

Small Quantities Protocol

Following a decision by the Board of Governors in 2005, the Agency initiated exchanges of letters with all States having a small quantities protocol (SQP) in order to give effect to the modifications in the standard text and the change in the SQP criteria. During 2007, SQPs were amended to reflect the modified text for four States. An SQP was rescinded and a new safeguards agreement with a modified SQP was concluded. By the end of 2007, there were 69 States with operative SQPs still requiring modification in accordance with the Board's decision.

Implementation of Integrated Safeguards

Integrated safeguards can be defined as the optimum combination of all safeguards measures available to the Agency under CSAs and APs to achieve maximum effectiveness and efficiency in meeting the Agency's safeguards obligations. They are implemented in a State for which the Agency has drawn the broader conclusion that all nuclear material has remained in peaceful activities. Under integrated safeguards, measures may be applied at reduced levels at certain facilities.

"Integrated safeguards can be defined as the optimum combination of all safeguards measures available to the Agency."

Integrated safeguards continued to be implemented in Australia, Bangladesh, Bulgaria, Canada, Ghana, Hungary, Indonesia, Japan, Latvia, Norway, Peru, Poland, Slovenia and Uzbekistan. During 2007, integrated safeguards implementation was initiated in the Czech Republic, Ecuador, Jamaica, Lithuania, Mali and Romania. In addition, State level integrated safeguards approaches were approved for Austria, Greece, Ireland and Portugal. In total, at the end of 2007, State level integrated safeguards approaches were approved for 24 States.

Progress has been made on the arrangements between the European Commission and the Agency for the introduction of integrated safeguards in States party to INFCIRC/193. Discussions on procedural matters began at the regular Liaison Committee meetings, with the aim of introducing integrated safeguards in the relevant Member States in 2008.

The phased implementation of integrated safeguards in Japan continued at the site and facility levels during 2007, and started in Canada. The use of low frequency unannounced inspections has substantially decreased the inspection effort needed

in both States and it is further anticipated that the transition to full implementation of integrated safeguards will result in additional savings in the inspection effort.

Safeguards Implementation Issues

Implementation of safeguards in the Democratic People's Republic of Korea

Since December 2002, the Agency has not been able to implement safeguards in the Democratic People's Republic of Korea (DPRK) and, therefore, cannot draw any safeguards conclusion.

In March 2007, pursuant to a request from the States in the Six-Party talks, and at the invitation of the DPRK, the Director General, along with a team of Agency experts, visited the DPRK. Following this visit, and subsequent expert level consultations, the Agency agreed with the DPRK on monitoring and verification arrangements related to the shutdown of the Yongbyon nuclear facility.

On 17 July 2007, the Agency confirmed the shutdown status of the following installations at the Yongbyon nuclear facility: the Nuclear Fuel Fabrication Plant; the Radiochemical Laboratory (the reprocessing plant); the 5 MW(e) Experimental Nuclear Power Plant; and the 50 MW(e) Nuclear Power Plant. The Agency also confirmed the shutdown status of the 200 MW(e) Nuclear Power Plant in Taechon. As of 31 December 2007, these installations remained shut down.

On 4 November 2007, the DPRK started the disablement of the Yongbyon nuclear facilities. The Agency was able to observe and document the disabling work, including the 5 MW(e) Experimental Nuclear Power Plant No. 1 core discharge activities, while conducting facility monitoring activities. The spent fuel rods from the 5 MW(e) reactor were measured by the Agency upon discharge. These fuel rods, and the remaining items in the reactor core, are under Agency containment and surveillance. The nuclear material which has been generated during the disabling activities at the Nuclear Fuel Fabrication Plant also remains under Agency containment and surveillance.

Implementation of safeguards in the Islamic Republic of Iran

During 2007, the Director General submitted four reports to the Board of Governors, including reports in February and May to the United Nations Security Council, on the implementation of the NPT safeguards agreement in Iran. Pursuant to its CSA, Iran continued to provide the Agency with access to declared nuclear material and facilities, and provided the required nuclear material accountancy reports in connection with such material and facilities. Iran also concluded a Facility Attachment for the Fuel Enrichment Plant at Natanz. In 2007, the Agency did not receive the type of information that Iran had previously been providing pursuant to the AP and as transparency measures.

In March 2007, Iran suspended the implementation of the modified Code 3.1 of its Subsidiary Arrangements to its CSA with respect to the early provision of design information. In August 2007, agreement was reached on a work plan for resolving outstanding safeguards implementation issues. By the end of 2007, the Agency was able to clarify Iran's statements with respect to the plutonium experiments and its declared past P-1 and P-2 centrifuge programmes. The Agency also received a copy of the 15 page uranium metal document describing the procedures for the reduction of uranium hexafluoride (UF_6) to uranium metal and the casting and machining of enriched and depleted uranium metal into hemispheres. The Agency will continue, in accordance with its procedures and practices, to seek corroboration of its findings and to verify these issues as part of its verification of the completeness of Iran's declarations. The clarification of the issues relating to HEU contamination, polonium-210, the Gchine mine and the alleged studies on the green salt project, high explosives testing and the missile re-entry vehicle, was ongoing.

While the Agency was able to verify the non-diversion of the declared nuclear material in Iran in 2007, the Agency was not in a position to provide credible assurances regarding the absence of undeclared nuclear material and activities in Iran.

On 24 March 2007, the United Nations Security Council adopted resolution 1747 (2007), inter alia, re-affirming its decision in Security Council resolution 1737 (2006) that Iran suspend all enrichment related and reprocessing activities, including research and development, and work on all heavy water related projects, including the construction of a heavy water moderated research reactor.

In 2007, Iran continued with the operation of the Pilot Fuel Enrichment Plant and the Fuel Enrichment Plant. Construction of the IR-40 reactor, and operation of the heavy water production plant, were

also continuing at the end of 2007. There were no indications of reprocessing related activities at any declared sites in Iran in 2007.

Implementation of safeguards in the Republic of Korea

In 2004, following Agency enquiries, and in connection with the submission of its initial declaration pursuant to its AP, the Republic of Korea declared that laboratory scale experiments on uranium enrichment had been previously carried out without having been reported to the Agency. It also acknowledged past undeclared experiments, which involved uranium conversion, chemical enrichment of uranium and fuel irradiation followed by an experiment involving the separation of plutonium. These activities should have been reported by the Republic of Korea to the Agency in accordance with its obligations under its safeguards agreement. Information on these issues was provided in a report by the Director General submitted to the Board of Governors in November 2004 and in the Safeguards Implementation Report for 2004.

On the basis of the assessment of the information provided by the Republic of Korea on its previously undeclared nuclear activities, and other verification activities carried out by the Agency — including inspections, verification of design information and complementary access — the Agency was able to clarify the scope of the undeclared experiments and the amounts of nuclear material involved. The Agency's findings show that the Republic of Korea's past experiments and activities involving uranium conversion, uranium enrichment and plutonium separation were terminated prior to 2001, that the equipment used has been dismantled or is being used for other non-nuclear activities, and that there is no indication of the continuation of these activities.

For 2007, the Agency has found no indication of the diversion of declared nuclear material, and no indication of undeclared nuclear material and activities in the Republic of Korea. Therefore, the Agency was able to conclude for this State that all nuclear material remained in peaceful activities.

In the Republic of Korea, relevant procedures for the future implementation of integrated safeguards started, and some were tested through joint rehearsals between the Agency and the Republic of Korea at various nuclear facilities and sites in 2007. These activities were in anticipation of the Agency drawing the broader conclusion for this State.

Detecting Undeclared Nuclear Material and Activities: Improved Technical Capabilities and Methods

Safeguards equipment development

Under the Agency's project for the identification and development of effective and appropriate techniques for Safeguards, a workshop sponsored by the USA studied the area of advanced sensors for safeguards. Task proposals, covering semiconductor sensors and equipment for sampling airborne gases, are currently under consideration in two Member States. In addition, 13 Member States and the European Commission have indicated their support of the Novel Technologies Project by establishing tasks in this area.

Given the growing use of laser methods for rapid on-site analysis of materials, elements and isotopes, a technical meeting on the 'Application of Laser Spectrometry Techniques in IAEA Safeguards' was convened. The experts agreed that laser spectrometry was an effective and cost efficient alternative to some existing inspection methods, as well as a novel solution for emerging safeguards verification and detection needs. As an outcome, development began on a low cost on-line enrichment monitor and an in-field forensics instrument for on-site sampling and analysis of compounds and elements.

"Environmental sampling continues to be used extensively to confirm the absence of undeclared nuclear material and activities ..."

A workshop on 'Advanced Safeguards Technology for the Future Nuclear Fuel Cycle' was hosted by Japan in November to provide guidance on the future expected scenarios of the nuclear industry and to focus on the development of new safeguards methods and instruments to support the Agency's verification activities. A study was also initiated to model releases of signature isotopes from nuclear fuel cycle processes.

Sample analysis

Environmental sampling continues to be used extensively to confirm the absence of undeclared nuclear material and activities in facilities and

FIG. 2. Analysing environmental samples at SAL.

locations subject to inspections and complementary access (Fig. 2). In 2007, the Safeguards Analytical Laboratory (SAL) completed the installation of a new inductively coupled plasma-mass spectrometer for measurements of uranium and plutonium in swipe samples.

The laboratories of the Network of Analytical Laboratories (NWAL) performing environmental sample analysis, including SAL, were used at full capacity in 2007. Laboratories in Brazil and China have started qualification processes to join the NWAL.

A special SAL study group was established in 2007 to make recommendations for the future development of the laboratory. The report, which was presented at the November meeting of the Board of Governors, recommended that the Agency's Laboratories, Seibersdorf, be consolidated and reconstructed, its independent analytical capabilities strengthened and further utilization of the NWAL investigated. In particular, the report gave higher priority to the procurement and installation of an ultra-high-sensitivity secondary-ion mass spectrometer (UHS-SIMS). The Board of Governors expressed its support for independent and timely analysis of safeguards samples and encouraged Member States to provide extrabudgetary support.

Design information verification

In States with CSAs and significant nuclear activities, the Agency verifies design information at any stage in the life of nuclear facilities. By the end of 2007, design information verification plans for the entire life cycle of a facility had been prepared for 596 facilities.

Research and development programme

Research and development activities carried out with the assistance of Member State Support Programmes are essential to meet safeguards challenges in the absence of independent Agency R&D capabilities. During 2007, the Agency prepared its R&D programme for 2008–2009, which contains 23 projects in such areas as development of safeguards concepts, information processing and analysis, verification technologies and training.

Covert nuclear trade

The Agency continued to analyse safeguards relevant information on possible covert trade in nuclear material. In addition, the procurement outreach programme gathered information, provided

on a voluntary basis, on procurement enquiries and export denials of nuclear related equipment, materials and technology in order to detect early proliferation indicators.

Neptunium and americium

While several States have not yet responded to the Agency's requests for voluntary information on neptunium and americium and others have not properly reported on them, evaluation of the information, when provided by States, has continued. During 2007, flow sheet verification for neptunium was carried out at a European Commission laboratory and at a reprocessing and plutonium conversion facility in Japan.

