International Atomic Energy Agency

ANNUAL REPORT 2006

IAEA

Atoms for Peace: The First Half Century

1957–2007

Annual Report 2006

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 2006.

IAEA
Atoms for Peace: The First Half Century
1957–2007

GC(51)/5

Contents

Member States of the International Atomic Energy Agency

(designation as of 31 December 2006)

AFGHANISTAN
ALBANIA
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BANGLADESH
BELARUS
BELGIUM
BELIZE
BENIN
BOLIVIA
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BULGARIA
BURKINA FASO
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHAD
CHILE
CHINA
COLOMBIA
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ETHIOPIA
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LATVIA
LEBANON
LIBERIA
LIBYAN ARAB JAMAHIRIYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAWI
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA
MAURITIUS
MEXICO
MONACO
MONGOLIA
MONTENEGRO
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
PAKISTAN
PANAMA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
SAUDI ARABIA
SENEGAL
SERBIA
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TUNISIA
TURKEY
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA
VIETNAM
YEMEN
ZAMBIA
ZIMBABWE

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

The Agency at a Glance

(as of 31 December 2006)

143 Member States.

67 intergovernmental and non-governmental organizations worldwide having formal agreements with the Agency.

49 years of international service.

2307 professional and support staff.

€262 million total regular budget for 2006, supplemented by extrabudgetary contributions received in 2006 amounting to **€29 million**.

$77.5 million target in 2006 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **3041** expert and lecturer assignments, **3229** meeting and workshop participants, **2477** participants in training courses and **1697** 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.

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

109 active CRPs involving **1410** approved research contracts and agreements. In addition, 69 Research Coordination Meetings were held.

237 safeguards agreements in force in **162** States involving **2142** safeguards inspections performed in 2006. Safeguards costs in 2006 amounted to **€92 million** in regular budget and **€8.4 million** in extrabudgetary resources.

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

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

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

200 publications and newsletters issued (in print and electronic formats) in 2006.

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 2006, the Board considered the *Nuclear Technology Review 2006*. In connection with the International Thermonuclear Experimental Reactor (ITER) project, it authorized the Director General to serve as depositary and approved the establishment of a Trust Fund.

In the area of safety and security, the Board considered the *Nuclear Safety Review for the Year 2005* and it established a number of safety standards. It considered the annual report on *Nuclear Security — Measures to Protect against Nuclear Terrorism*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2005*. It approved a number of safeguards agreements and additional protocols. The Board kept under its consideration the implementation of safeguards in the Islamic Republic of Iran and the Democratic People's Republic of Korea. The Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute held a number of meetings.

The Board considered the *Technical Cooperation Report for 2005* and set targets for the Technical Cooperation Fund for the 2007–2008 biennium.

Composition of the Board of Governors (2006–2007)

Chair: H.E. Mr. Ernest PETRIČ
Ambassador, Governor from Slovenia

Vice-Chairpersons: H.E. Mr. Thomas STELZER
Ambassador, Governor from Austria

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

Argentina
Australia
Austria
Belarus
Bolivia
Brazil
Canada
Chile
China
Colombia
Croatia
Cuba
Egypt
Ethiopia
Finland
France
Germany
Greece
India
Indonesia
Japan
Korea, Republic of
Libyan Arab Jamahiriya
Morocco
Nigeria
Norway
Pakistan
Russian Federation
Slovenia
South Africa
Sweden
Syrian Arab Republic
Thailand
United Kingdom of Great Britain and Northern Ireland
United States of America

The General Conference

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

In 2006, the General Conference — upon the recommendation of the Board — approved Malawi, Montenegro, Mozambique and Palau for membership of the Agency. By the end of 2006, the Agency's membership had risen to 143.

On the occasion of the 50th General Conference, the opening session featured a videotaped address by the Secretary-General of the United Nations, Mr. Kofi Annan, as well as an address by the Federal President of Austria, Dr. Heinz Fischer. A record number of 49 ministerial level delegations attended the Conference and there were 103 speakers in the general debate.

A special exhibit on display throughout the General Conference featured significant memorabilia associated with the early years of the Agency and a photo gallery depicting significant events during the Agency's first half century. In addition, there was a special exhibit — 'Nuclear Technologies for the Environment: Protecting Air, Earth and Oceans' (Fig. 1).

FIG. 1. The special exhibit on 'Nuclear Technologies for the Environment: Protecting Air, Earth and Oceans', in the lobby of the Austria Center Vienna, for the 50th regular session of the Agency's General Conference.

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 15, generally follows the programme structure as given in *The Agency's Programme and Budget 2006–2007* (GC(49)/2). The introductory chapter, 'Issues and Events in 2006', 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 2006* 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/Anrep2006/*.
- 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 NPT.

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
BWR	Boiling water reactor
CRP	Coordinated research project
EBRD	European Bank for Reconstruction and Development
EC	European Commission
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
ICAO	International Civil Aviation Organization
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
ICTP	International Centre for Theoretical Physics
IEA	OECD International Energy Agency
ILO	International Labour Organization
INFCIRC	Information Circular (IAEA)
INIS	International Nuclear Information System
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IRPA	International Radiation Protection Association
ISO	International Organization for Standardization
LWR	Light water reactor
NATO	North Atlantic Treaty Organization
NEA	OECD Nuclear Energy Agency
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PAHO	Pan American Health Organization/WHO
PET	Positron emission tomography
PHWR	Pressurized heavy water reactor
PWR	Pressurized water reactor
RBMK	Light boiling water cooled graphite moderated pressure tube 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
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNOPS	United Nations Office for Project Services
UNSC	United Nations Security Council
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization
WWER	Water cooled and moderated energy reactor

Issues and Events in 2006

The Agency's work under the three pillars of its mandate covering ***technology***, ***safety*** and ***verification*** continued to provide the basis for ensuring that nuclear technology contributes to the promotion of "peace, health and prosperity". This chapter reviews significant developments around the world during 2006 as they related to the Agency's own activities.

Technology

Within its nuclear technology programme, the Agency facilitates the exchange of nuclear information and knowledge, builds capacity, and transfers technology to its Member States, mainly through its technical cooperation programme. The aim is to facilitate and contribute to the use of nuclear science and associated technologies to meet, in a sustainable manner, the socioeconomic needs of Member States — through the safe use of nuclear power, and in food production, human health, water resources management, environmental protection and industrial applications.

Nuclear Power: Status and Trends

At the end of 2006, there were 435 nuclear power reactors in operation worldwide, representing approximately 370 gigawatts (GW(e)) of generating capacity and supplying about 16% of the world's electricity. Two new reactors were connected to the grid — in China and India — while eight were retired — two in Bulgaria, one each in Slovakia and Spain, and four in the United Kingdom. There were three construction starts, plus the resumption of active construction at one plant in the Russian Federation, for a total capacity of 23 641 megawatts (MW(e)) under construction by the end of the year. A number of countries announced plans for significant expansion, specifically China, India, Japan, Pakistan, the Russian Federation and the Republic of Korea. In addition, Argentina, France, South Africa, Ukraine and the USA have expressed an intention to expand their existing programmes.

Access to reliable and adequate sources of energy is essential for development. The demand for energy around the world continues to increase rapidly, with the latest projections by the IEA estimating that at current consumption levels, global energy consumption will increase by 53% by the year 2030. Approximately 70% of this growth will come from developing countries. For the first time these projections also recognize that nuclear power, among other energy sources, would not only help to meet the increased demand for energy and enhance the security of energy supply, but would also mitigate the discharge of carbon into the atmosphere, since energy produced from fossil fuels accounts for about half of human-made greenhouse gases. In this context, new medium term projections by the Agency and the IEA point to the possibility of a substantial expansion in the use of nuclear power. The Agency also established an interdepartmental 'Nuclear Power Support Group' to provide coordinated support to interested Member States considering the introduction or expansion of nuclear power.

In the USA, a number of companies and consortia have announced plans for licence applications which mention approximately 30 new reactors. Two site preparation applications were submitted in Canada. An ongoing energy review by the United Kingdom is addressing the issue of whether new nuclear power stations would make a significant contribution to meeting its energy policy goals. Utilities from Estonia, Lithuania and Latvia launched a joint feasibility study of a new nuclear power plant to serve all three countries.

"... 17 of the 29 reactors now being built are in developing countries."

While the use of nuclear power has thus far been concentrated in industrialized countries, the pattern is quite different in terms of *new* construction: 17 of the 29 reactors now being built are in developing countries. For example, India has seven reactors under construction, and is planning a substantial increase in capacity by 2022. China has four reactors under construction and envisages a more than fivefold expansion in nuclear generating capacity by 2020. Some States in the Asia–Pacific region are planning to include nuclear power in their energy mix. For example, Indonesia recently announced that it has decided to build two 1000 MW reactors in central Java, and Vietnam has expressed its intention to move forward with a nuclear power programme. In this connection, a workshop was held under Agency

auspices in December in Vienna on a wide spectrum of issues for the introduction of nuclear power in developing countries.

Life Extension and Reliability of Nuclear Power Plants

While nuclear power plants require significant up-front financial investment, they are relatively inexpensive to operate. There is thus a strong incentive to operate existing well run nuclear plants for as long as it is safe to do so. Through its technical cooperation programme, the Agency assisted Argentina, Hungary, Mexico and Ukraine in extending the operating life of their nuclear power plants through improvements in maintenance scheduling, training, scientific visits and workshops.

In the USA, the Nuclear Regulatory Commission approved licence renewals of 20 years each for eight nuclear power plants. The Netherlands granted a 20 year extension for the Borssele nuclear power plant and, in a shift from the country's earlier nuclear power phase-out policy, set operating conditions for *new* nuclear plants. The French Nuclear Safety Authority conditionally cleared all of Electricité de France's 1300 MW(e) PWRs for an additional ten years of operation. And in Canada, the Point Lepreau plant received a licence renewal until 2011.

Innovative Technologies for Nuclear Power Generation

Investment in R&D is important for the future growth of nuclear power. Scientific and technical research must focus on new designs of reactors of different sizes, with higher efficiency and greater availability, shorter construction times, and lower capital costs.

In January 2006, the Russian Federation announced an initiative to develop a Global Nuclear Power Infrastructure to provide nuclear fuel cycle services — including uranium enrichment — on a non-discriminatory basis and under the supervision of the Agency, taking full account of non-proliferation requirements. Another initiative, the Global Nuclear Energy Partnership (GNEP) — proposed by the USA — seeks to expand the worldwide use of economical nuclear energy to meet growing electricity demand, while reducing the risks of nuclear material being misused. Within this framework, GNEP began initial planning in 2006 on an Advanced Burner Test Reactor.