Information technology

The Agency's project to re-engineer the safeguards information system reached a turning point in 2007 with completion of Phase II (foundation projects), dealing with the installation of the architecture and development of common building blocks. Phase III (implementation projects) began in 2007 with the aim of establishing a new integrated safeguards environment, primarily through the installation of a new production environment based on a single modular platform and a future-proof service oriented architecture. Information from open sources, commercial satellite imagery, in-house databases and other sources was collected, analysed and used extensively to support the evaluation of State nuclear activities in 2007.

Remote monitoring

By the end of 2007, 146 systems (96 surveillance and 50 radiation monitoring systems) with remote transmission capabilities were authorized for inspection use in 16 States.[3] The application of this technology has resulted in the enhanced effectiveness and efficiency of safeguards implementation.

Full remote monitoring was implemented during 2007 in Lithuania, Romania, Slovakia, the Czech Republic and Ukraine. Partial remote monitoring (i.e. 'status of health' information) was implemented in the Czech Republic, Ukraine, Kazakhstan and Bulgaria. Significant progress was made with the implementation of remote monitoring in Canada: unattended, remotely monitored systems were operating at all three multi-unit on-load refuelled power reactor facilities, resulting in a reduction of the inspection effort.

Significant Safeguards Projects

Rokkasho Reprocessing Plant

Most of the commissioning activities for the Rokkasho Reprocessing Plant (RRP) in Japan were completed in 2007. This included the first shearing and reprocessing of PWR and BWR spent fuel and the production and storage of the first canisters of MOX powder. Safeguards inspection procedures, based on continuous presence during operation, were implemented. The safeguards approach for the RRP was further elaborated during 2007 and at the end of 2007 was being subject to review before approval.

JMOX

During 2007, development of a safeguards approach for the MOX fuel fabrication plant in Japan (JMOX) continued including elements of the integrated safeguards approach for the site. The basic systems for safeguarding JMOX and the sharing of costs have been agreed. Construction of JMOX at the Rokkasho site is due to start in 2008.

Pebble Bed Modular Reactor

The Agency initiated a task for safeguarding the Pebble Bed Modular Reactor in cooperation with South Africa. The main objective is to complete system studies of the reactor, its supporting facilities and processes as well as to develop the necessary procedures and equipment for safeguards implementation.

Chernobyl

A feasibility study for the installation of a safeguards site data integration system was successfully completed in 2007. A camera system for monitoring the reactor hall of Unit 4 was also successfully tested.

Quality Management

During 2007, new elements of the quality management system (QMS) of the Department of

[3] As well as in Taiwan, China.

Safeguards were developed, implementation was extended and the elements of the system already in place were operated successfully.

A methodology to assess safeguards implementation costs was also established within the scope of the QMS. In addition, arrangements for recording and following up of non-conformities, as well as for implementing corrective actions, were established. Finally, training was provided in essential areas of QMS, such as corrective actions, process improvement, quality auditing and document control.

Seven internal quality audits were carried out during 2007. Selection of the areas to be audited was based on their importance to the overall process of drawing sound safeguards conclusions.

Assistance to State Systems of Accounting for and Control of Nuclear Material

The effectiveness and efficiency of Agency safeguards depend, to a large extent, on the effectiveness of State systems of accounting for and control of nuclear material (SSACs) and regional systems of accounting for and control of nuclear material (RSACs), and on the level of their cooperation with the Agency. The Secretariat continued to work with SSACs and RSACs on safeguards implementation issues such as the quality of operators' systems for the measurement of nuclear material, the timeliness and accuracy of State reports and declarations, and support for the Agency's verification activities.

Emphasis was placed on the implementation of the IAEA SSAC Advisory Service (ISSAS). Upon the request of States, ISSAS missions were conducted in Armenia, Switzerland and Ukraine. A preparatory meeting for an ISSAS mission was held in Niger.

With regard to the provision of training to SSAC personnel, 11 national, regional and international training courses were conducted in 2007. These included: an international SSAC course in the USA; a regional SSAC course in Argentina; two regional courses devoted to the establishment of an SSAC at the facility level in China and Ukraine; seven national training courses in Egypt, South Africa and Vietnam; and courses at Agency Headquarters for SSAC personnel from Egypt, Lebanon, Niger and the Republic of Korea.

Two regional technical meetings on AP implementation were conducted in Botswana (for African States) and in Australia (for the Asia–Pacific region). With the aim of assisting in the establishment and strengthening of SSACs, two outreach activities were conducted in Vietnam and Turkmenistan. In addition, in coordination with the Governments of Australia, Japan and Vietnam, the Agency hosted a seminar on APs for Vietnam in August 2007.

Standing Advisory Group on Safeguards Implementation

The Standing Advisory Group on Safeguards Implementation held two plenary meetings in 2007. The main issues considered were the State evaluation process, the physical model and its use in information analysis, the nuclear trade and technology analysis, long term strategic planning, and proliferation resistance and its impact on safeguards.

Advisory Committee on Safeguards Verification within the Framework of the IAEA Statute

The Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute (Committee 25) met twice in 2007, concluding its work of considering ways and means to strengthen the Agency's safeguards system. The documentation and clarifications provided by the Secretariat to the Committee described measures to improve the effectiveness and efficiency of the safeguards system in several areas, which increased the understanding and awareness of Member States in this regard.

Verification in Iraq Pursuant to UNSC Resolutions

Objective

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

Status of Verification Activities

The Agency's Iraq Nuclear Verification Office, which had been established to implement the relevant UNSC resolutions, was closed down following the termination by the UNSC of the Agency's mandate under those resolutions in June 2007 (S/RES/1762 (2007)). However, pursuant to Iraq's safeguards agreement, the Agency continued to: consolidate its information assets; collect and analyse a range of information, including satellite imagery; update its knowledge of the formerly relevant facilities in Iraq; and perform a physical inventory verification of the nuclear material present in the country.

Management of Technical Cooperation

Management of Technical Cooperation for Development

Objective

To contribute to sustainable social and economic benefits in Member States and their increased self-reliance in the application of nuclear techniques.

Fifty years ago, the Agency's technical cooperation programme — or the technical assistance programme, as it was then known — was modest and focused on building up nuclear expertise and helping to create the institutions and facilities that would support the safe introduction of nuclear technology. Today the picture has changed, due to the evolution of skills, infrastructure and needs in the Member States themselves. The development of nuclear capacities and infrastructure in some regions has paved the way for South–South cooperation, stimulating an increase in regional self-sufficiency and an expansion in collective, specialized expertise. In this context, the Agency continued in 2007 to support the capacities of Member States and help forge strong partnerships for sustainable development.

Strengthening the Agency's Technical Cooperation Programme

In 2007, Member States approved the continuation of the 2007–2008 cycle, which saw three new projects added to the programme: one in Lithuania on enhancing national capabilities to license a new nuclear power plant, and two regional projects in Latin America to support country programming and enhance operational safety in nuclear installations. In response to Member State requests, a paper on approaches to ensure that technical cooperation programme resources are sufficient, assured and predictable was prepared for the Board of Governors. The paper provides a historical overview of the initiatives and suggestions made over the years regarding this theme, with a view to building on past experiences. It also re-examines approaches to funding in the light of the new development environment.

Programme Cycle Management Framework

As part of efforts to strengthen programme quality, the Agency introduced a more systematic approach to quality criteria for screening technical cooperation project concepts and project designs. These criteria cover relevance to national policies and development priorities, government commitment, sustainability and the adoption of results based management principles.

"... the Agency introduced a more systematic approach to quality criteria for screening technical cooperation project concepts and project designs."

The Programme Cycle Management Framework (PCMF) IT application was enhanced to support the implementation of projects designed in the previous technical cooperation cycle, and to facilitate submission of project concepts. The Secretariat can now use the system to screen project concepts using quality and other technical cooperation criteria, and Member States can prioritize their prequalified concepts. The IT system will be further enhanced in 2008.

Country Programme Frameworks

To date, 104 Country Programme Frameworks (CPFs) have been prepared. Of these, 84 have been signed by Member States and the Agency, while 20 are in the draft stage. An additional six Member States are planning to implement CPFs, which would bring the total of planned and implemented CPFs to 110. In 2007, Burkina Faso and Thailand signed CPFs for the first time, while the CPFs of Belarus and Romania were revised and updated.

National Liaison Officer Guidelines

The National Liaison Officer (NLO) acts as a focal point for Agency activities in a country. Based on recommendations from the Standing Advisory Group on Technical Assistance and Cooperation

Note: Further details on the technical cooperation programme are available in the *Technical Cooperation Report for 2007*, which is included in the CD-ROM attached to this document.

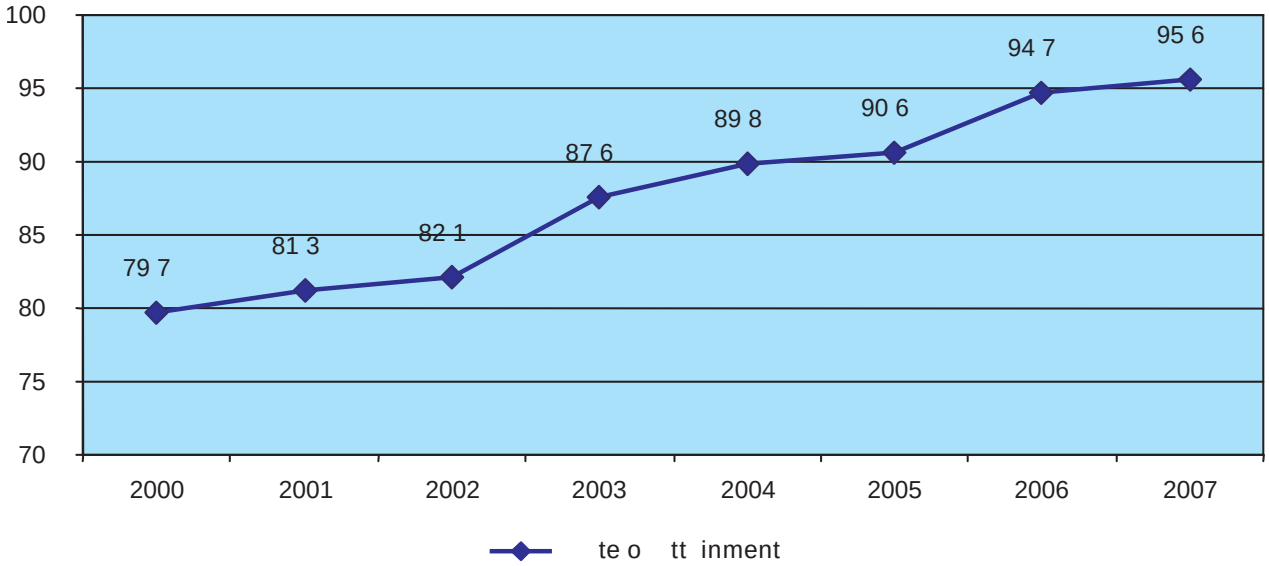


FIG. 1. Rate of attainment of the TCF between 2000 and 2007.

(SAGTAC), guidelines outlining the key roles and responsibilities of NLOs were finalized for Member States. These guidelines are available at *http://tc.iaea.org/tcweb/participation/recipientcountry/nlo_roles/nv_eng_2008-02-28.pdf.*

Framework for Regional Programming

In 2007, SAGTAC provided contributions for the improvement of the draft Regional Programming Framework. For example, in coordination with the ARCAL Regional Agreement, the Agency produced a 'Regional Strategic Profile' (RSP) that defines priority areas for regional technical cooperation in nuclear applications in human health, food and agriculture, the environment, radiation protection, waste safety and energy development for the period 2007–2012. A 'European Regional Profile' was also developed for 2009–2013. This profile was particularly important for 14 European Union Member States as they took the common position to focus more on regional programming and to reduce national technical cooperation projects.

The Africa region responded to SAGTAC's recommendations with the adoption of the concept of the 'Regional Strategic Cooperation Framework' (RCF). The RCF was endorsed by AFRA member countries at a 'High Level Policy Review Seminar', organized by Egypt and held in Aswan in November, to serve as the principal planning tool for setting regional cooperation priorities and developing AFRA regional cooperative programmes for the period 2008–2013. For the Asia and the Pacific region, the RCA Medium Term Strategy and Implementation Plan for 2006–2011, issued in 2007, was used to formulate the 2007–2008 regional programme.

Gender Policy

In keeping with General Conference resolutions calling on the Agency to enhance sensitivity to gender concerns as part of its programme activities, the Department of Technical Cooperation was selected to establish a framework incorporating a gender perspective in technical cooperation activities. Progress was made in increasing the number of women in management and decision making in the Agency, with women accounting for 31% of the staff in the Professional and higher categories, up from 25% in the previous reporting period. Suggestions on how gender concerns can be incorporated into the development process are provided in the CPF Guidelines, which are now available in all of the Agency's official languages.

Environmental Considerations

Nuclear energy and other nuclear applications have distinct environmental advantages. A 'Focus Group on the Environment' articulated three main goals for the Agency's regular and technical cooperation programmes: protecting humans and the ecosystem from ionizing radiation; optimizing the environmental benefits of nuclear technology; and facilitating the sustainable use and management of natural resources. The Agency is currently

developing modalities to ensure that environmental considerations are integrated into technical cooperation programme activities.

Financial Highlights

The technical cooperation programme continues to grow, and the Technical Cooperation Fund (TCF), in particular, recorded a very good year. Pledges and payments against the 2007 TCF target totalled $76.6 million, or 95.8% of the $80.0 million target, with the rate of attainment at the end of 2007 standing at 95.6% (Fig. 1), reflecting unpaid pledges of $0.1 million. The use of these resources was also high, with a record implementation of $83.9 million. For the programme as a whole, new resources stood at $100.3 million, down slightly from the 2006 high of $101.0 million. Implementation, measured against the adjusted programme for 2007, reached a rate of 74.9% ($100.0 million), just below the rate of 75.2% in 2006.

In 2007, technical cooperation activities supported capacity building and national infrastructure development, developing common approaches to knowledge management in nuclear technology and nuclear education, and providing practical activities aimed at ensuring the sustainable development of nuclear power and non-power nuclear applications. A guidance document on *Planning and Execution of Knowledge Management Assist Missions for Nuclear Organizations* was developed for experts and Member States.

Communications and Resource Mobilization

Recognizing the importance of conducting outreach in a coordinated and strategic fashion, the Agency initiated work on both a communication strategy and a resource mobilization strategy for its technical cooperation activities. The communication strategy, which aims to provide information on and raise awareness of the work of the technical cooperation programme and to build support for activities at the national and regional levels, is being developed and implemented on a modular basis. The resource mobilization strategy aims to develop partnerships to strengthen the impact of the programme and to increase the level of funding for technical cooperation activities to meet the resource needs of the programme.

Legislative Assistance

The Agency continued to provide legislative assistance to Member States in 2007. A total of eight national and regional workshops and seminars were held on a range of legal subjects and issues. For example, a Regional Workshop for Latin American and Caribbean States focusing on the international legal framework governing nuclear safety, security and safeguards — the '3S' concept — was organized in June in Vienna.

On a bilateral basis, the Agency provided legislative assistance in drafting national nuclear legislation to 25 Member States, which reflects a substantial increase compared with the year before. In addition, at the request of Member States, training on issues related to nuclear legislation was provided to scientific visitors at Agency Headquarters.

In the framework of a regional technical cooperation project, the Agency trained three African Fellows in international nuclear law. The Agency conducted lectures at training sessions of the World Nuclear University, in July in the Republic of Korea, and the International School of Nuclear Law, in August in France.

In 2007, a third publication in the IAEA International Law Series was issued, which provides explanatory texts of the 1997 Vienna Convention and the 1997 Convention on Supplementary Compensation.

Annex

Note: Tables A24–A28 are available on the attached CD-ROM.

Table A1. Allocation and utilization of regular budget resources in 2007 (unless otherwise indicated, the amounts in this table are given in euros)

Major Programme/Programme	2007 Original budget (at $1.0000)	2007 Adjusted budget (at $1.365)	Total expenditure		Unused (overexpended) budget
			Amount	% of adjusted budget	
	(1)	(2)	(3)	(3) / (2) (4)	(2) – (3) = (5)
1. Nuclear Power, Fuel Cycle and Nuclear Science					
1. Overall Management, Coordination and Common Activities	707 600	664 000	667 856	100.58%	(3 856)
A. Nuclear Power	5 265 900	4 879 000	4 870 894	99.83%	8 106
B. Nuclear Fuel Cycle and Materials Technologies	2 496 800	2 319 200	2 344 388	101.09%	(25 188)
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	10 348 900	9 740 600	9 742 438	100.02%	(1 838)
D. Nuclear Science	8 831 800	8 433 200	8 410 424	99.73%	22 776
Sub-total – Major Programme 1	**27 651 000**	**26 036 000**	**26 036 000**	**100.00%**	**(0)**
2. Nuclear Techniques for Development and Environmental Protection					
2. Overall Management, Coordination and Common Activities	768 100	723 100	753 256	104.17%	(30 156)
E. Food and Agriculture	12 291 900	11 667 000	11 671 069	100.27%	(4 069)
F. Human Health	7 950 100	7 487 700	7 358 874	95.73%	128 826
G. Water Resources	3 395 500	3 198 400	3 223 845	98.01%	(25 445)
H. Assessment and Management of Marine and Terrestrial Environments	5 237 700	4 986 200	5 010 916	98.23%	(24 716)
I. Radioisotope Production and Radiation Technology	1 991 700	1 856 600	1 900 898	98.16%	(44 298)
Sub-total – Major Programme 2	**31 635 000**	**29 919 000**	**29 918 857**	**100.00%**	**143**
3. Nuclear Safety and Security					
3. Overall Management, Coordination and Common Activities	983 900	913 800	937 258	102.57%	(23 458)
J. Safety of Nuclear Installations	8 346 800	7 837 700	7 826 283	99.85%	11 417
K. Radiation and Transport Safety	5 157 700	4 829 800	4 820 030	99.80%	9 770
L. Management of Radioactive Waste	6 204 800	5 775 700	5 703 729	98.75%	71 971
M. Nuclear Security	1 385 300	1 298 600	1 325 041	102.04%	(26 441)
X. Incident and Emergency Preparedness and Response	971 500	908 400	963 081	106.02%	(54 681)
Sub-total – Major Programme 3	**23 050 000**	**21 564 000**	**21 575 421**	**100.05%**	**(11 421)***
4. Nuclear Verification					
4. Overall Management, Coordination and Common Activities	1 011 800	957 500	986 757	103.06%	(29 257)
N. Safeguards	109 867 200	102 892 500	101 160 284	98.32%	1 732 216
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)					
Sub-total – Major Programme 4	**110 879 000**	**103 850 000**	**102 147 041**	**98.36%**	**1 702 959**
5. Information Support Services					
P. Public Information and Communication	3 402 700	3 211 800	3 023 765	94.15%	188 035
Q. Information and Communications Technology (ICT)	7 701 200	7 377 900	7 431 925	100.73%	(54 025)
S. Conference, Translation and Publishing Services	5 312 100	5 079 300	4 989 171	98.23%	90 129
Sub-total – Major Programme 5	**16 416 000**	**15 669 000**	**15 444 861**	**98.57%**	**224 139**
6. Management of Technical Cooperation for Development					
6. Overall Management, Coordination and Common Activities	553 200	524 700	813 042	154.95%	(288 342)
T. Management of Technical Cooperation for Development	15 267 800	14 515 300	14 141 133	97.42%	374 167
Sub-total – Major Programme 6	**15 821 000**	**15 040 000**	**14 954 175**	**99.43%**	**85 825**
7. Policy and General Management					
U. Executive Management, Policy-Making and Coordination	13 823 700	12 840 900	12 070 835	94.00%	770 065
V. Administration and General Services (excluding V.6 – Security Enhancement)	37 295 700	36 275 700	37 254 552	102.70%	(978 852)
W. Oversight Services and Performance Assessment	1 840 600	1 723 400	1 499 704	87.02%	223 696
Sub-total – Major Programme 7	**52 960 000**	**50 840 000**	**50 825 091**	**99.97%**	**14 909**
Sub-total	**278 412 000**	**262 918 000**	**260 901 446**	**99.23%**	**2 016 554**
Transfer to the Equipment Replacement Fund	0	0	2 016 554	0.00%	(2 016 554)
Sub-total	**278 412 000**	**262 918 000**	**262 918 000**	**100.00%**	**0**
8. Special Appropriation for Security Enhancement	**2 500 000**	**2 500 000**	**2 445 232**	**97.81%**	**54 768**
TOTAL – Agency Programmes	**280 912 000**	**265 418 000**	**265 363 232**	**99.98%**	**54 768**
9. Reimbursable Work for Others	2 699 000	2 543 000	2 629 267	103.39%	(86 267)
TOTAL	**283 611 000**	**267 961 000**	**267 992 499**	**100.01%**	**(31 499)**

* Emergency assistance as per GOV/1999/15.