An international initiative on innovative nuclear technologies, the Generation IV International Forum (GIF), grew to 13 members in 2006 with the addition of China and the Russian Federation.[1] Four 'system arrangements' were signed during the year by GIF members, covering collaborative research and development on fast reactor systems, gas cooled fast reactor systems, very high temperature gas cooled reactor systems and supercritical water cooled reactor systems.

The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), which provides a forum for studying innovative nuclear energy systems and associated requirements, grew to 28 members with the addition of Belarus, Japan, Kazakhstan and Slovakia.[2] In July, INPRO completed Phase 1 of its work, specifically the development of a methodology to assess innovative nuclear energy systems in terms of economics, safety, environment, waste management, proliferation resistance, physical protection and infrastructure. Phase 2, which began in July 2006, will: further improve the assessment methodology, address infrastructure issues; and include collaborative projects on technical issues to be addressed for improved economics, safety and proliferation resistance.

Energy Assessments

The Agency offers energy assessment services, considering all energy sources, that help build a State's capability for energy analysis and planning. Increasing global demand for energy led to 29 new requests for these services in 2006, a substantial increase over previous years. To cater to these requests, 21 technical cooperation projects, incorporating all of these new requests, were established by the Secretariat and approved by the Board of Governors in 2006. A total of 112 Member States and six international and regional organizations are now using the Agency's energy assessment tools. In terms of building capacity for sustainable energy development and planning, 274 professionals from 51 States were trained by the Agency through various regional and national courses.

---

[1] 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.

[2] The 28 members of INPRO are: 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 EC.

Uranium Supply: Demand Forecasts

A steady supply of nuclear fuel is required to cope with the anticipated future growth of nuclear power. The Agency and the OECD/NEA together publish biennial projections on the availability of uranium and its production and demand in the future.[3] Total uranium production in 2004 (the most recent year for which complete data are available) amounted to over 40 000 tonnes. Canada and Australia accounted for 51% of production, with five countries (Kazakhstan, Namibia, Niger, the Russian Federation, and Uzbekistan) accounting for 38%. Newly mined uranium provided approximately two thirds of the world requirements of 67 000 tonnes, with the balance being met by secondary sources such as civil and military stockpiles, spent fuel reprocessing, and re-enrichment of depleted uranium. It is estimated that by 2025 the projected growth in the world's nuclear energy capacity would raise the annual uranium requirements to between 80 000 and 100 000 tonnes.

Uncertainty regarding the future availability of secondary sources, improved global prospects for nuclear energy and the lingering effects of low mining investments in the past have led to a substantial rise in spot market prices, by a factor of two in 2006 to $187 per kg U, and a factor of ten since the all-time low (in terms of constant dollars) in 2000. In the longer term, uranium resources are considered to be adequate to meet projected estimates for the growth of nuclear power. The recent rise in the spot price has led to increased exploration worldwide. A number of new mining projects, including those in countries that currently are not uranium producers, have also been announced that could substantially boost global production capacity, and are indeed necessary to meet demand. In response to this the Agency provided guidance and assistance to Member States on different aspects of uranium exploration and production.

"Spent fuel management is one of the more important factors influencing the future of nuclear energy."

Spent Fuel and Waste Management

Spent fuel management is one of the more important factors influencing the future of nuclear energy. The amount of spent nuclear fuel generated annually is about 10 500 tonnes of heavy metal. About one third of this is reprocessed, with the uranium and plutonium contained in the fuel being recycled. The remaining two thirds is kept in safe interim storage awaiting a decision on its future management. The long term management and disposal of this fuel continues to be a challenge in view of the rising expectations for nuclear power and the increasing spent fuel inventories around the world. In June, the Agency organized a conference in Vienna where the recent trends and initiatives on spent fuel management were discussed.

Regardless of which option is chosen for the management of spent fuel, there will always be a need for the deep geological disposal of high level waste, long lived waste or the spent fuel itself. While most experts agree that technical solutions exist for safe permanent disposal, progress in demonstrating these solutions has not been rapid. In 2006, the world's only operating geological repository, the Waste Isolation Pilot Plant in the USA, received its first recertification from the US Environmental Protection Agency since its opening in 1999. France passed new legislation setting goals for the licence application for a deep geological repository with the aim of opening it by 2025, and for a prototype reactor by 2020 to test the transmutation of long lived radioisotopes. The Swedish nuclear fuel and waste management company filed an application for an encapsulation plant — the first step towards final disposal — in Oskarshamn.

Low and intermediate level waste from reactor operations and decommissioning, and from the use of radioactive material in medicine, research and industry, is being well managed in many countries with disposal facilities in operation. Other countries are being supported by the Agency through the assessment of different technologies and the dissemination of information.

Decommissioning of Nuclear Facilities

Roughly three quarters of the world's operating reactors are 20 or more years old. This means that decommissioning decisions and needs are likely to grow in importance over the next two decades. The Agency provides information and guidance to Member States in support of research on strategic, methodological and technological approaches to

[3] *Uranium 2005: Resources, Production and Demand*, A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, OECD, Paris (2006).

decommissioning, as well as on when to choose decommissioning over licence renewal. In 2006, the Agency provided assistance to 12 Member States through individual technical cooperation projects, in addition to carrying out a large regional project focusing on the decommissioning of nuclear power plants and research reactors. In addition, legal and technical advice and training were provided for the decommissioning and cleanup of former nuclear sites in Iraq through a new project that started in 2006. The project aims to reduce the overall radiological risk to the public and the environment through the remediation of contaminated areas and disposal sites at the former Iraq nuclear complex. The Agency also initiated an international Research Reactor Decommissioning Demonstration Project to assist Member States in decommissioning activities.

The decommissioning of reactor unit 4 at the Chernobyl nuclear power plant remains a technically complex task 20 years after the accident that resulted in its destruction. In 2006, work was completed to stabilize the existing shelter before the start of construction of a new shelter.

As of 2006, nine power plants around the world had been completely decommissioned, with their sites released for unconditional use. Seventeen plants have been partially dismantled and safely enclosed, 30 are being dismantled prior to eventual site release and 30 are undergoing minimum dismantling prior to long term enclosure. Decommissioning was completed at the Big Rock Point nuclear power plant in the USA, and the site was released for unrestricted public use.

During the year, the Agency assisted several Member States in their efforts to dismantle nuclear power plants. For example, at the Ignalina 1 plant in Lithuania, the Agency's efforts were focused on upgrading local capabilities and, in doing so, facilitating Lithuania's coordination with major international donors for this project. At the severely contaminated A-1 nuclear power plant in Slovakia, the Agency's decommissioning assistance focused on the development of remote viewing equipment and remotely operated tools, both of which are essential given the difficulty of access to a number of components and areas.

New Approaches to the Nuclear Fuel Cycle

A number of suggestions have recently been put forward regarding new approaches to the nuclear fuel cycle with the aim of establishing an assured supply of nuclear fuel for all States having nuclear power programmes. The proposals include the following:

- In January 2006, the Russian Federation proposed a 'Global Nuclear Power Infrastructure' to provide nuclear fuel cycle services, including uranium enrichment centres, on a non-discriminatory basis and under the supervision of the Agency.
- In February 2006, the USA proposed a 'Global Nuclear Energy Partnership', which includes, as one of its elements, a mechanism for reliable fuel services.
- In May 2006, the World Nuclear Association, in conjunction with the four commercial enrichment companies, issued a report on *Ensuring Security of Supply in the International Nuclear Fuel Cycle.* The report describes a three level mechanism to assure supplies of LEU.
- In June 2006, six countries that export enriched uranium (France, Germany, the Netherlands, the Russian Federation, the United Kingdom and the USA) circulated a proposal on a 'Concept for a Multilateral Mechanism for Reliable Access to Nuclear Fuel'.
- In September 2006, Japan proposed an 'IAEA Standby Arrangements System for the Assurance of Nuclear Fuel Supply', under Agency auspices. The United Kingdom proposed an 'Enrichment Bond' to provide prior consent for the provision of enrichment services. The Nuclear Threat Initiative offered a two to one matching grant offer of $50 million to the Agency to set up a fuel reserve. Germany proposed an international enrichment centre at an international site.

The Agency continued in 2006 to facilitate discussions of these proposals with a view to formulating recommendations regarding the establishment of assurance of supply mechanisms for the consideration of the Board of Governors in 2007, with an initial focus on assurances of supply of nuclear fuel for nuclear power plants. In this connection, it organized a special event entitled 'New Framework for the Utilization of Nuclear Energy: Assurances of Supply and Non-Proliferation' during the 50th regular session of the General Conference in Vienna. The discussions at the special event, which involved more than 300 representatives from 61 Member States and various industry and other organizations, indicated that the various international proposals that were recently made were seen to be mutually compatible with each other. However, it was recognized that establishing a fully

developed, multilateral framework that is equitable and accessible to all users of nuclear energy, and that is in accordance with agreed nuclear non-proliferation norms, would be a complex endeavour likely requiring an incremental approach with multiple assurances in place.

Research Reactor Conversion and HEU Repatriation

At an international conference in Oslo in June, strategies were discussed to minimize the use of high enriched uranium (HEU) in the civilian sector. Participants agreed on the feasibility of converting civilian sector activities to the use of low enriched uranium (LEU). However, concerns were voiced that strategies for HEU minimization should not result in a limited number of countries acquiring better scientific results, and therefore a commercial advantage. The need to reduce military stockpiles of HEU was also emphasized as an important contribution to ongoing non-proliferation and disarmament efforts.

In response to Member State requests for assistance in converting research reactors from the use of HEU to LEU fuel, the Triga reactor in Piteşti, Romania, and the RECH 1 facility in La Reina, Chile, were fully converted through national technical cooperation projects. Conversion projects in Portugal and Poland made significant advances, with the Agency conducting international competitive tender processes to procure a new LEU core for Portugal and LEU lead test assemblies for Poland.

In 2006, the Agency provided support to Member States participating in international programmes to return research reactor fuel to the country of origin. Within the framework of the Russian Research Reactor Fuel Return Programme, and under contracts arranged by the Agency, three shipments containing more than 300 kg of fresh HEU fuel were returned to the Russian Federation from Poland, Germany and the Libyan Arab Jamahiriya. In addition, the Agency assisted in the first shipments of irradiated Russian research reactor fuel from Uzbekistan in early 2006. The Agency also made significant progress towards the safe removal of irradiated Russian research reactor spent fuel from the Vinča Institute in Serbia to the Russian Federation.