Table A2. Extrabudgetary funds in support of the regular budget 2007
(unless otherwise indicated, the amounts in this table are in euros)

Major Programme/Programme	Extrabudgetary budget figures GC(49)/2	Resources: Unused balance as at 1 Jan. 2007	Resources: Receipts[a] as at 31 Dec. 2007	Resources: Adjustments as at 31 Dec. 2007	Total resources as at 31 Dec. 2007	Total expenditure as at 31 Dec. 2007	Unused balance as at 31 Dec. 2007
	(1)	(2)	(3)	(4)	(2) + (3) + (4) (5)	(6)	(5) – (6) (7)
1. Nuclear Power, Fuel Cycle and Nuclear Science							
1. Overall Management, Coordination and Common Activities	0	0	0	0	0	0	0
A. Nuclear Power	1 946 000	1 374 530	2 766 335	3 569	4 144 434	1 592 398	2 552 036
B. Nuclear Fuel Cycle and Materials Technologies	376 000	284 524	295 081	0	579 605	297 165	282 440
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	0	150 920	0	0	150 920	88 921	61 999
D. Nuclear Science	11 000	192 342	387 182	358	579 882	390 626	189 256
Sub-total – Major Programme 1	**2 333 000**	**2 002 316**	**3 448 598**	**3 927**	**5 454 841**	**2 369 110**	**3 085 731**
2. Nuclear Techniques for Development and Environmental Protection							
2. Overall Management, Coordination and Common Activities	0	1 815 640	362 483	35 560	2 213 683	1 165 104	1 048 579
E. Food and Agriculture (includes FAO)	2 819 000	11 330	1 631 554	0	1 642 884	1 418 385	224 499
F. Human Health	40 000	49 089	51 936	1 439	102 464	92 964	9 500
G. Water Resources	0	188 296	13 020	0	201 316	83 820	117 496
H. Assessment and Management of Marine and Terrestrial Environments	650 000	297 752	466 616	4 148	768 516	606 803	161 713
I. Radioisotope Production and Radiation Technology	0	4 241		0	4 241	0	4 241
Sub-total – Major Programme 2	**3 509 000**	**2 366 348**	**2 525 609**	**41 147**	**4 933 104**	**3 367 076**	**1 566 028**
3. Nuclear Safety and Security							
3. Overall Management, Coordination and Common Activities	192 000	1 625 835	3 119 096	9 667	4 754 598	1 441 057	3 313 541
J. Safety of Nuclear Installations	3 768 000	1 434 857	2 915 753	23 566	4 374 176	1 712 044	2 662 132
K. Radiation and Transport Safety	3 248 000	2 414 866	1 234 558	(157 701)	3 491 723	1 500 450	1 991 273
L. Management of Radioactive Waste	802 000	1 025 918	222 115	6 796	1 254 829	705 836	548 993
M. Nuclear Security	13 250 000	8 812 704	16 443 312	463 876	25 719 892	11 098 023	14 621 869
X. Incident and Emergency Preparedness and Response	570 000	637 876	1 324 465	20 423	1 982 764	701 412	1 281 352
Sub-total – Major Programme 3	**21 830 000**	**15 952 056**	**25 259 299**	**366 627**	**41 577 982**	**17 158 822**	**24 419 160**
4. Nuclear Verification							
4. Overall Management, Coordination and Common Activities	0	1 166 266	891 147	0	2 057 413	0	2 057 413
N. Safeguards	12 144 000	23 295 544	8 344 294	299 953	31 939 791	12 798 981	19 140 810
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)	12 295 000	146 157	63 434	3 301	212 892	214 141	(1 249)
Sub-total – Major Programme 4	**24 439 000**	**24 607 967**	**9 298 875**	**303 254**	**34 210 096**	**13 013 122**	**21 196 974**
5. Information Support Services							
P. Public Information and Communication	735 000	473 759	260 921	22 294	756 974	404 009	352 965
Q. Information and Communications Technology (ICT)	0	3 036	317 800	0	320 836	0	320 836
S. Conference, Translation and Publishing Services	0	0	0	0	0	0	0
Sub-total – Major Programme 5	**735 000**	**476 795**	**578 721**	**22 294**	**1 077 810**	**404 009**	**673 801**
6. Management of Technical Cooperation for Development							
6. Overall Management, Coordination and Common Activities	0	0	0	0	0	0	0
T. Management of Technical Cooperation for Development	136 000	312 053	213 512	0	525 565	246 372	279 193
Sub-total – Major Programme 6	**136 000**	**312 053**	**213 512**	**0**	**525 565**	**246 372**	**279 193**
7. Policy and General Management							
U. Executive Management, Policy-Making and Coordination	0	68 495	559 177	8 433	636 105	57 245	578 860
V. Administration and General Services	0	615 451	160 470	176 118	952 039	448 053	503 986
W. Oversight Services and Performance Assessment	136 000	14 318	0	(14 224)	94	0	94
Sub-total – Major Programme 7	**136 000**	**698 264**	**719 647**	**170 327**	**1 588 238**	**505 298**	**1 082 940**
Total Extrabudgetary Programme Fund	**53 118 000**	**46 415 799**	**42 044 261**	**907 576**	**89 367 636**	**37 063 809**	**52 303 827**

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

Table A3. Technical cooperation disbursements by Agency programme and region in 2007

I. Summary of all regions
(in thousands of dollars)

	Programme	Africa	Asia and the Pacific	Europe	Latin America	Global/ inter-regional	Total
A	Nuclear Power	428.6	1 217.6	918.2	513.8	268.6	3 346.8
B	Nuclear Fuel Cycle and Materials Technologies	35.7	118.1	30.2	135.2	0.0	319.2
C	Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	1 047.6	407.5	527.2	291.6	0.0	2 273.9
D	Nuclear Science	2 252.5	1 259.1	2 948.6	1 137.0	14.1	7 611.3
E	Food and Agriculture	6 871.2	2 223.8	595.7	2 115.7	105.2	11 911.5
F	Human Health	8 443.8	4 887.1	7 669.2	5 262.9	147.0	26 410.0
G	Water Resources	1 482.1	559.5	495.8	1 175.9	5.0	3 718.3
H	Assessment and Management of Marine and Terrestrial Environments	363.5	873.0	1 152.0	896.7	25.6	3 310.9
I	Radioisotope Production and Radiation Technology	1 708.4	2 732.8	1 592.8	946.7	10.4	6 991.0
J	Safety of Nuclear Installations	365.5	1 668.4	3 098.3	448.0	21.0	5 601.2
K	Radiation and Transport Safety	1 255.2	2 437.3	1 419.3	1 687.2	31.2	6 830.1
L	Management of Radioactive Waste	576.3	909.0	4 978.0	451.3	262.4	7 177.0
M	Nuclear Security	262.6	381.0	1 288.5	50.0	0.0	1 982.1
N	Safeguards	55.1	0.0	0.0	0.0	0.0	55.1
P	Public Information and Communication	2.4	0.0	0.0	0.0	0.0	2.4
T	Management of Technical Cooperation for Development	645.3	594.1	1 057.5	1 014.0	980.3	4 291.3
U	Executive Management, Policy Making and Coordination	219.6	39.7	134.0	12.2	0.0	405.5
X	Emergency Preparedness	205.4	361.3	475.5	36.8	0.0	1 079.0
Total		26 220.8	20 669.1	28 380.9	16 175.0	1 870.9	93 316.6

Table A3. Technical cooperation disbursements by Agency programme and region in 2007 (cont.)

II. Distribution by region
(in thousands of dollars)

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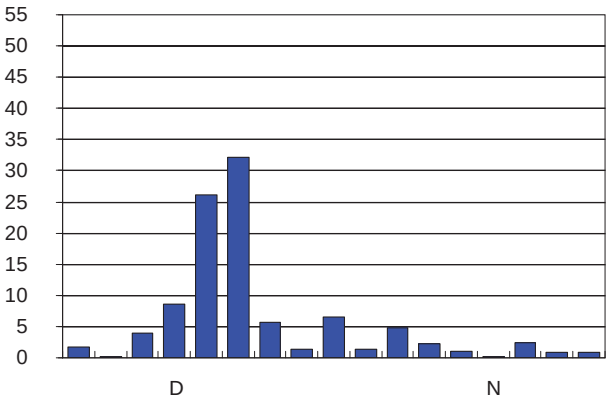

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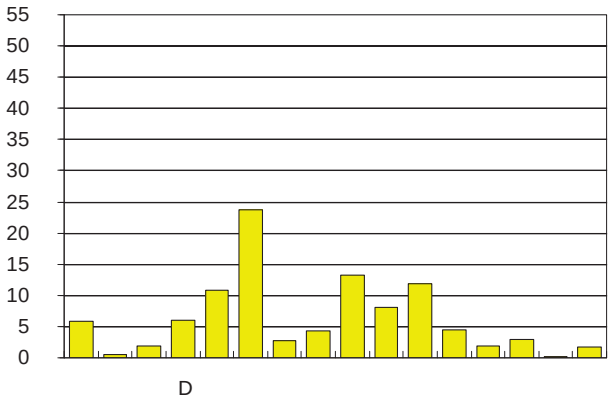

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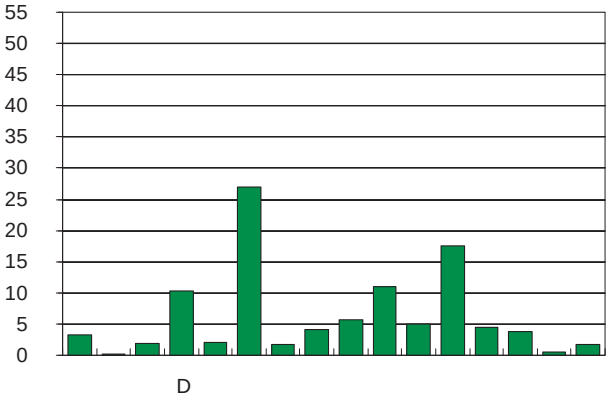

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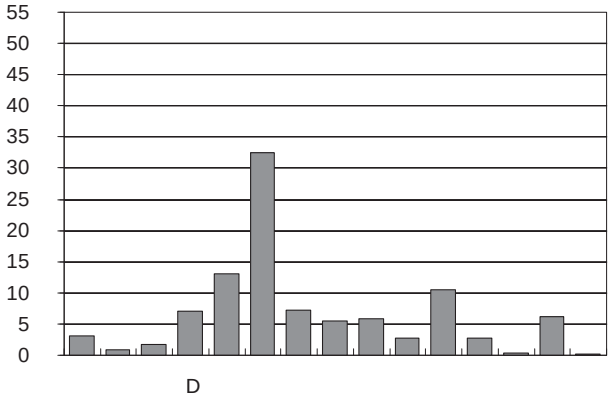

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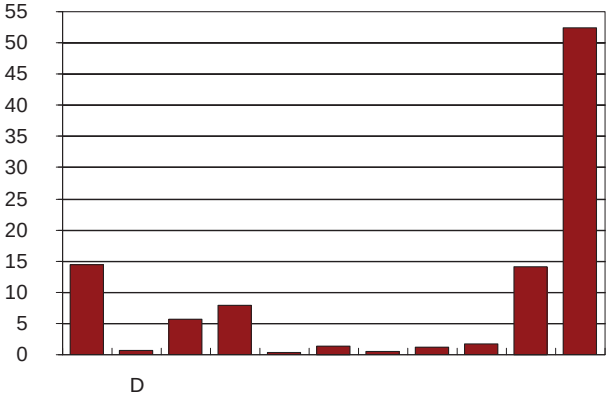

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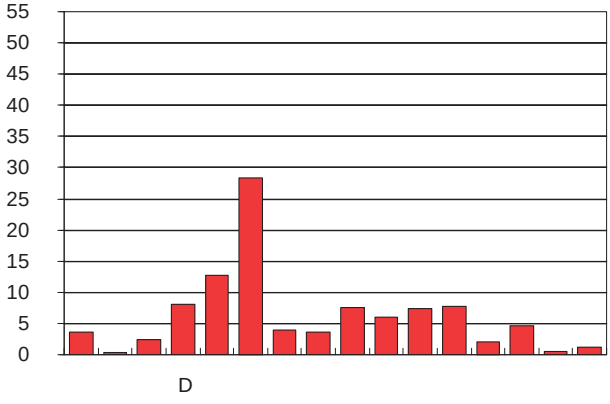

Note: Letters denote Agency programmes, which are explained in the previous summary.

Table A4. Approximate quantities of material subject to Agency safeguards at the end of 2007

Type of material	Quantity of material (SQs)			Quantity in SQs
	Comprehensive safeguards agreements[a]	INFCIRC/66[b] type agreement	Voluntary offer agreements	
Nuclear material				
Plutonium[c] contained in irradiated fuel and in fuel elements in reactor cores	101 000	1 157	14 305	116 462
Separated plutonium outside reactor cores	1 244	5	9 807	11 056
HEU (equal to or greater than 20% ^{235}U)	270	1	49	320
LEU (less than 20% ^{235}U)	14 359	108	680	15 147
Source material[d] (natural and depleted uranium and thorium)	7 157	107	1 481	8 745
U-233	19	—	—	19
Total significant quantities	**124 049**	**1378**	**26 322**	**151 749**
Non-nuclear material[e]				
Heavy water (tonnes)	—	450	—	—

Note: The quantities of material are given in significant quantities, defined as the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded. Significant quantities take into account unavoidable losses due to conversion and manufacturing processes and should not be confused with critical masses. They are used in establishing the quantity component of the Agency's inspection goal.

[a] Covering safeguards agreements pursuant to the NPT and/or the Treaty of Tlatelolco and other comprehensive safeguards agreements; includes facilities in Taiwan, China.

[b] Covering facilities in India, Israel and Pakistan.

[c] The quantity includes an estimated 10 824 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 C/S measures are applied) and plutonium in fuel elements loaded into core.

[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 A5. Number of facilities under safeguards or containing safeguarded material on 31 December 2007

Facility type	Number of facilities			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b] type agreements	Voluntary offer agreements	Total
Power reactors	191	5	1	197
Research reactors and critical assemblies	138	3	1	142
Conversion plants	18	0	0	18
Fuel fabrication plants	37	2	0	39
Reprocessing plants	7	1	0	8
Enrichment plants	12	0	2	14
Separate storage facilities	90	2	6	98
Other facilities	64	0	1	65
Subtotals	**557**	**13**	**11**	**581**
Other locations	367	1	0	368
Totals	**924**	**14**	**11**	**949**

[a] Covering safeguards agreements pursuant to the NPT and/or the Treaty of Tlatelolco and other comprehensive safeguards agreements; includes facilities in Taiwan, China.

[b] Covering facilities in India, Israel and Pakistan.

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a, b] and small quantities protocols[c] (as of 31 December 2007)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Afghanistan	X	In force: 20 February 1978	257	In force: 19 July 2005
Albania[1]		In force: 25 March 1988	359	Signed: 2 December 2004
Algeria		In force: 7 January 1997	531	Approved: 14 Sept. 2004
Andorra	X	*Signed: 9 January 2001*		*Signed: 9 January 2001*
Angola				
Antigua and Barbuda[2]	X	In force: 9 Sept. 1996	528	
Argentina[3]		In force: 4 March 1994	435/Mod.1	
Armenia		In force: 5 May 1994	455	In force: 28 June 2004
Australia		In force: 10 July 1974	217	In force: 12 December 1997
Austria[4]		Accession: 31 July 1996	193	In force: 30 April 2004
Azerbaijan	Amended: 20 November 2006	In force: 29 April 1999	580	In force: 29 November 2000
Bahamas[2]	Amended: 25 july 2007	In force: 12 Sept. 1997	544	
Bahrain	*Signed: 19 September 2007*	*Signed: 19 September 2007*		
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados[2]	X	In force: 14 August 1996	527	
Belarus		In force: 2 August 1995	495	Signed: 15 November 2005
Belgium		In force: 21 February 1977	193	In force: 30 April 2004
Belize[5]	X	In force: 21 January 1997	532	
Benin	X	*Signed: 7 June 2005*		*Signed: 7 June 2005*
Bhutan	X	In force: 24 October 1989	371	
Bolivia[2]	X	In force: 6 February 1995	465	
Bosnia and Herzegovina[6]		In force: 28 December 1973	204	
Botswana		In force: 24 August 2006	694	In force: 24 August 2006
Brazil[7]		In force: 4 March 1994	435	
Brunei Darussalam	X	In force: 4 November 1987	365	
Bulgaria		In force: 29 February 1972	178	In force: 10 October 2000
Burkina Faso	X	In force: 17 April 2003	618	In force: 17 April 2003
Burundi	In force: 27 September 2007	In force: 27 September 2007		In force: 27 September 2007
Cambodia	X	In force: 17 December 1999	586	
Cameroon	X	In force: 17 December 2004	641	Signed: 16 December 2004
Canada		In force: 21 February 1972	164	In force: 8 September 2000
Cape Verde	*Amended: 27 March 2006*	*Signed: 28 June 2005*		*Signed: 28 June 2005*
Central African Republic	*Approved: 7 March 2006*	*Approved: 7 March 2006*		*Approved: 7 March 2006*
Chad	*Approved: 22 November 2007*	*Approved: 22 November 2007*		*Approved: 22 November 2007*
Chile[8]		In force: 5 April 1995	476	In force: 3 November 2003
China		In force: 18 September 1989	369*	In force: 28 March 2002
Colombia[8]		In force: 22 December 1982	306	Signed: 11 May 2005

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Comoros	*Signed: 13 December 2005*	*Signed: 13 December 2005*		*Signed: 13 December 2005*
Congo, Republic of the				
Costa Rica[2]	Amended: 12 January 2007	In force: 22 November 1979	278	Signed: 12 December 2001
Côte d'Ivoire		In force: 8 September 1983	309	Approved: 22 November 2007
Croatia	X	In force: 19 January 1995	463	In force: 6 July 2000
Cuba[2]		In force: 3 June 2004	633	In force: 3 June 2004
Cyprus	X	In force: 26 January 1973	189	In force: 19 February 2003
Czech Republic[9]		In force: 11 September 1997	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	In force: 9 April 2003
Denmark[10]		In force: 21 February 1977	193	In force: 30 April 2004
Djibouti				
Dominica[5]	X	In force: 3 May 1996	513	
Dominican Republic[2]	Amended: 11 October 2006	In force: 11 October 1973	201	Signed: 20 September 2007
Ecuador[2]	Amended: 7 April 2006	In force: 10 March 1975	231	In force: 24 October 2001
Egypt		In force: 30 June 1982	302	
El Salvador[2]	X	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	X	*Approved: 13 June 1986*		
Eritrea				
Estonia[11]		Accession: 1 December 2005	193	Accession: 1 December 2005
Ethiopia	X	In force: 2 December 1977	261	
Fiji	X	In force: 22 March 1973	192	In force: 14 July 2006
Finland[12]		Accession: 1 October 1995	193	In force: 30 April 2004
France		In force: 12 September 1981	290*	In force: 30 April 2004
	X	In force: 26 October 2007[13]		
Gabon	X	*Signed: 3 December 1979*		*Signed: 8 June 2005*
Gambia	X	In force: 8 August 1978	277	
Georgia		In force: 3 June 2003	617	In force: 3 June 2003
Germany[14]		In force: 21 February 1977	193	In force: 30 April 2004
Ghana		In force: 17 February 1975	226	In force: 11 June 2004
Greece[15]		Accession: 17 Dec. 1981	193	In force: 30 April 2004
Grenada[2]	X	In force: 23 July 1996	525	
Guatemala[2]	X	In force: 1 February 1982	299	Signed: 14 December 2001
Guinea				
Guinea-Bissau				
Guyana[2]	X	In force: 23 May 1997	543	
Haiti[2]	X	In force: 9 March 2006	681	In force: 9 March 2006
Holy See	Amended: 11 September 2006	In force: 1 August 1972	187	In force: 24 September 1998

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Honduras[2]	Amended: 20 September 2007	In force: 18 April 1975	235	Signed: 7 July 2005
Hungary[16]		Accession: 1 July 2007	193	Accession: 1 July 2007
Iceland	X	In force: 16 October 1974	215	In force: 12 Sept. 2003
India		In force: 30 September 1971 In force: 17 November 1977 In force: 27 September 1988 In force: 11 October 1989 In force: 1 March 1994	211 260 360 374 433	
Indonesia		In force: 14 July 1980	283	In force: 29 Sept. 1999
Iran, Islamic Republic of		In force: 15 May 1974	214	Signed: 18 December 2003
Iraq		In force: 29 February 1972	172	
Ireland		In force: 21 February 1977	193	In force: 30 April 2004
Israel		In force: 4 April 1975	249/Add.1	
Italy		In force: 21 February 1977	193	In force: 30 April 2004
Jamaica[2]	Rescinded: 15 December 2006	In force: 6 November 1978	265	In force: 19 March 2003
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	In force: 9 May 2007
Kenya				
Kiribati	X	In force: 19 December 1990	390	Signed: 09 November 2004
Korea, Republic of		In force: 14 November 1975	236	In force: 19 February 2004
Kuwait	X	In force: 7 March 2002	607	In force: 2 June 2003
Kyrgyzstan	X	In force: 3 February 2004	629	Signed: 29 January 2007
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	Amended: 5 September 2007	In force: 5 March 1973	191	
Lesotho	X	In force: 12 June 1973	199	
Liberia				
Libyan Arab Jamahiriya		In force: 8 July 1980	282	In force: 11 August 2006
Liechtenstein		In force: 4 October 1979	275	Signed: 14 July 2006
Lithuania		In force: 15 October 1992	413	In force: 5 July 2000
Luxembourg		In force: 21 February 1977	193	In force: 30 April 2004
Madagascar	X	In force: 14 June 1973	200	In force: 18 Sept. 2003
Malawi	X	In force: 3 August 1992	409	In force: 26 July 2007
Malaysia		In force: 29 February 1972	182	Signed: 22 November 2005
Maldives	X	In force: 2 October 1977	253	
Mali	Amended: 18 April 2006	In force: 12 September 2002	615	In force: 12 September 2002
Malta[17]		Accession: 1 July 2007	193	Accession: 1 July 2007
Marshall Islands		In force: 3 May 2005	653	In force: 3 May 2005
Mauritania	X	*Signed: 2 June 2003*		*Signed: 2 June 2003*
Mauritius	X	In force: 31 January 1973	190	In force: 17 December 2007
Mexico[18]		In force: 14 September 1973	197	Signed: 29 March 2004