Applications of Nuclear Science and Technology

Achieving sustainable food security

The Agency continues to assist Member States in building capacity to produce food crops with improved characteristics. A good example is in Peru, where nine mutant varieties of barley, developed with Agency support, now cover 90% of the barley producing area. These crops are being planted in the Andes in harsh and extreme climatic conditions. Since gaining access to these improved varieties of barley, the Andean population has been experiencing a sustained improvement in food and economic security.

Cancer therapy

It is estimated that by the year 2020, approximately 150 million cases of cancer will occur in developing countries out of a projected worldwide total of 260 million cases. Although cancer prevention is the single most cost effective strategy in many developing countries, comprehensive early detection and diagnosis of cancer — and especially its treatment by radiotherapy — remain a necessity (Fig. 1).

In 2006, the Agency — in cooperation with WHO — initiated studies to compare radiotherapy techniques for breast cancer, which is the most common cause of cancer related deaths in the world among women, and new research was started on radiation treatments for cancer of the oesophagus. Educational and training materials were developed, covering, for example, radiation oncology, clinical research, and radiotherapy planning and delivery.

"The Agency's Programme of Action on Cancer Therapy (PACT) seeks to assist developing countries in integrating radiotherapy into the broader framework of cancer prevention and control."

The Agency's Programme of Action on Cancer Therapy (PACT) seeks to assist developing countries in integrating radiotherapy into the broader framework of cancer prevention and control. In 2006, it helped raise awareness of the growing cancer epidemic in the developing world and the need for comprehensive and multidisciplinary cancer control planning through Nobel Peace Prize special events in Bangkok and Cape Town. In addition, relationships have been built with leading organizations in the field of cancer control and research — for example the International Agency for Research on Cancer, the International Union Against Cancer and WHO — to

FIG. 1. Agency assistance, through its technical cooperation programme, is helping to raise the level of cancer care in Zimbabwe.

assist Member States with comprehensive cancer control programmes. Training syllabuses for doctors and nurses working in radiation oncology were also prepared in 2006. Progress was also made towards the establishment of PACT Model Demonstration Sites in Nicaragua and the United Republic of Tanzania, in collaboration with WHO and other partners.

PACT's fundraising efforts throughout the year secured a number of grants, donations and in-kind contributions. These included $500 000 from the OPEC Fund for International Development, $500 000 from the USA, $200 000 from the US National Cancer Institute, and radiotherapy machines from Nordion, Canada. In addition, PACT received more than $1 000 000 in extrabudgetary contributions from various Member States in 2006.

Improving the Nutrition and Health of Children

The IAEA Nobel Cancer and Nutrition Fund was established by the Board of Governors using the Agency's share of the award money from the 2005 Nobel Peace Prize and other contributions. In addition to cancer related projects, the fund focuses on training programmes on the use of nuclear techniques to determine the role of nutrition in helping to ensure the healthy development of children. In 2006, the Agency set up IAEA Nobel Peace Prize Fund Schools for Nutrition in Latin America and Africa. The theme for each of these information sharing and training events reflected priority areas in nutrition during early life of special relevance to the region. Thus, in Guatemala the theme was 'Combating the Double Burden of Malnutrition', while in Uganda it was 'Integrating Nutrition into the Management of HIV/AIDS'.

"Under a regional technical cooperation project, countries throughout Central America have used the sterile insect technique (SIT) as part of an environmentally friendly programme for controlling fruit flies."

Sterile Insect Technique

Under a regional technical cooperation project, countries throughout Central America have used the sterile insect technique (SIT) as part of an environmentally friendly programme for controlling fruit flies. In addition to reducing insecticide use, the result in many cases is far greater capacity to produce and export fruit and vegetables. For example, Nicaragua initiated commercial shipments of capsicum to the USA in 2006.

In the southern Rift Valley, tsetse population suppression carried out by local farmers and

the Ethiopian Government, in preparation for sterile tsetse fly releases, has already reduced the prevalence of nagana disease in livestock in certain areas. The UN Trust Fund for Human Security, funded by Japan, has awarded $1.7 million to the Agency's tsetse eradication project, and the USA contributed an additional $1.6 million.

Faster and More Economical Diagnosis of Avian Influenza

The early, rapid and sensitive diagnosis of diseases originating from animals and that infect people has received special attention because of the renewed importance given to potential natural disasters. Agency activities in this area, carried out through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, have also shifted focus on how to respond in a more timely and proactive manner to potential threats to animal and human security. With respect to the threat posed by avian influenza, a major contribution was the development in 2006 through an Agency CRP of a new approach to identify these pathogens that takes less than one hour, is rugged and simple enough for use in the field, allows the results to be transmitted remotely, and is cost effective. This nuclear based method offers significant advantages over traditional methods, which require samples to be sent to a central laboratory, often taking up to one week for receipt of the results. It has the added advantage of avoiding handling of and exposure to the live virus. The technique is planned to be released for commercial use in the second half of 2007. In this connection, developing Member States received assistance from the Agency's Laboratories, Seibersdorf, in analyses of avian influenza samples for primary diagnosis or for confirmation of strains.

Management of Water Resources

Isotope hydrology is an effective tool in managing water resources that uses isotope dating techniques to help determine the availability and capacity of underground aquifers and other water resources. At the 4th World Water Forum, held in Mexico City in March 2006, a major theme was 'Water for Growth and Development'. Hydrological variability — that is, periodic changes in water availability — was considered to be a significant factor influencing economic growth. The role of the Agency in this area was recognized through its promotion of isotope techniques to provide information for understanding the atmospheric water cycle and for managing groundwater resources.

Agency assistance to Member States in 2006 included regional technical cooperation projects covering Chile, Colombia, Costa Rica, Ecuador, Nicaragua, Peru and Uruguay for managing groundwater resources in Latin America. Through this project, hydrogeological maps were developed, conceptual models were validated and associated databases were made available and are now in use in the participating institutions.

Nuclear Science Serving the Arts

A novel application of nuclear techniques is in the conservation of objects of art and the protection of cultural heritage. A portable X ray fluorescence spectrometer was designed and constructed at the Agency's Laboratories, Seibersdorf, as part of a CRP. Following a request from the Museum of Fine Arts in Vienna, the instrument was used in 2006 to examine the famous 16th century gold sculpture 'Saliera' by Benvenuto Cellini. The spectrometer provided data on the chemical composition of the various parts of this sculpture in support of evaluations of the optimum conservation strategy.

"A novel application of nuclear techniques is in the conservation of objects of art and the protection of cultural heritage."

In China, four ancient production kilns from the Tang dynasty were discovered, and shards from them were characterized to determine their mineral composition. In Lebanon, Byzantine amphorae were analysed to establish their origin and place of production. And in Peru, nuclear techniques were used on Inca pottery samples to distinguish fraudulent from authentic samples, identify the place of production and shed light on the production process.

Safety and Security

A demonstrated high standard of nuclear, radiation, transport and radioactive waste safety is essential to sustain the future growth of nuclear power and technology. As part of this pillar, the Agency supports Member States in their efforts to attain a high level of safety and security by promoting adherence to international legal

instruments prescribing the basic norms for the safe use of nuclear technology and the wide application of internationally accepted standards reflecting best practices.[4]

Nuclear Safety: Major Trends and Issues

Member State efforts to maintain a high level of safety continued to be successful in 2006. Overall, the safety performance at nuclear power plants remained strong. Occupational radiation protection indicators showed improvement over 2005, with no worker or member of the public receiving a significant radiation dose as a result of the operation of a nuclear power plant. In addition, there were no events at any power plant that resulted in a release of radioactivity that would cause harm to the environment. Research reactors also continued to be operated safely during the year. The safety record for the transport of radioactive material remained good. As shipments continue to be denied, an International Steering Committee on Denial of Shipments of Radioactive Material, comprising Member States and international organizations, was constituted to coordinate international efforts in this area.

Harmonizing Safety Standards

In September, the Board of Governors approved the publication of the *Fundamental Safety Principles*, a set of ten new principles that consolidate and replace the earlier safety fundamentals publications and constitute the basis on which to establish requirements for the safety of facilities and activities to protect people and the environment against exposure to ionizing radiation. These new principles were co-sponsored by a number of other international organizations.[5]

Strengthening Regulatory Infrastructures by Sharing Knowledge

In line with the unified approach of the Safety Fundamentals, the Agency developed a new safety review initiative known as the Integrated Regulatory Review Service (IRRS). This service is designed to: facilitate the exchange of experience and mutual learning among regulatory bodies; contribute to the enhancement of Member State legislative and regulatory infrastructures; harmonize regulatory approaches; and review a Member State's self-assessment. During the year, the Agency conducted IRRS missions of limited scope to Romania and the United Kingdom, and a full scope mission to France.

The peer review mechanism established under the safety conventions is another important instrument for sharing experience and for mutual learning. In May, the Agency hosted the second review meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Parties emphasized the importance of: fostering improvements to national strategies for spent fuel and radioactive waste management; engaging stakeholders, including the public, on waste issues; and enhancing the control of disused sealed sources. By the end of 2006, the Joint Convention had 42 Contracting Parties, up from 35 in 2005.

An international conference on effective nuclear regulatory systems, held in February in Moscow, provided a forum for senior nuclear safety, radiation safety and nuclear security regulators to share knowledge and experience in improving regulatory effectiveness. The key challenges identified included: the need to ensure regulatory independence; the complexity of coordinating safety and security priorities; and the importance of securing adequate financial and human resources for regulatory work, particularly in view of expectations for expansion in the use of nuclear power.

Regional safety networks are providing important opportunities for sharing and learning from experience. The Ibero-American Nuclear and Radiation Safety Network became operational in 2006, and the Asian Nuclear Safety Network has continued to expand its range of activities in China, Japan and the Republic of Korea and in national centres in other participating countries.

The number of commitments by States to use the Code of Conduct on the Safety and Security of Radioactive Sources continued to increase, from 79 to 88 States as of the end of 2006. A number of Member States have amended, or are in the process of strengthening, their national legislation to take into account the recommendations given in the Code. The number of Member States agreeing to implement the Code's supplementary Guidance on the Import and Export of Radioactive Sources also continued to grow, from 17 States in 2005 to 37 States at the end of 2006.

Incident and Emergency Response

Emergency preparedness and response arrangements are vital in ensuring the safety and security

[4] The status of participation by States in multilateral treaties for which the Director General is depositary is given in Tables A7 and A8 in the Annex.