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
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	In force: 12 May 2003
Montenegro	*Approved: 13 June 2007*	*Approved: 13 June 2007*		*Approved: 13 June 2007*
Morocco	Rescinded: 15 November 2007	In force: 18 February 1975	228	Signed: 22 September 2004
Mozambique	*Approved: 22 November 2007*	*Approved: 22 November 2007*		*Approved: 22 November 2007*
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	X	In force: 5 June 1975	229[13]	
		In force: 21 February 1977	193	In force: 30 April 2004
New Zealand[19]	X	In force: 29 February 1972	185	In force: 24 September 1998
Nicaragua[2]	X	In force: 29 December 1976	246	In force: 18 February 2005
Niger		In force: 16 February 2005	664	In force: 2 May 2007
Nigeria		In force: 29 February 1988	358	In force: 4 April 2007
Norway		In force: 1 March 1972	177	In force: 16 May 2000
Oman	X	In force: 5 September 2006	691	
Pakistan		In force: 5 March 1962 In force: 17 June 1968 In force: 17 October 1969 In force: 18 March 1976 In force: 2 March 1977 In force: 10 September 1991 In force: 24 February 1993 In force: 22 February 2007	34 116 135 239 248 393 418 705	
Palau	Amended: 15 March 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[8]	X	In force: 23 March 1984	316	In force: 11 December 2001
Papua New Guinea	X	In force: 13 October 1983	312	
Paraguay[2]	X	In force: 20 March 1979	279	In force: 15 September 2004
Peru[2]		In force: 1 August 1979	273	In force: 23 July 2001
Philippines		In force: 16 October 1974	216	Signed: 30 September 1997
Poland[20]		Accession: 1 March 2007	193	Accession: 1 March 2007
Portugal[21]		Accession: 1 July 1986	193	In force: 30 April 2004
Qatar				
Republic of Moldova	X	In force: 17 May 2006	690	Approved: 13 September 2006
Romania		In force: 27 October 1972	180	In force: 7 July 2000
Russian Federation		In force: 10 June 1985	327*	In force: 16 October 2007
Rwanda				
Saint Kitts and Nevis[5]	X	In force: 7 May 1996	514	
Saint Lucia[5]	X	In force: 2 February 1990	379	
Saint Vincent and the Grenadines[5]	X	In force: 8 January 1992	400	

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Samoa	X	In force: 22 January 1979	268	
San Marino	X	In force: 21 September 1998	575	
Sao Tome and Principe				
Saudi Arabia	X	*Signed: 16 June 2005*		
Senegal	X	In force: 14 January 1980	276	Signed: 15 December 2006
Serbia[22]		In force: 28 December 1973	204	
Seychelles	Amended: 31 October 2006	In force: 19 July 2004	635	In force: 13 October 2004
Sierra Leone	X	*Signed: 10 November 1977*		
Singapore	X	In force: 18 October 1977	259	Signed: 22 September 2005
Slovakia[23]		Accession: 1 Dec. 2005	193	Accession: 1 December 2005
Slovenia[24]		Accession: 1 September 2006	193	Accession: 1 September 2006
Solomon Islands	X	In force: 17 June 1993	420	
Somalia				
South Africa		In force: 16 Sept. 1991	394	In force: 13 September 2002
Spain		Accession: 5 April 1989	193	In force: 30 April 2004
Sri Lanka		In force: 6 August 1984	320	
Sudan	X	In force: 7 January 1977	245	
Suriname[2]	X	In force: 2 February 1979	269	
Swaziland	X	In force: 28 July 1975	227	
Sweden[25]		Accession: 1 June 1995	193	In force: 30 April 2004
Switzerland		In force: 6 September 1978	264	In force: 1 February 2005
Syrian Arab Republic		In force: 18 May 1992	407	
Tajikistan	Amended: 6 March 2006	In Force: 14 Dec. 2004	639	In force: 14 December 2004
Thailand		In force: 16 May 1974	241	Signed: 22 September 2005
The Former Yugoslav Rep. of Macedonia	X	In force: 16 April 2002	610	In force: 11 May 2007
Timor-Leste	*Approved: 11 September 2007*	*Approved: 11 September 2007*		*Approved: 11 September 2007*
Togo	X	*Signed: 29 November 1990*		*Signed: 26 September 2003*
Tonga	X	In force: 18 November 1993	426	
Trinidad and Tobago[2]	X	In force: 4 November 1992	414	
Tunisia		In force: 13 March 1990	381	Signed: 24 May 2005
Turkey		In force: 1 September 1981	295	In force: 17 July 2001
Turkmenistan		In force: 3 January 2006	673	In force: 3 January 2006
Tuvalu	X	In force: 15 March 1991	391	
Uganda	X	In force: 14 February 2006	674	In force: 14 February 2006
Ukraine		In force: 22 January 1998	550	In force: 24 January 2006
United Arab Emirates	X	In force: 9 October 2003	622	
United Kingdom		In force: 14 December 1972	175[26]	
		In force: 14 August 1978	263*	In force: 30 April 2004
	X	Approved: 16 September 1992[13]		
United Republic of Tanzania	X	In force: 7 February 2005	643	In force: 7 February 2005

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
United States of America	X	In force: 9 December 1980 In force: 6 April 1989	288* 366[13]	Signed: 12 June 1998
Uruguay[2]		In force: 17 September 1976	157	In force: 30 April 2004
Uzbekistan		In force: 8 October 1994	508	In force: 21 December 1998
Vanuatu				
Venezuela[2]		In force: 11 March 1982	300	
Vietnam		In force: 23 February 1990	376	Signed: 10 August 2007
Yemen, Republic of	X	In force: 14 August 2002	614	
Zambia	X	In force: 22 September 1994	456	
Zimbabwe	X	In force: 26 June 1995	483	

Key

States: States not party to the NPT whose safeguards agreements are of INFCIRC/66 type.
States: Non-nuclear-weapon States which are party to the NPT but have not brought into force a safeguards agreement pursuant to Article III of that Treaty.
* : Voluntary offer safeguards agreement for NPT nuclear weapon States.

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[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 light of the application of safeguards pursuant to a CSA. Unless otherwise indicated, the safeguards agreements referred to are CSAs concluded pursuant to the NPT.

[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 that conclude CSAs, provided that they fulfil certain conditions (including that the quantities of nuclear material do not exceed the limits of paragraph 37 of INFCIRC/153), have the option to conclude a so-called "small quantities protocol" (SQP), thus holding in abeyance the implementation of most of the detailed provisions set out in Part II of a CSA as long as these conditions continue to apply. This column contains countries whose SQPs have been approved by the Board of Governors and for which, as far as the Secretariat is aware, these conditions continue to apply. For those States that have accepted the modified standard SQP text, which was approved by the Board of Governors on 20 September 2005, the current status is reflected.

[1] *Sui generis* CSA. On 28 November 2002, upon approval by the Board of Governors, an exchange of letters entered into force confirming that the safeguards agreement satisfies the requirement of Article III of the NPT. (INFCIRC 359/Mod.1.)

[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 satisfies 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 bilateral 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 between the non-nuclear weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Austria had acceded, entered into force for Austria.

[5] Date refers to a safeguards agreement pursuant to Article III of the NPT. Upon approval by the Board of Governors, an exchange of letters entered into force (for Saint Lucia on 12 June 1996 and for Belize, Dominica, Saint Kitts and Nevis and Saint Vincent and the Grenadines on 18 March 1997) confirming that the safeguards agreement satisfies the requirement of Article 13 of the Treaty of Tlatelolco.

[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 satisfies 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 satisfies 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; for Panama on 20 November 2003) confirming that the safeguards agreement satisfies the requirement of Article III of the NPT.

[9] 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.

[10] The application of safeguards in Denmark under the bilateral NPT safeguards agreement INFCIRC/176, in force since 1 March 1972, was suspended on 5 April 1973, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Denmark had acceded, entered into force for Denmark. 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.

[11] The application of safeguards in Estonia under the NPT safeguards agreement INFCIRC/547, in force since 24 November 1997, was suspended on 1 December 2005, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Estonia had acceded, entered into force for Estonia.

[12] The application of safeguards in Finland under the bilateral 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.

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

[14] 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.

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

[16] The application of safeguards in Hungary under the bilateral NPT safeguards agreement INFCIRC/174, in force since 30 March 1972, was suspended on 1 July 2007, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Hungary had acceded, entered into force for Hungary.

[17] The application of safeguards in Malta under the bilateral NPT safeguards agreement INFCIRC/387, in force since 13 November 1990, was suspended on 1 July 2007, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Malta had acceded, entered into force for Malta.

[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] Whereas the NPT safeguards agreement and small quantities protocol with New Zealand (INFCIRC/185) also apply to Cook Islands and Niue, the AP thereto (INFCIRC/185/Add.1) does not apply to those territories.

[20] The application of safeguards in Poland under the NPT safeguards agreement INFCIRC/179, in force since 11 October 1972, was suspended on 1 March 2007, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Poland had acceded, entered into force for Poland.

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

[22] 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 Serbia (formerly Serbia and Montenegro) to the extent relevant to the territory of Serbia.

[23] The application of safeguards in Slovakia under the bilateral NPT safeguards agreement with the Czechoslovak Socialist Republic (INFCIRC 173), in force since 3 March 1972, was suspended on 1 December 2005, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Slovakia had acceded, entered into force for Slovakia.

[24] The application of safeguards in Slovenia under the NPT safeguards agreement INFCIRC/538, in force since 1 August 1997, was suspended on 1 September 2006, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Slovenia had acceded, entered into force for Slovenia.

[25] 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 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Sweden had acceded, entered into force for Sweden.

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

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute

(status as of 31 December 2007)

P&I	Agreement on the Privileges and Immunities of the IAEA
VC	Vienna Convention on Civil Liability for Nuclear Damage
CPPNM	Convention on the Physical Protection of Nuclear Material
CPPNM-AM	Amendment to the Convention on the Physical Protection of Nuclear Material
ENC	Convention on Early Notification of a Nuclear Accident
AC	Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
JP	Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention
NS	Convention on Nuclear Safety
RADW	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
PAVC	Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage
SUPP	Convention on Supplementary Compensation for Nuclear Damage (not yet entered into force)
RSA	Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA)
VI	Acceptance of Amendment to Article VI of the IAEA Statute
XIV.A	Acceptance of Amendment to Article XIV.A of the IAEA Statute
*	Agency Member State
S	Signatory
P	Party
CS	Contracting State
r	Existing reservation/declaration

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	AFGHANISTAN			P		Sr	Sr						S	P	
*	ALBANIA	P		P		P	P						S		
*	ALGERIA			Pr	CS	Pr	Pr		S				S	P	P
	ANDORRA			Pr											
*	ANGOLA					P							S		
	ANTIGUA BARB			P											
*	ARGENTINA	P	P	Pr		Pr	Pr	S	P	P	P	CS	S	P	P
*	ARMENIA		P	P		P	P		P				S		
*	AUSTRALIA	P		P		Pr	Pr		P	P		S			
*	AUSTRIA			Pr	CS	P	Pr		Pr	P					
*	AZERBAIJAN			Pr									S		
	BAHAMAS														

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	BAHRAIN														
*	BANGLADESH			P		P	P		P				S		
	BARBADOS														
*	BELARUS	Pr	P	Pr		Pr	Pr		P	P	P		S	P	P
*	BELGIUM	Pr		Pr		P	P	S	P	P					
*	BELIZE												S		
*	BENIN	P											S		
	BHUTAN														
*	BOLIVIA	P	P	P		Pr	Pr						S		
*	BOSNIA AND HER		P	P		P	P								
*	BOTSWANA			P									S		
*	BRAZIL	P	P	P		P	P		P	P			S	P	P
	BRUNEI														
*	BULGARIA	P	P	P	CS	P	P	P	P	P			S	P	P
*	BURKINA FASO			P									S		
	BURUNDI														
	CAMBODIA			P											
*	CAMEROON	P	P	P		P	P	P					S		
*	CANADA	Pr		P		Pr	Pr		P	P				P	P
	CAPE VERDE			P											
*	CENT. AFR. REP.														
*	CHAD														
*	CHILE	Pr	Pr	P		P	P	P	P				S		
*	CHINA	Pr		Pr		Pr	Pr		P	Pr			S		
*	COLOMBIA	P	S	P		P	Pr						S		
	COMOROS			P											
	CONGO														
*	COSTA RICA			P		P	P						S		
*	CROATIA	P	P	P	CS	P	P	P	P	P			S	P	P
*	CT. D'IVOIRE					S	S						S		
*	CUBA	Pr	P	Pr		Pr	Pr		S				S		
*	CYPRUS	P		Pr		P	P		P				S		
*	CZECH REP.	P	P	P		P	P	P	P	P	S	S	S	P	P

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	D.P.R. KOREA					Sr	Sr								
*	D.R. CONGO	P		P		S	S						S		
*	DENMARK	Pr		P		P	S	P	Pr	Pr					
	DJIBOUTI			P											
	DOMINICA			P											
*	DOMINICAN RP			S									S		
*	ECUADOR	P		P									S		
*	EGYPT	P	P			Pr	Pr	P	S				S		
*	EL SALVADOR			P		Pr	Pr						S	P	
	EQ. GUINEA			P											
*	ERITREA														
*	ESTONIA	P	P	P		P	P	P	P	P			S		
*	ETHIOPIA												S	P	
	FIJI														
*	FINLAND	P		Pr		P	Pr	P	P	P				P	P
*	FRANCE			Pr		Pr	Pr	S	P	P				P	P
*	GABON														
	GAMBIA														
*	GEORGIA			P									S		
*	GERMANY	Pr		Pr		Pr	Pr	P	P	P				P	P
*	GHANA	P		P					S				S		
*	GREECE	P		Pr		Pr	Pr	P	P	P			S	P	P
	GRENADA			P											
*	GUATEMALA			Pr		P	P						S		
	GUINEA			P											
	GUINEA-BISSAU														
	GUYANA			P											
*	HAITI			S									S		
*	HOLY SEE	P				S	S							P	P
*	HONDURAS			P									S		
*	HUNGARY	Pr	P	P		P	P	P	P	P	S		S	P	P
*	ICELAND	P		P		P	P		S	P			S		
*	INDIA	P		Pr	CS	Pr	Pr		P						

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	INDONESIA	Pr		Pr		Pr	Pr		P	S	S	S	S		
*	IRAN, ISL. REP.	P				Pr	Pr						S		P
*	IRAQ	P				Pr	Pr						S		
*	IRELAND	P		Pr		P	Pr		P	P			S	P	P
*	ISRAEL		Sr	Pr		Pr	Pr		S				S		
*	ITALY	Pr		Pr		Pr	Pr	P	P	P	S	S		P	P
*	JAMAICA	P		P									S		
*	JAPAN	P		P		P	Pr		P	Pr				P	P
*	JORDAN	Pr				P	P		S				S		
*	KAZAKHSTAN	P		P					S	S			S		
*	KENYA			P	CS								S		
	KIRIBATI														
*	KOREA REP.	Pr		Pr		P	Pr		P	P			S	P	P
*	KUWAIT	P		Pr		P	P		P				S		
*	KYRGYZSTAN									P			S		
	LAO P. DEM. R.														
*	LATVIA	P	P	P		P	P	P	P	P	P		S	P	P
*	LEBANON		P	P		P	P		P	S	S	S	S		
	LESOTHO														
*	LIBERIA														
*	LIBYAN A. J.			P	CS		P						S		
*	LIECHTENSTEIN			P		P	P							P	P
*	LITHUANIA	P	P	P		P	P	P	P	P	S	S	S	P	P
*	LUXEMBOURG	Pr		Pr		P	P		P	P				P	P
*	MADAGASCAR			P									S		
*	MALAWI														
*	MALAYSIA					Pr	Pr						S		
	MALDIVES														
*	MALI			P		P	P		P				S		
*	MALTA			P									S	P	P
*	MARSHALL ISL.			P											
*	MAURITANIA														
*	MAURITIUS	P				Pr	Pr						S		

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	MEXICO	Pr	P	P		P	P		P				S	P	P
	MICRONESIA														
*	MONACO			P		Pr	Pr		S					P	P
*	MONGOLIA	P		P		P	P						S		
*	MONTENEGRO	P	P	P		P	P						S		
*	MOROCCO	Pr	S	P		P	P	S	S	P	P	CS	S	P	
*	MOZAMBIQUE			Pr											
*	MYANMAR					Pr							S	P	P
*	NAMIBIA			P									S		
	NAURU			P											
	NEPAL														
*	NETHERLANDS	P		Pr		Pr	Pr	P	P	P				P	P
*	NEW ZEALAND	P		P		P	Pr								
*	NICARAGUA	P		P		Pr	Pr		S				S		
*	NIGER	P	P	P		S	S						S		
*	NIGERIA	P	P	P	CS	P	P		P	P			S		
*	NORWAY	P		Pr		P	Pr	P	P	P					
	OMAN			Pr											
*	PAKISTAN	Pr		Pr		Pr	Pr		P				S	P	P
	PALAU			P											
*	PANAMA			P		P	P						S	P	
	PAPUA N. GUIN.														
*	PARAGUAY			P		S	S						S		
*	PERU		P	Pr		Pr	Pr		P	S	S	S	S	P	P
*	PHILIPPINES	P	P	P		P	P	S	S	S	S	S	S		
*	POLAND	P	P	P	CS	P	P	P	P	P	S		S	P	P
*	PORTUGAL	Pr		Pr		P	P	S	P				S		
*	QATAR			Pr		P	P						S		
*	REP. MOLDOVA		P	P		P	P		P				S		
*	ROMANIA	Pr	P	Pr	CS	Pr	Pr	P	P	P	P	CS	S	P	P
*	RUSSIAN FED.	Pr	P	Pr		Pr	Pr		P	P					
	RWANDA														
	SAINT LUCIA														

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	SAMOA														
	SAN MARINO														
	SAO TOME PRN														
*	SAUDI ARABIA					Pr	Pr						S		
*	SENEGAL	P		P		S	S						S		
*	SERBIA	P	P	P		P	P						S		
*	SEYCHELLES			P	CS								S		
*	SIERRA LEONE					S	S						S		
*	SINGAPORE	Pr				P	P		P				S		
*	SLOVAKIA	P	P	P		Pr	Pr	P	P	P			S	P	P
*	SLOVENIA	P		P		P	P	P	P	P			S	P	P
	SOLOMON ISLS														
	SOMALIA														
*	SOUTH AFRICA	Pr		Pr		Pr	Pr		P	P			S		
*	SPAIN	P	S	Pr	CS	Pr	Pr	S	P	P			S	P	P
*	SRI LANKA					Pr	Pr		P				S		
	ST. KITTS NEV.														
	ST. VINCT GRN.		P			P	P	P							
*	SUDAN			P		S	S		S				S		
	SURINAME														
	SWAZILAND			P											
*	SWEDEN	P		Pr		P	Pr	P	P	P				P	P
*	SWITZERLAND	Pr		Pr		P	P	S	P	P				P	P
*	SYRIAN A. REP	P				S	S		S				S		
*	TAJIKISTAN			P									S		
*	TFYR MACEDONIA		P	P		P	P		P				S		
*	THAILAND	Pr				Pr	Pr						S		
	TIMOR LESTE														
	TOGO			P											
	TONGA			P											
	TRINIDAD TOBAG		P	P											
*	TUNISIA	P		P		P	P		S				S		P
*	TURKEY	Pr		Pr		Pr	Pr	P	P				S	P	P

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	TURKMENISTAN			P	CS										
	TUVALU														
*	UGANDA			P									S		
*	UK	P	S	Pr		Pr	Pr	S	P	P				P	P
*	UKRAINE	Pr	P	P		Pr	Pr	P	Pr	P	S	S	S	P	P
*	UNTD. RP. TANZ.			P		P	P						S		
*	URUGUAY		P	P		P	P		P	P			S		
*	USA			P		Pr	Pr		P	P		S			
*	UTD ARAB EMR.			P		Pr	Pr						S		
*	UZBEKISTAN			P									S		
	VANUATU														
*	VENEZUELA												S		
*	VIETNAM	P				Pr	Pr						S		
*	YEMEN			P											
*	ZAMBIA												S		
*	ZIMBABWE					S	S						S		

Table A8. Conventions negotiated and adopted under the auspices of the Agency and/or for which the Director General is the depositary (status and relevant developments)

Agreement on the Privileges and Immunities of the IAEA (reproduced in INFCIRC/9/Rev. 2). In 2007, 3 States accepted the Agreement. By the end of the year, there were 78 Parties.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2007, 2 States adhered to the Convention. By the end of the year, there were 35 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2007, the status remained unchanged with 2 Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2007, 8 States adhered to the Convention. By the end of the year, there were 130 Parties.

Amendment to the Convention on the Physical Protection of Nuclear Material. Adopted on 8 July 2005. In 2007, 7 States adhered to the Amendment. By the end of the year, there were 13 Contracting States.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2007, 2 States adhered to the Convention. By the end of the year, there were 101 Parties.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (reproduced in INFCIRC/336). Entered into force on 26 February 1987. In 2007, 2 States adhered to the Convention. By the end of the year, there were 99 Parties.

Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (reproduced in INFCIRC/402). Entered into force on 27 April 1992. In 2007, 1 State adhered to the Protocol. By the end of the year, there were 25 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2007, 2 States adhered to the Convention. By the end of the year, there were 60 Parties.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (reproduced in INFCIRC/546). Entered into force on 18 June 2001. In 2007, 1 State adhered to the Convention. By the end of the year, there were 45 Parties.

Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/566). Entered into force on 4 October 2003. In 2007, the status remained unchanged with 5 Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Opened for signature on 29 September 1997. In 2007, the status remained unchanged with 3 Contracting States and 13 Signatories.

Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA). In 2007, 1 state signed the Agreement. By the end of the year, there were 109 States that concluded RSAs.

Fourth Agreement to Extend the 1987 Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) (reproduced in INFCIRC/167/Add.22). Entered into force on 26 February 2007 with effect from 12 June 2007. In 2007, 12 States adhered to the Agreement. By the end of the year, there were 13 Parties.

African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (Third Extension) (reproduced in INFCIRC/377). Entered into force on 4 April 2005. In 2007, 4 States adhered to the Agreement. By the end of the year, there were 30 Parties.

Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) (reproduced in INFCIRC/582). Entered into force on 5 September 2005. In 2007, 1 State adhered to the Agreement. By the end of the year, there were 14 Parties.

Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) (reproduced in INFCIRC/613/Add.1). Entered into force on 29 July 2002. In 2007, the status remained unchanged with 7 Parties.

Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/702). Entered into force on 24 October 2007. In 2007, 6 States and EURATOM adhered to the Agreement. By the end of the year, there were 7 Parties.

Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/703). Entered into force on 24 October 2007. In 2007, 5 States and EURATOM adhered to the Agreement. By the end of the year, there were 6 Parties.