[5] The other organizations are the EC, FAO, ICAO, ILO, OECD/NEA, PAHO, UNEP and WHO.

of the public. Although only a small number of the incidents that occurred in 2006 involved significant exposure to ionizing radiation, there is a continuing need to promote the worldwide exchange of information on the causes and lessons learned from incidents and emergencies. In this regard, the Agency cooperates with Member States in harmonizing the relevant international communication and assistance systems. In 2006, the Agency's Incident and Emergency Centre underwent a major upgrade, resulting in an enhancement of Agency capabilities as a global focal point for nuclear and radiological emergency preparedness and response.

Civil Liability for Nuclear Damage

Responding to increased interest among States, the Agency's International Expert Group on Nuclear Liability (INLEX) discussed new developments in the field of civil liability for nuclear damage, and considered the need to further develop the nuclear liability regime to address gaps and ambiguities in the scope and coverage of the existing instruments. In this respect, it concluded that the gaps should be addressed by way of issue specific actions, such as clarification during outreach activities, the development of guidelines and generic minimum legislation to assist States, and by States setting limits beyond the standards contained in the international nuclear liability instruments or adopting common standards. The Group recommended the establishment of new maximum limits for the exclusion of small quantities of nuclear material from the scope of application of the relevant nuclear liability instruments. The maximum limits will require the approval of the Board of Governors, as foreseen in the relevant instruments.

"... the Agency cooperates with Member States in harmonizing the relevant international communication and assistance systems."

The second Regional Workshop on Liability for Nuclear Damage, held in Lima in December, sought to foster greater adherence to the international nuclear liability regime and facilitated discussions on possible difficulties, concerns or issues that States in the region may have with the regime. In particular, the participants — although aware of the advantages of having a special liability regime in order to avoid the intricacies of private international law and also to strengthen the assurances of compensation for damage in cases of accidents — identified issues preventing States from acceding to the existing international nuclear liability instruments.

Nuclear Security

Through its nuclear security programme, the Agency continued to help Member States implement the enhanced regime of international legal instruments relevant to nuclear security. International legal instruments provide a strategic framework and a common platform for States to work together to enhance their collective nuclear security. The obligations on States that flow from these international instruments are being addressed by a combination of national and international activities. These instruments include: the Convention on the Physical Protection of Nuclear Material (CPPNM) and the Amendment thereto; the International Convention for the Suppression of Acts of Nuclear Terrorism; and UN Security Council resolution 1540 (2004) on preventing the proliferation of weapons of mass destruction.

The Agency continued to implement an updated version of its Nuclear Security Plan, which came into operation in 2006 and will run until 2009. The importance given to nuclear security activities is reflected in the extrabudgetary funding provided by a range of donor States and organizations. In 2006, the Agency supported national efforts to enhance nuclear security through prevention measures — comprising both protection and risk reduction components — as well as detection and response measures.

Work was completed with the Russian Federation and the USA on a tripartite initiative to secure and manage radioactive sources in countries of the former Soviet Union. A significant amount of radioactive material has been secured, and the effort has resulted in much greater regional awareness of this problem. During the year, the Agency also arranged for the recovery of over 100 high activity and neutron sources in Africa and Latin America.

Activities aimed at developing nuclear security guidance were strengthened through the publication of a series of reports containing recommendations and practical arrangements that incorporate best practices as contributed by experts from Member States. The first three guidance publications — covering *Technical and Functional Specifications for Border Monitoring Equipment*, *Nuclear Forensics Support* and *Monitoring for Radioactive Material in International Mail* — were issued in 2006.

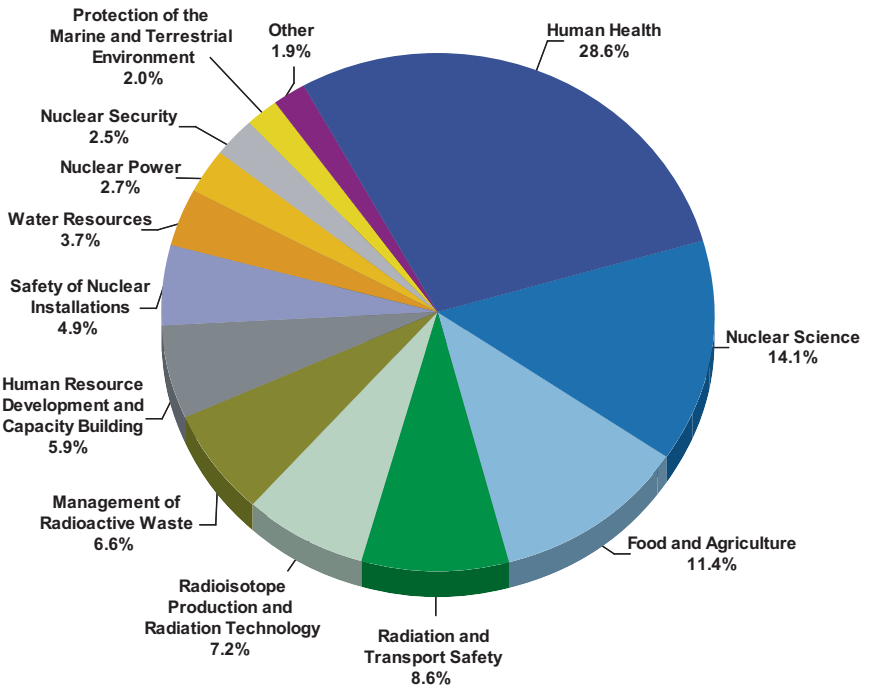


FIG. 2. Distribution of technical cooperation disbursements in 2006 by Agency programme.

Technical Cooperation

To encourage greater self-reliance in Member States, the Agency helps to build, strengthen and maintain national and regional capacities for using nuclear technology in a safe, secure and sustainable manner. The technical cooperation programme helps developing nations, in matching appropriate technologies to identified needs, building relevant technical competences and expertise, and promoting scientific and technical cooperation between countries.

The main areas of work in 2006 were human health, food and agriculture, radiation and transport safety, nuclear science, physical and chemical applications, water resources, and the management of radioactive waste (Fig. 2). The programme is funded by voluntary contributions to the Technical Cooperation Fund (TCF), as well as extrabudgetary contributions, government cost sharing and contributions in kind. All of these resources are applied directly to technical cooperation projects. In 2006, a total of $97 million was disbursed in over 115 countries, 172 training courses were arranged for 2477 participants, 3041 expert missions were organized, 1697 fellows and scientific visitors were trained, and $51.8 million worth of equipment and supplies were provided.

Overall, new resources reached a record high of $101 million in 2006, with $76.8 million for the TCF, $22.3 million in extrabudgetary resources and $1.9 million of in-kind contributions. Net new obligations during the year were $104.5 million, which represented an increase of more than 30% over 2005.

Verification

Another pillar of the Agency's programme is concerned with providing assurances to the international community regarding the peaceful use of nuclear material. The Agency's verification programme is at the centre of multilateral efforts to curb the proliferation of nuclear weapons.

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: (1) that there is no indication of diversion of declared nuclear material from peaceful activities; and (2) that there is no indication of undeclared nuclear material and activities for the State as a whole. To be able to draw the 'broader conclusion' that '*all* nuclear material remained in peaceful activities', both a 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, based on its verification activities, draws a conclusion, for a given year, with respect to whether *declared* nuclear material remained in peaceful activities.[6]

For those States for which the broader conclusion was drawn and a State level integrated safeguards (IS) approach has been approved, the Secretariat is able to implement IS — the optimum combination of all safeguards measures available to the Agency under CSAs and APs which achieves maximum effectiveness and efficiency within available resources.

"During 2006, the Agency continued to facilitate the conclusion of comprehensive safeguards agreements and additional protocols."

Safeguards Conclusions for 2006

At the end of 2006, safeguards were applied for 162 States with safeguards agreements in force with the Agency (Fig. 3). Seventy-five States had both CSAs and APs in force. For 32 of these States, the Agency concluded that *all* nuclear material remained in peaceful activities. For eight States — Austria, Chile, the Czech Republic, Greece, Ireland, Luxembourg, Mali and Portugal — this conclusion was drawn for the first time. For 43 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 78 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.[7]

For three States that had item specific safeguards agreements in force in 2006, the Secretariat concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities. Safeguards were implemented with regard to declared nuclear material in selected facilities in four of the five nuclear weapon States that had voluntary offer safeguards agreements in force. For these four States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities was not withdrawn, except as provided for in the agreements, and remained in peaceful activities.

The Secretariat could not draw any safeguards conclusions for States without safeguards agreements in force.

Integrated safeguards were implemented during 2006 in Australia, Bulgaria, Hungary, Indonesia, Japan, Norway, Peru, Slovenia and Uzbekistan, while implementation was initiated in Latvia and Poland. In addition, an approved IS approach for Canada was awaiting initial implementation in early 2007, and approaches were developed and approved for Bangladesh and Ghana.

Conclusion of Safeguards Agreements, Additional Protocols and Small Quantities Protocols

During 2006, the Agency continued to facilitate the conclusion of CSAs and APs. In this connection, the Secretariat convened regional seminars during the year in Quito and Sydney. The Agency also

FIG. 3. Agency safeguards inspectors examining a fresh fuel basket at a nuclear facility.

[6] The status with regard to the conclusion of safeguards agreements, APs and small quantities protocols is given in Table A6 in the Annex. The status of participation by States in multilateral treaties for which the Director General is depositary is given in Tables A7 and A8.

[7] The Secretariat was not able to perform verification activities in the Democratic People's Republic of Korea in 2006, and could therefore not draw any safeguards conclusions for that State.

convened an interregional seminar in Vienna on the role of State systems of accounting for and control of nuclear material (SSACs) in implementing safeguards in States with small quantities protocols (SQPs).

As a result of these and other activities, the number of States that had yet to conclude CSAs in accordance with their obligations under the NPT decreased from 36 (at the end of 2005) to 31 (as of 31 December 2006). The year was also noteworthy in terms of the conclusion of APs, which entered into force for seven States. By the end of 2006, a total of 78 States had APs in force. Of the two States that, at the end of 2005, were implementing APs pending their entry into force, one brought its protocol into force, while the other informed the Agency that it would no longer implement it. One State acceded to the safeguards agreement between non-nuclear-weapon States of Euratom, Euratom and the Agency, as well as the AP thereto. The Board of Governors also approved an item specific safeguards agreement for a State in respect of a nuclear power plant under construction.

Following a decision by the Board of Governors in 2005, the Agency initiated exchanges of letters with all States with SQPs with a view to amending or rescinding their SQPs to reflect the revised standardized text and changed eligibility criteria. The Secretariat continued to communicate with States throughout 2006 in order to implement the Board's decision. During the year, SQPs were amended with nine of the 98 States with SQPs and rescinded with one State. By the end of the year, 11 States had accepted the revised standardized SQP text.