Table A9. Integrated Regulatory Review Service (IRRS) missions in 2007

Type of mission	Country
Preparatory IRRS	Germany; Pakistan; Spain; Ukraine
IRRS	Australia; Kenya; Japan; Mexico; Mongolia; Uganda

Table A10. Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal missions in 2007

	Country
RaSSIA	Algeria; Cameroon; Gabon; Mauritius; Niger; Uzbekistan

Table A11. Safety Culture Assessment Review Team (SCART) missions in 2007

Type	Organization/power plant	Country
Preparatory SCART	ASCO, Vandellos II	Spain
SCART	Sta. Maria de Garona	Spain

Table A12. Operational Safety Review Team (OSART) missions in 2007

Type	Plant and reactor type	Country
Preparatory-OSART	Chinon, PWR	France
Preparatory-OSART	Cruas, PWR	France
Preparatory-OSART	Bushehr, WWER	Islamic Republic of Iran
Preparatory-OSART	Mihama, PWR	Japan
Preparatory-OSART	Balakovo, WWER	Russian Federation
Preparatory-OSART	Forsmark, BWR	Sweden
Preparatory-OSART	Arkansas, PWR	USA

OSART	Tihange, PWR	Belgium
OSART	Loviisa, WWER	Finland
OSART	Chinon, PWR	France
OSART	Neckarwestheim, PWR	Germany
OSART	Yonggwang, PWR	Republic of Korea
OSART	Khmelnitski, WWER	Ukraine
Follow-up OSART	Borssele, PWR	Netherlands
Follow-up OSART	Volgodonsk, WWER	Russian Federation

Table A13. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2007

Type	Plant and reactor type	Country
PROSPER	Angra, PWR	Brazil
PROSPER	Kanupp, PHWR	Pakistan

Table A14. International Probabilistic Safety Assessment Review Team (IPSART) missions in 2007

Type	Plant and reactor type	Country
Preparatory IPSART	Chashma 1, PWR	Pakistan
IPSART	Armenia, WWER	Armenia

Table A15. Review of Accident Management Programmes (RAMP) missions in 2007

Type	Plant and reactor type	Country
Preparatory RAMP		China; Romania
RAMP	Ignalina, LWGR	Lithuania

Table A16. Safety Aspects of Long Term Operation (SALTO) missions in 2007

Type	Country
Preparatory SALTO	Czech Republic
SALTO	Hungary; Republic of Korea; Pakistan; Ukraine

Table A17. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2007

Type	Country
INSARR	Islamic Republic of Iran
INSARR	Norway
INSARR	Syrian Arab Republic
Follow-up INSARR	Thailand

Table A18. Safety Evaluation During Operation of Fuel Cycle Facilities (SEDO) missions in 2007

Type	Country
SEDO	Brazil

Table A19. Emergency Preparedness Review (EPREV) missions in 2007

Type	Country
EPREV	Egypt; Russian Federation; Tajikistan

Table A20. Safety review service and expert missions in 2007

Type	Country
Mission to review international experience with the aim of enhancing ANPP self-assessment practices	Armenia
Assess the radiological situation at the peninsula on the basis of monitoring results	Azerbaijan
Discuss main aspects involved in the disposal of naturally radioactive material waste	Brazil
Pre-project mission to evaluate status of refurbishment	Bulgaria
Public exposure control with emphasis on waste safety	Chile
Assessment needs in occupational radiation protection and education and training	China
Mission to provide assistance in enhancing compliance with the IAEA safety standards and improving management systems at new nuclear power plants	China
Development of safety culture at the Haiyang nuclear power plant	China
Promotion of nuclear safety and enhancement of the management of nuclear power plants	China
Review preparatory activities for decommissioning plan for heavy water reactors	China
Streamlined reliability centred maintenance at the Qinshan Nuclear Power Centre	China
Instrumentation and control system training and qualification of operators	Colombia
Review waste safety regulatory framework and assist with elaboration of national work plan	Colombia
Review results obtained and planned activities on Armenian nuclear power plant primary piping in-service inspection, leak before break concept application and high energy piping integrity	Czech Republic
Validate the IAEA action plan to ensure the safety and security of the CREN-K RR	Democratic Republic of the Congo
Review current status of NCNSRC	Egypt

Follow-up evaluation studies for nuclear power plant sites: Regulatory requirements and El-Dabaa workplan	Egypt
Advice on the legal and regulatory framework for decommissioning	Georgia
Public exposure control with emphasis on waste safety	Guatemala
Preliminary findings and lessons learned from the 16 July 2007 earthquake near the Kashiwazaki-Kariwa nuclear power plant	Japan
Radioactive waste management	Jordan
Assess the implementation of safety measures during core conversion	Kazakhstan
Peer review of radioactive waste management	Republic of Korea
Review of activities related to the continuous operation programme at KHNP	Republic of Korea
Evaluate site proposals for uranium mill tailings at Mali-Sui	Kyrgyzstan
Regulatory review of on-site emergency preparedness plans and procedures for BNPP-1	Islamic Republic of Iran
Implementation of new regulations for radiation protection of workers, public and environment	Islamic Republic of Iran
Assist safety aspects of the Tajoura research reactor, including core conversion and new instrumentation and control system	Libyan Arab Jamahiriya
Draft regulations to license research reactors	Malaysia
Assist establishment of national guidelines for development and assessment of the safety analysis report	Malaysia
Review requirements for certification of research reactor operators	Malaysia
Education and training appraisal mission on radiation protection and safety of radiation sources	Morocco
Site selection and evaluation for the first nuclear power plant	Nigeria
Preparatory meeting for the preliminary safety analysis report review of KANUPP-2 and KANUPP-3	Pakistan
Review Chapter 19 of Chashma 2 safety analysis report	Pakistan
Review of the post accident monitoring system	Pakistan
Review regulatory framework for control of public exposure, waste safety, decommissioning and remediation	Paraguay
Training needs assessment	Philippines
Advise CNCAN on development of review plan for licensing radioactive waste disposal facility	Romania
Assist CNCAN with regulatory review of support documentation for the Saligny Radwaste Disposal Project	Romania
Decommissioning plan for the WWR-S research reactor	Romania
Review ANDRAD's documentation and technical programme for development of the Saligny Radwaste Disposal Project	Romania

Review decommissioning planning status for the Vinča reactor	Serbia
Development and public acceptance of spent fuel disposal concept	Slovenia
Evaluate the outcome of safety assessment and site characterization work for repository	Slovenia
Review radiation protection programme of the TRR-1/M1 RR	Thailand
Meteorological and atmospheric dispersion studies for Sinop nuclear power plant site evaluation	Turkey
Comprehensive safety assessment of radioactive waste in Ukraine	Ukraine
Conduct of the safety assessment, establishment of computing capability, data acquisition and personnel training	Ukraine
Establish work plan for Activity 3.5 at the Chernobyl nuclear power plant	Ukraine
Review ageing management and lifetime evaluation of the RPV of the Rovno nuclear power plant	Ukraine
Review of the draft decommissioning plan for the Chernobyl nuclear power plant units 1, 2 and 3	Ukraine
Magnox decommissioning peer review	United Kingdom
Assess the implementation of safety measures during core conversion	Uzbekistan

Table A21. International Physical Protection Advisory Service (IPPAS) missions in 2007

Type	Country
IPPAS	Ghana
IPPAS follow-up	Indonesia; Ukraine
International Team of Experts (ITE) mission	Bahrain; Bosnia and Herzegovina; The Former Yugoslav Republic of Macedonia

Table A22. IAEA SSAC Advisory Service (ISSAS) missions in 2007

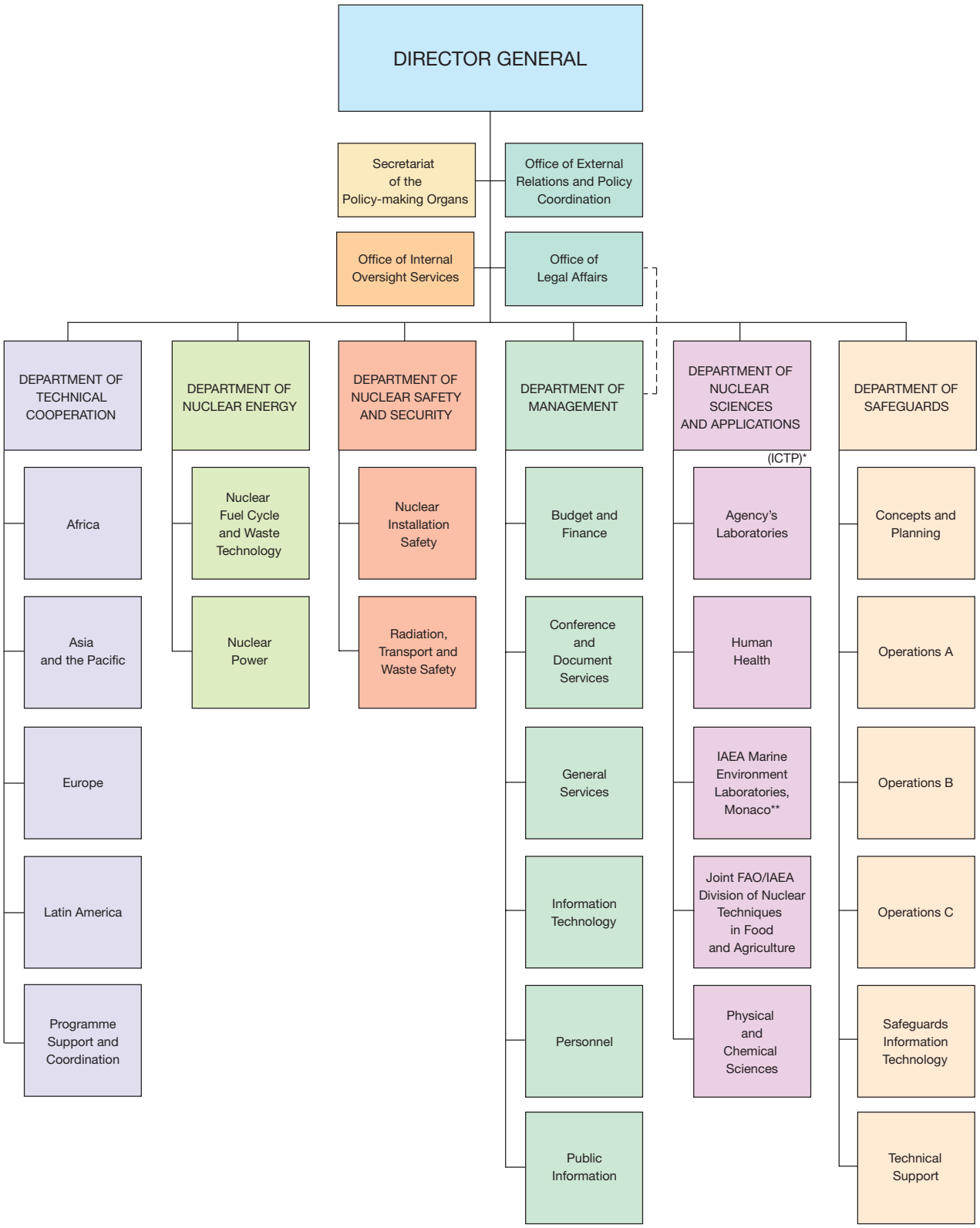
Type	Country
ISSAS	Armenia; Switzerland; Ukraine

Table A23. National strategies missions in 2007 for regaining control over radioactive sources

Type	Country
Verify inventory and orphan sources project	Burkina Faso; Cameroon; Kenya; Mali; Nigeria; Zambia

Organizational Chart

(as of 31 December 2007)



* 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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