Committee 25

A committee established by the Board of Governors to consider ways and means to strengthen the effectiveness and efficiency of the safeguards system met three times in 2006 and considered documents produced by the Secretariat on further strengthening safeguards.

Public Outreach

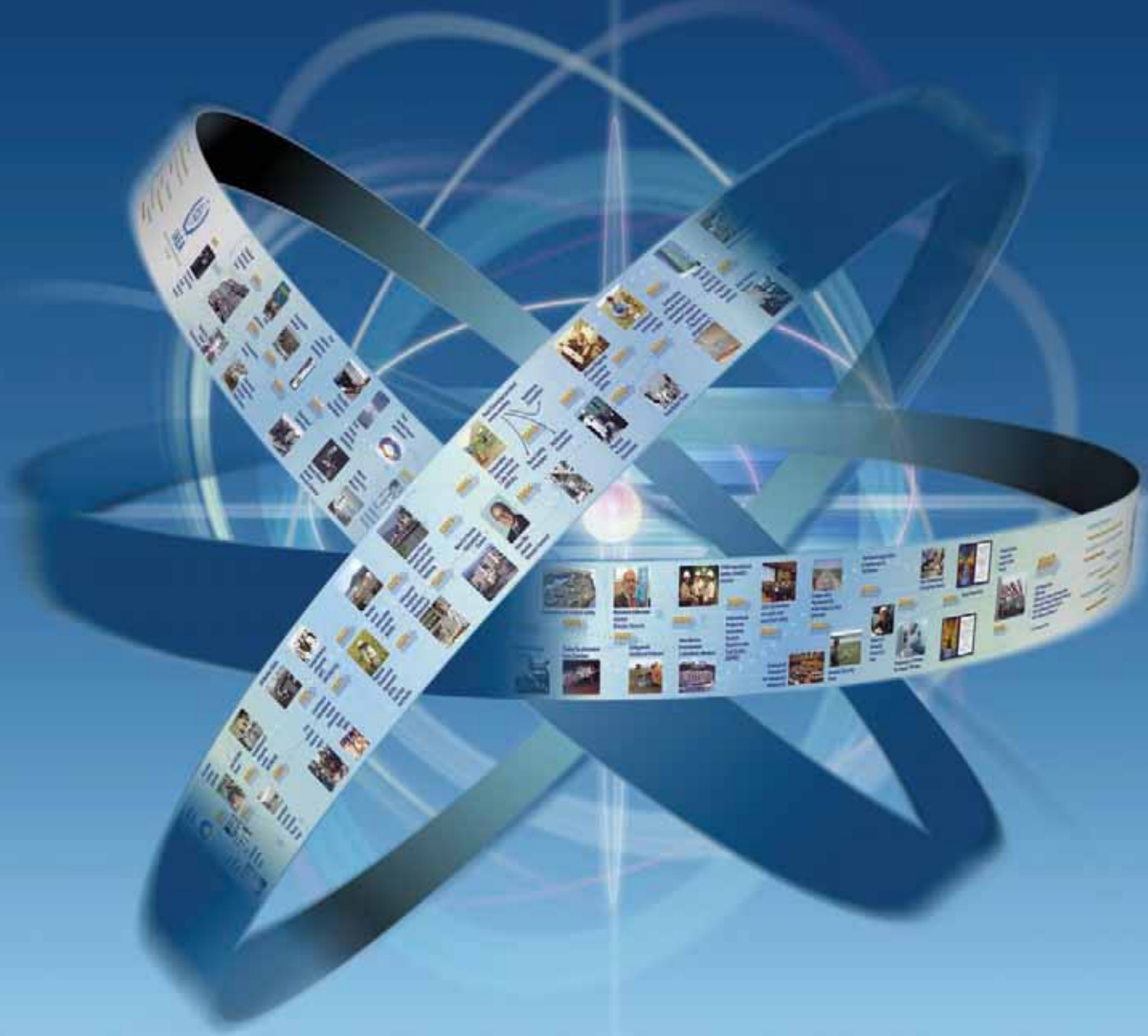
The Agency's public outreach visibility continued to increase during the year, particularly in the area of verification. There was heightened media interest in the meetings and deliberations of its Policy-making Organs, mainly as a result of a number of topical events dealing with non-proliferation issues. In addition, the Agency's public web site, *iaea.org*, was selected as one of three winners of the 2006 'Web4Dev Awards'. Sponsored by the World Bank, this award recognizes excellence in web site design and management. The Agency shared this honour with two other UN organizations.

The 50th regular session of the General Conference, held from 18 to 22 September, visibly set the scene for the start of the Agency's 50th anniversary year in 2007, with a high level of participation and a number of special displays and presentations by Member States and the Secretariat, including a special exhibit during the conference entitled 'Nuclear Technologies for the Environment: Protecting Air, Earth and Oceans', which reflected the multi-faceted work of the Agency on the environment and highlighted its contributions to the UN Millennium Development Goals.

Conclusion

The role of the Agency continues to expand, and with it the need for adequate resources to deal effectively with the many problems within its mandate, such as hunger, disease and poverty, and with issues of nuclear safety, security, verification and disarmament. By partnering with its stakeholders — Member States, international organizations, non-governmental organizations, national counterparts and the public — the Agency will seek to further contribute to sustainable strategies that help in addressing and alleviating the problems and furthering the causes of peace and development.

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. To encourage the improvement of public understanding of nuclear power.

Nuclear Power Plant Operating Performance and Life Cycle Management

To assist Member States in improving the operation and life cycle management of existing nuclear power plants, the Agency disseminates operating experience, knowledge and best practices in the areas of instrumentation and control (I&C), life cycle management, organizational performance, and excellence in the performance of nuclear power plant personnel.

With regard to I&C modernization, three technical meetings were held in 2006 covering: on-line condition monitoring of equipment and processes in nuclear power plants using advanced diagnostic systems; the impact of modern technology on I&C in nuclear power plants; and implementation and licensing of digital I&C systems and equipment in nuclear power plants. A workshop, jointly organized by the Agency and the Electric Power Research Institute, was held on the modernization of I&C systems in nuclear power plants to share expertise and experience.

Six publications were issued in 2006 in the area of integrated life cycle management of nuclear power plants covering: nuclear power plant life management process guidelines and practices for heavy water reactors (IAEA-TECDOC-1503); material degradation and related managerial issues of nuclear power plants; principles and guidelines on plant life management for the long term operation of LWRs (Technical Reports Series No. 448); embrittlement and interpretation of reactor pressure vessel and internal material (published jointly with the Joint Research Centre of the EC); nuclear power plant life management and longer term operation (published jointly with the OECD/NEA); and indicators for management of planned outages in nuclear power plants (IAEA-TECDOC-1490). The Agency also extended its series of CRPs on optimal measurement of irradiation fracture parameters — using relatively small test specimens — to assess reactor pressure vessel structural integrity.

In the area of organizational performance, the Agency published *The Management System for Facilities and Activities* (GS-R-3) in 2006. This publication, issued in the IAEA Safety Standards Series, replaces earlier reports on quality assurance and reflects the evolution of the field shown conceptually in Fig. 1. The Agency and FORATOM organized a workshop in Romania on management and organizational change, a topic of particular interest in the nuclear power area given the current unprecedented pace of organizational change. The critical factors for success that were identified are: strong leadership; involvement of the workforce throughout the change process; and effective regulation. It was emphasized that both nuclear organizations and their regulators understand that enhancing safety is an essential part of all successful change.

The nuclear industry spends a significant amount of its resources conducting competency assessments of personnel for employee selection, trainee assessment, qualification and authorization. To promote the achievement of excellence in the performance of nuclear power plant personnel, the Agency published *Competency Assessments for*

FIG. 1. Evolution of quality management systems.

Nuclear Industry Personnel, which provides guidance to ensure that these human resources are used effectively. Three further publications were issued in 2006: *Human Resource Issues Related to an Expanding Nuclear Power Plant Programme* (IAEA-TECDOC-1501); *Guidelines for Upgrade and Modernization of Nuclear Power Plant Training Simulators* (IAEA-TECDOC-1500); and *Authorization of Nuclear Power Plant Control Room Personnel: Methods and Practices with Emphasis on the Use of Simulators* (IAEA-TECDOC-1502).

Strengthening National and Regional Nuclear Power Infrastructures

In his statement to the 61st regular session of the United Nations General Assembly, the Director General stated that "As a sophisticated technology, nuclear power requires a correspondingly sophisticated infrastructure." In 2006, the Agency issued two publications on infrastructure: *Basic Infrastructure for a Nuclear Power Project* (IAEA-TECDOC-1513) and *Potential for Sharing Nuclear Power Infrastructure between Countries* (IAEA-TECDOC-1522). Work also began on a publication defining milestones in the development of the infrastructure necessary for a country to introduce its first nuclear power plant. All of these publications will help Member States in: assessing their own status and progress, determining their degree of preparedness for developing their first nuclear power plant, and determining the infrastructure necessary for planning, purchasing, building, operating and maintaining the first power plant. They will also assist the Agency in deciding when training or other services are appropriate for the efficient use of resources.

A workshop on issues for the introduction of nuclear power — co-sponsored by Canada, China, France, India, Japan, the Republic of Korea, the Russian Federation and the USA — was held in December in Vienna. Representatives of countries that do not currently operate nuclear power plants also attended this workshop, which focused on a wide range of infrastructure issues and provided an opportunity to better understand the needs and concerns of countries interested in initiating a nuclear power programme.

Technology Development

The Agency seeks to foster innovation in nuclear power and fuel cycle technologies. Its work programme covers three major areas: the Agency's Technical Working Groups (TWGs) on light water, heavy water, fast and gas cooled reactors; the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO); and activities on small and medium sized reactors (SMRs), and on seawater desalination using nuclear power.

The TWGs bring together experts from developing and industrialized Member States to: identify key areas for scientific and technical information exchange; provide assistance, documentation and training; and pool R&D resources from national organizations towards agreed common goals. Work in 2006 included the publication of *Theoretical and Experimental Studies of Heavy Liquid Metal Thermal Hydraulics* (IAEA-TECDOC-1520), training workshops on nuclear power plant simulators for education, and CRPs on a range of nuclear reactor technology issues.

"INPRO facilitates innovation by providing an open forum for nuclear system supplier countries and potential new users of nuclear power."

Other work included a regional training course on high temperature gas cooled reactors (HTGRs) and the organization in South Africa of the 3rd International Topical Meeting on High Temperature Reactor Technology. Both meetings reviewed the technical and economic feasibility of HTGRs for high efficiency electricity generation and for process heat applications, as well as hydrogen production and coal conversion. HTGR designs are attractive for these applications because they produce outlet temperatures of around 1000°C due to the absence of metallic material in the reactor core.

INPRO facilitates innovation by providing an open forum for nuclear system supplier countries and potential new users of nuclear power to study problems associated with introducing innovative nuclear energy systems. Its approach is holistic, incorporating economics, safety, proliferation resistance, resource use, waste minimization and infrastructure. In addition, it places special emphasis on the needs of developing countries. Further

details on INPRO's work in 2006 can be found in the introductory chapter of this report, 'Issues and Events in 2006'.

Small and Medium Sized Reactors

Large reactor designs benefit from economies of scale but are not necessarily suitable for countries with limited investment capacities or small electricity grids. The Agency's assistance in the development of SMRs is concentrated on Member States that could benefit from incremental additions to nuclear power capacity with a relatively small initial capital investment (Fig. 2). The focus is on economic competitiveness for different applications (electricity, district heat, desalination and combinations), passive safety design, and reactors without on-site refuelling. Two publications were issued in 2006, one on the *Status of Innovative Small and Medium Sized Reactor Designs 2005: Reactors with Conventional Refuelling Schemes* (IAEA-TECDOC-1485) and the other on *Advanced Nuclear Power Plant Design Options to Cope with External Events* (IAEA-TECDOC-1487). The latter publication took a broader approach to address advanced plants of various capacity, not just SMRs. In the area of nuclear desalination, the Agency convened the 8th meeting of the International Nuclear Desalination Advisory Group (INDAG) in Vienna, and conducted a training course on the technology and economics of desalination system modelling at the Abdus Salam ICTP in Trieste.

FIG. 2. An example of an SMR — the System Integrated Modular Advanced Reactor (SMART) in the Republic of Korea (photo credit: KAERI).

Databases in Support of Nuclear Power Operations

The Agency maintains a number of widely used databases to support the operation of nuclear power operations in Member States that are easily accessible on the Internet. Several of these are supplemented by print or CD-ROM versions. The latter include *Nuclear Power Reactors in the World* (Reference Data Series No. 2) and *Operating Experience with Nuclear Power Stations in Member States in 2005*, both issued in 2006. These publications, as well as *Country Nuclear Power Profiles,* are based on the *Power Reactor Information System* (*http://www.iaea.org/programmes/a2/index.html*). Other databases supporting operations include the *Electronic Nuclear Training Catalogue* and the *Nuclear Economic Performance Information System.* ■

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 Environment

Accurate knowledge of uranium resources is essential for planning nuclear development activities and for analysing the potential role of nuclear power in the development of sustainable energy. The latest update of the biennial 'Red Book' — *Uranium 2005: Resources, Production and Demand* — was published jointly by the Agency and the OECD/NEA in 2006. Reviewing data from 43 countries, the results of the most recent world uranium market fundamentals were presented and a statistical profile of the world uranium industry as of 1 January 2005 was provided. In 2004, uranium production totalled 40 263 t, an increase of almost 12% over production in 2002 (Fig. 1).

The uranium market is uncertain in the medium term, due to limited information on available secondary supplies and on new uranium production centres. Secondary supplies are expected to decline in importance as stockpiles diminish. By 2015, reactor requirements will need to be met increasingly by the expansion of existing production capacity and by the development of additional production centres.

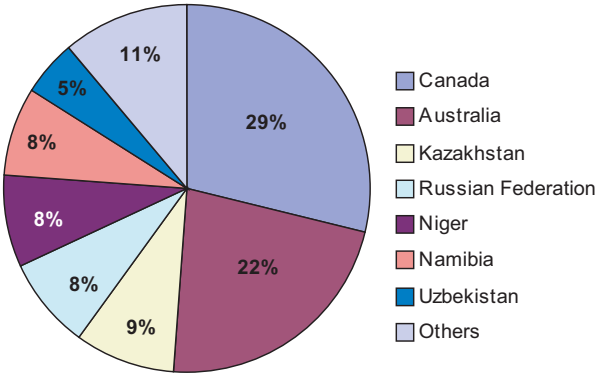


FIG. 1. Uranium production by country.

Uranium resources are adequate in the longer term. Approximately 4.7 million tonnes of conventional uranium can be mined for less than $130/kg, which is sufficient, at the 2004 consumption rate, for 85 years. However, total world uranium resources are considered to be much higher. The recent rise in the spot price has led to increased exploration worldwide. A significant number of new mining projects have been announced that could substantially boost the world's uranium production capacity, and will be needed to meet demand.

The 2006 version of the 'Red Book' was the 21st edition of this important joint publication. To mark the anniversary, the OECD/NEA published *The Red Book Retrospective*, which analyses the key data and information in the first 20 editions of the 'Red Book' and gives a historical profile of the world uranium industry. Two general conclusions are that, historically, increased prices are rapidly followed by increased exploration, and that the ratio of identified resources to production has been fairly stable over the past 15–20 years, indicating that new resources are continuously found even when prices are low.

The increasing interest in uranium production increases the demand for skilled labour and for information. In this connection, the Agency organized four meetings on different aspects of uranium exploration and production, in Argentina, China, India and Kazakhstan. These meetings covered subjects such as aerial and ground geophysical techniques for uranium exploration, advanced mining and milling methods and equipment, in situ leaching of uranium deposits, mine remediation and environmental issues.

Nuclear Fuel Performance and Technology

To assist Member States in improving the utilization of nuclear fuel, several Agency activities in 2006 addressed increasing fuel burnup. A technical meeting reviewed the current performance of high burnup LWR fuel and discussed the technical and economic issues associated with even higher

burnup, concluding that there is still some limited scope for extending fuel burnup with current technology. An important task is to enhance the predictive capability of codes used in modelling high burnup fuel behaviour. A second technical meeting considered the modelling of PHWR fuel, where there is a significant potential to increase burnup using slightly enriched uranium oxide fuel.

Changes in water chemistry can profoundly influence fuel oxidation rates and the migration of corrosion products from the steam generators to the fuel, where they can deposit as crud. As reactor performance increases and reactors age, the problem of controlling the water chemistry becomes ever more challenging. Optimization and control of water chemistry can help minimize problems with fuel oxidation and deposit buildup, and control operational exposure. A CRP was started in 2006 to study the influence of water chemistry parameters on fuel performance; Member States will be able to use the results to ensure that optimum water chemistry is specified for their nuclear reactors, ensuring safe and reliable generation of electricity.

"... the Agency ... organized a conference [that] addressed emerging initiatives that may have a significant impact on future spent fuel management, ..."

Delayed hydride cracking (DHC) of zirconium alloys is an important mechanism for reactor core materials degradation and failures. An earlier CRP dealt with zirconium materials for CANDU and RBMK pressure tubes. Work began in 2006 on a follow-up CRP with the objective of transferring experimental knowledge and establishing concerted testing procedures for DHC rates measurement in cladding tubes made of different zirconium alloys.

Management of Spent Fuel

Inventories of spent nuclear fuel are growing. By the end of 2004, approximately 280 000 tonnes of heavy metal (t HM) of spent fuel had been discharged globally. Roughly one third of this has been reprocessed, leaving about 190 000 t HM of spent fuel in storage. An increasing interest in reprocessing was seen in 2006, at least for the longer term.

In the area of spent fuel performance assessment and research, the Agency, in cooperation with the OECD/NEA, organized a conference on the management of spent fuel from nuclear power reactors. Held in Vienna in June, this conference addressed, among other things, emerging initiatives that may have a significant impact on future spent fuel management, such as the US Global Nuclear Energy Partnership (GNEP), the Russian Federation's Global Nuclear Power Infrastructure initiative, the French choices for the back end of the fuel cycle and the Indian plans for an advanced closed fuel cycle, anticipating significant growth in civilian nuclear power capacity. Sessions covered safety and technology issues connected to the storage of spent fuel for shorter or longer periods, in particular the trend away from wet storage to dry storage in containers. The conference concluded that spent fuel management is one of the more important factors influencing the future of nuclear energy, and that new initiatives, including recycling options, will be needed. Storage will remain a mature and safe interim solution, but continued follow-up is important as storage periods are extended. Irrespective of the fuel cycle option, geological disposal will eventually be required. It was also recognized that continued work is required to further develop safety standards, and more progress needs to be made in the framework of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, both in terms of ensuring wider adherence to it and in improving the process for its review.

Topical Advanced Nuclear Fuel Cycle Issues

In the area of high temperature gas cooled reactors (GCRs), the Agency held a technical meeting on the current status and future perspectives of GCR fuels. The meeting reviewed conventional and advanced fuel designs, fabrication technology, quality assurance and quality control, fuel irradiation qualification, fuel performance, fuel modelling and overall fuel cycle issues. The meeting recognized critical areas of work on GCR fuel — such as the generation of a new set of modern coated particle materials data, and pyro-carbon creep and shrinkage — that will assist in designing fuels with high fuel performance at high temperatures. In addition, the meeting emphasized the importance of preparing a

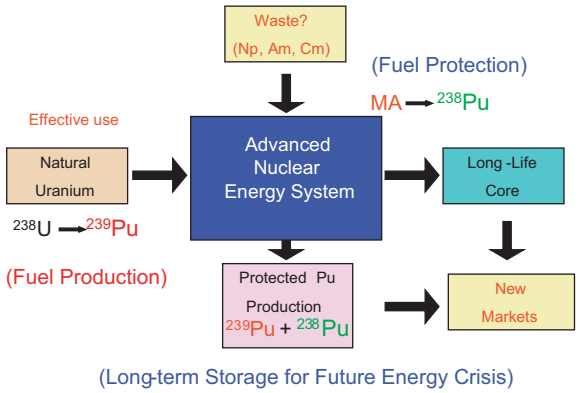


FIG. 2. Schematic of the P³ concept (MA: minor actinides).

detailed waste management plan to facilitate future growth in the area of GCRs.

In evaluating the issue of proliferation resistance associated with different advanced fuel cycles, the Agency began work in 2006 on protected plutonium production (P^3) and utilization, in collaboration with the Tokyo Institute of Technology (Fig. 2). The P^3 concept aims to produce plutonium with higher proliferation resistance and to incinerate minor actinides. It involves the generation of a sufficient quantity of 'poison' plutonium-238 isotope by the transmutation of minor actinides that are intentionally added to fresh fuel. The addition to low enriched uranium (LEU) LWR fuel of a small amount (<1%) of neptunium-237 or americium-241 with a large neutron capture cross-section enhances the formation of plutonium-238 in spent fuel. The presence of the plutonium-238 isotope, which has very high spontaneous neutron release and high decay heat, makes nuclear weapons manufacturing and maintenance technologically difficult and reduces its usefulness as a weapon material. System studies are in progress on conceptual implementation of the P^3 model with different fuel cycle scenarios employing different advanced reactors and fuels.

Nuclear Fuel Cycle Information Systems

The Agency maintains a number of databases and simulation systems to support related Agency programmes and to provide Member States with reliable and up to date information on worldwide nuclear fuel cycle activities. The databases include the: Nuclear Fuel Cycle Information System; World Distribution of Uranium Deposits; Post-Irradiation Examination Facilities; Minor Actinide Property Database; and Nuclear Fuel Cycle Simulation System (VISTA). In 2006, a publication was issued describing the technical features of VISTA (IAEA-TECDOC-1535). ■

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. 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, Data Banks and Capacity Building

In 2006, the IAEA published updated projections on global nuclear power development that show a significant potential increase in global nuclear power capacity up to the year 2030 (see *http://www.iaea.org/OurWork/ST/NE/Pess/RDS1.shtml*). Figure 1 shows updated low and high projections for worldwide nuclear power capacity. The low projection includes only firm plans announced by governments and power utilities for the construction of new nuclear power reactors, for lifetime extensions of existing reactors and for retirements of reactors. Even in this low projection, global nuclear power capacity will increase to 414 GW(e) by 2030. In the high projection, which incorporates additional power reactors suggested by long term government and utility plans, global nuclear power capacity is estimated to reach 679 GW(e) in 2030.

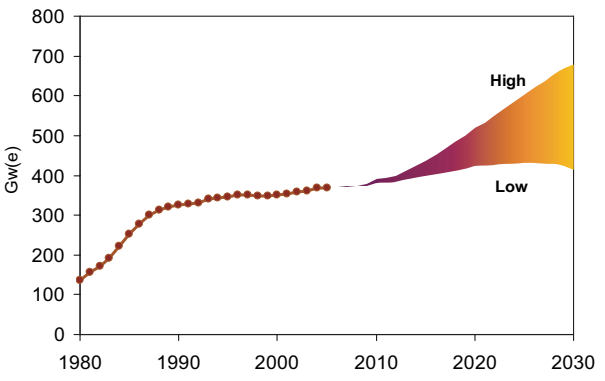


FIG. 1. Projections for worldwide nuclear power capacity up to 2030.

The Agency offers analytical tools for energy–environment analyses and provides training and assistance in their application. Use of these tools reached a record level in 2006, with 112 Member States and six international or regional organizations applying them in their analyses. Also in 2006, a major modification was made to the SIMPACTS (Simplified Approach for Estimating Impacts of Electricity Generation) model, which assesses and compares the environmental impacts of different electricity generation technologies, by the addition of a new module for estimating the impacts of liquid effluents.

Special emphasis is given by the Agency to building capacity in interested Member States, both for energy system analysis for sustainable development in general, and for assessing the potential role of nuclear power in meeting a country's future energy needs. A total of 274 professionals from 49 Member States were trained in regional and national courses held in 2006. A large number of new requests were received from Member States for the Agency's assistance in conducting energy studies to evaluate future energy options. To cater to these requests, the Agency in 2006 designed 19 new technical cooperation projects involving 63 countries.

Energy, Economic and Environment Analysis

Partly because of rising oil prices, energy security occupied the attention of many governments in 2006. In this regard, the Agency completed two new studies on energy supply security. The first study quantified the costs incurred in implementing specific supply security enhancement measures beyond the least cost market solution, incorporating nuclear power into the general energy supply security context. The study's conclusions show that no one approach to energy supply security carries the same costs and benefits for different countries.

The second study, *Analyses of Energy Supply Options and Security of Energy Supply in the Baltic States* (IAEA-TECDOC-1541), provided a detailed quantification of the costs of specific national and regional energy supply security measures aimed at reducing dependence on imports of oil and gas, and at replacing electricity generation lost through the scheduled closing by 2009 of Lithuania's Ignalina nuclear power plant. The study showed that, among the alternatives analysed, integrated regional approaches to energy supply security are more cost effective than individual national efforts.

Three other studies carried out in 2006 contributed to the understanding of sustainable energy development. Under the aegis of the Agency and UNDESA, partner institutions in Brazil and South Africa completed in-depth country profiles that included assessments of potential energy system pathways and supporting policies that would be consistent with the overall achievement of national sustainable development goals. Both studies were carried out under the World Summit for Sustainable Development's Partnerships for Sustainable Development, through a project led by the Agency on 'Designing Country Profiles on Sustainable Energy Development'. The profile of Brazil, which was published in 2006, highlighted the importance of 'technology leapfrogging' (e.g. ethanol production and deep water drilling) to reduce oil imports. The report on South Africa (available at *http://www.iaea.org/Our-Work/ST/NE/Pess/assets/South_Africa_Report_May06.pdf*) highlighted the policies and measures being considered to meet growing energy needs in the context of national development priorities, including bringing power to remote and rural areas.

"The Agency is also an active participant in 'UN-Energy', ... the UN's principal interagency mechanism in the field of energy."

The Agency is also an active participant in 'UN-Energy', which was created in 2004 as the UN's principal interagency mechanism in the field of energy. As part of this effort, the Agency led a study that combined its models for analysing national energy systems with data provided by the Energy Commission of Ghana, FAO, UNEP and UNIDO. The resulting pilot study for Ghana provided insights on policy options identified by UNDESA in line with the Johannesburg Plan of Implementation's call for countries to increase their use of renewable energy resources.

As part of its information dissemination activities, a new brochure, *Nuclear Power and Sustainable Development*, was distributed at the 14th session of the Commission on Sustainable Development, held in New York in April 2006. The brochure was also made available at the combined second meeting of the Parties to the Kyoto Protocol and 12th session of the Conference of the Parties in Nairobi in November.

Nuclear Information and Knowledge Management

The Agency's International Nuclear Information System (INIS) remains a very important information resource and nuclear knowledge preservation tool for Member States. In 2006, its membership grew to 140; the INIS bibliographic database was increased by 122 412 records and reached a total of 2 778 427 references. Over 200 000 electronic full text documents were also made available to INIS members on the Internet.

In 2006, the Agency published *Knowledge Management for Nuclear Industry Operating Organizations* (IAEA-TECDOC-1510) and a special publication on *Risk Management of Knowledge Loss in Nuclear Industry Organizations.* Training activities included a 'School of Nuclear Knowledge Management' at the Abdus Salam ICTP, as well as nuclear knowledge management workshops in Japan, Kazakhstan, the Republic of Korea and Ukraine. The Agency also continued to assist the World Nuclear University Summer Institute, providing support, in particular, to participants from developing countries.

In response to an increasing number of requests by Member States for Agency assistance, new national and regional technical cooperation projects were developed for Europe and Asia, including a regional Asian project in support of the Asian Network for Education in Nuclear Technology. In addition, a new CRP on the comparative analysis of methods and tools for nuclear knowledge preservation began in 2006. Special emphasis was given to improved communication with Member States with the introduction in 2006 of a newsletter and a web site (*http://www.iaea.org/inisnkm*) for INIS and nuclear knowledge management.

The International Nuclear Library Network (INLN) (*http://inln.iaea.org/*) is coordinated by the Agency to assist nuclear libraries worldwide in the provision of information and services to users without additional cost to their parent organizations. In 2006, Australia joined the INLN as its sixth member. ■

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

Agency products in the area of atomic and nuclear data are increasingly used by Member States for the design of nuclear reactor and fuel handling facilities, theoretical nuclear physics calculations, and the preparation of national databases for nuclear applications.

A CRP that ended in 2006 addressed the issue of tritium buildup in fusion machines, with a major emphasis on the International Thermonuclear Experimental Reactor (ITER). A review article summarizing important results was submitted to the journal *Nuclear Fusion*; more complete results are being submitted as separate articles to the journal *Atomic and Plasma-Material Interaction Data for Fusion*. The numerical data collected in the CRP are being reviewed for inclusion in the atomic and molecular database. This work will be extended to characterize the formation of fine dust within the fusion plasma region. This dust represents a significant safety hazard and might also jeopardize the operation of fusion devices by acting as an important carrier of any resulting tritium.

New data standards for neutron cross-sections were prepared by the Agency and finalized in 2006. They are now being adopted around the world. Extensively revised thermal scattering data were produced in 2006 through an Agency data development project in conjunction with the University of Stuttgart. These new evaluations have been adopted in recent reconstructions of a number of important nuclear applications libraries maintained by the OECD/NEA and the USA.

"New data standards for neutron cross-sections prepared by the Agency are now being adopted around the world."

The Agency's Reference Input Parameter Library (RIPL-2) has been used extensively, providing comprehensive reference input parameter data for theoretical nuclear reaction calculations. In 2006, these data facilitated the measurement of important nuclear reaction data and in predicting cross-sections. Further improvements to the database are being developed through the new RIPL-3 initiative.

Based on a modelling code for reactor physics calculations called WIMS-D that was originally developed in the United Kingdom, applications databases were assembled by the Agency in 2006. These databases contain fission product yields, decay data, and cross-sections for actinides, fission products, and structural and other major reactor materials (including hydrogen bound in water, oxygen, aluminium, U-235 and U-238).

Nuclear cross-section data for studying the thorium–uranium nuclear fuel cycle were produced in 2006 through a CRP entitled 'Evaluated Nuclear Data for Thorium–Uranium Fuel Cycle'. The data are already being applied in a number of fuel cycle analyses.

Research Reactors

The characterization of materials is very important for fabricating efficient, reliable machine components. In this regard, the Agency published *Neutron Reflectometry: A Probe for Materials Studies* in 2006. This monograph summarizes work on characterizing surfaces, and reviews the application of neutron reflectometry in fields from biological sciences to engineering. Other work in this area included the completion of a CRP and the initiation of another one. The completed CRP produced detection systems for fast neutron radiography, software to correct radiographs, and a microtron based neutron source. The new CRP concerns the measurement of residual stresses that develop in materials during synthesis. It will focus on residual stress measurements, the standardization of instruments, and intercomparison studies.

The Agency intensified its support for Member States participating in international programmes to return research reactor fuel to the country of origin. For example, to assist countries participating in the Russian Research Reactor Fuel Return (RRRFR)

programme, it conducted meetings on technical and administrative preparations for shipping the fuel, and on transit requirements and arrangements for shipping irradiated fuel (Fig. 1). In addition, the Agency procured ten spent fuel casks — under a €4 million contract — to directly assist the RRRFR programme.

Under a technical cooperation project aimed at safely removing irradiated Russian research reactor spent fuel from the Vinča Institute in Serbia, the Agency concluded a $9.75 million contract with a consortium of Russian companies to repackage the spent fuel and ship it to the Russian Federation. On-site operations began in November.

A regional technical cooperation project assessed alternatives for managing spent fuel from research reactors in Latin America. The project identified options for operational and interim storage, spent fuel conditioning and final disposal. Follow-up projects will study alternatives for interim storage, develop engineering and preliminary safety documents, and complete the engineering work for a dual purpose, research reactor spent fuel storage and transport cask. The Agency also provided assistance to countries shipping eligible irradiated research reactor fuel to the USA, in particular through a technical meeting where national experience was reviewed and recommendations made to facilitate future shipments.

The Agency initiated a new CRP in 2006 to assist States in the conversion of their Miniature Neutron Source Reactors (MNSRs) with HEU cores to LEU fuel. The conversion is to be carried out with minimal reduction of the utilization capacity of the reactors, in concert with international non-proliferation initiatives to reduce and eventually eliminate the use of HEU in civil commerce. Preliminary work in the CRP included preparations for the conversion of MNSRs operating in China and five other countries operating MNSRs supplied by China.

A report on *Understanding and Managing Ageing of Material in Spent Fuel Storage Facilities* (Technical Reports Series No. 443) was published based on the results of a completed CRP. This CRP drew from strategies developed for ageing management in nuclear power plants and recommended adaptation of these methods to smaller fuel storage facilities at research and test reactors. The CRP provided a valuable insight into age related phenomena at storage facilities in the countries participating in the CRP and led to the formulation of a set of suggested strategies for ageing management that have been applied in a number of facilities in those countries. In addition, a CRP on the corrosion of research reactor aluminium clad spent fuel in water (phase II) was concluded in 2006. This CRP demonstrated that water quality affects crevice and galvanic corrosion and that sediments produce degradation independent of water quality. It also clarified the influence of sediments and orientation of the aluminium specimens used to study corrosion mechanisms.

"The CRP provided a valuable insight into age related phenomena at storage facilities ... and led to the formulation of strategies for ageing management."

The Agency began international collaborative work on the use of LEU in accelerator driven subcritical assemblies. The main objective of the undertaking is to demonstrate the technical feasibility of using LEU in assembly systems currently operating with HEU, and in future projects involving these assemblies.

In a CRP on the use of LEU targets for the small scale production of molybdenum-99, a workshop in Serpong, Indonesia, trained the participants in a technique developed by Argonne National Laboratory to recover molybdenum-99 from irradiated LEU targets. A second workshop was held in cooperation with the major international commercial producers of molybdenum-99 to review operational aspects of the production of this isotope.

FIG. 1. Handling a transport cask with fresh HEU prior to shipment back to the Russian Federation under the RRRFR programme.

Utilization of Accelerators and Nuclear Spectrometry

Accelerators

Charged particle accelerators provide powerful analytical techniques in fields such as materials science, environmental science, cultural heritage and the biosciences. In 2006, the Agency, through its technical cooperation programme, provided training for fellows at the Agency's Laboratories, Seibersdorf on the application of X ray fluorescence (XRF) techniques to the study of objects of historical or archaeological importance. The Agency also cooperated in three international conferences and a workshop on microprobe techniques and applications of accelerator generated neutrons, and facilitated the participation of young scientists from developing Member States in these events to help build human resource capabilities. A further initiative to build human resource capabilities was the convening of a 'school' on ion beam analysis and accelerator applications conducted in cooperation with the Abdus Salam ICTP.

Neutron research and the pursuit of new developments in neutron science in many Member States are supported by making optimum use of more intense and better adapted neutron beams at new spallation sources and existing research reactors. In this connection, a new CRP was initiated on improved production and utilization of short pulsed, cold neutrons at low–medium energy spallation neutron sources.

Nuclear Instrumentation and Spectrometry

Through its technical cooperation programme, the Agency conducted training programmes both at the Agency's Laboratories, Seibersdorf, and in the field on the effective use of modern nuclear instruments; on the development and use of training materials based on information and communication technology (ICT); on the methods and applications of XRF techniques; and on the application of nuclear analytical techniques in support of air pollution monitoring. To support practical experiments, approximately 450 ICT based training kits were prepared for trainees.

The Agency completed tests with laboratories in Brazil, the United Republic of Tanzania and Zambia on innovative methods in maintaining and repairing nuclear instruments. The tests involved equipment and communication software for remote diagnosis and technical advice through the Internet. First results showed the advantage of prompt and accurate interaction to avoid costly mistakes in the use of nuclear electronic equipment.

A quality manual for nuclear instrumentation services was prepared and is now being used at the Agency's Laboratories, Seibersdorf. After testing of the procedures is complete, the manual will be made available to Member States. In addition, specialized software for automation was implemented to improve the quality of measurements. The Agency also carried out proficiency tests for laboratories in Europe and Latin America applying nuclear analytical techniques in support of air pollution studies.

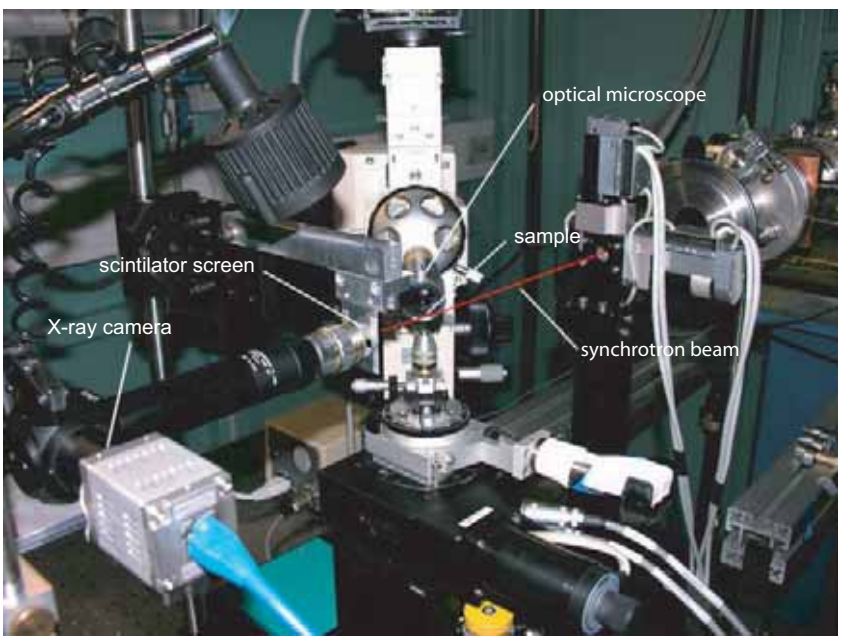


FIG. 2. X ray phase contrast imaging set-up.

A new X ray phase contrast micro-tomography technique, based on synchrotron radiation, was developed by the Agency (Fig. 2) in support of the sterile insect technique. It was applied in the study of morphology and 3D imaging of malaria mosquitoes.

To better characterize materials, a new CRP was initiated on unifying nuclear spectrometries. The goal is to develop integrated instruments and analytical methods for use in both small laboratories and state of the art synchrotron sources.

"On 21 November 2006, ministers representing the seven Parties to ITER signed an Agreement setting up the ITER International Fusion Energy Organization."

Nuclear Fusion

The Agency fosters international cooperation in fusion and plasma physics research under the guidance of the International Fusion Research Council (IFRC). On 21 November 2006, ministers representing the seven Parties to ITER signed an Agreement setting up the ITER International Fusion Energy Organization (Fig. 3), an Agreement on Privileges and Immunities and an Arrangement on Provisional Application of the agreements to allow immediate cooperation pending the official entry into force of the agreements. The Director General of the Agency serves as the Depositary for both agreements.

Agency activities in 2006 included meetings to outline general guidance and recommendations regarding safety requirements for first generation fusion power plants. The Agency also contributed to two joint experiments in a series of such experiments intended to disseminate knowledge in fusion research. These joint experiments involve cooperation between a host laboratory and the Abdus Salam ICTP. The Agency also collaborated with the Kurchatov Institute, in Moscow, on a joint experiment on tokamaks, and with the University of Cairo in a joint experiment on plasma physics. These experiments presented an opportunity for young experts from a range of Member States to work together on a variety of fusion topics.

A new CRP, entitled 'Pathways to Energy from Inertial Fusion — An Integrated Approach', was initiated in 2006. The aim is the further development of inertial fusion energy to enhance awareness in Member States of beam–plasma–matter interactions, which are important in experiments and applications using intense laser or particle beams.

The 21st IAEA Fusion Energy Conference (FEC) was hosted by China in the city of Chengdu. More than 700 scientists and senior policy makers from 39 countries and 3 international organizations attended the meeting, the first FEC following the decision to build ITER. It was noted that material development programmes should be developed as part of a broad international approach in order to combine resources with the aim of delivering faster and cheaper fusion data and results. ■

FIG. 3. The signatories of the ITER Agreement, together with French President Jacques Chirac (centre).

Food and Agriculture

Objective

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

Reducing Soil Erosion

In many parts of the world soil erosion is a major form of land degradation that can have severe effects on people, local economies and the environment. The Agency has assisted Member States in establishing the extent of soil erosion using radionuclides still in the soil as a result of nuclear weapons testing in the past or from cosmic radiation and atmospheric deposition of nuclides. Soil conservation measures, such as no-tillage and grass strips, were introduced when the rates of erosion were determined. These simple measures led to reductions in soil erosion rates of 20–90% in Chile, China, Morocco, Romania and Vietnam, resulting in an increase in the productivity of the land.

Improving Water Use Efficiency

Improving water use efficiency in agriculture is a major focus of the Agency's programme in food and agriculture. Research in Bangladesh, China, India, Nepal and Pakistan using nitrogen-15 isotopic techniques and neutron probes established that the novel cultivation of rice in raised beds without continuous flooding can lead to significant savings in the use of irrigation water compared with the traditional practice of growing rice in paddy fields.

Research supported by the Agency involving Algeria, Australia, China, India, Morocco, Pakistan and Yemen demonstrated that a carbon isotope discrimination technique can be used for the selection of wheat varieties, resulting in greater grain yield and increased water use efficiency through a greater tolerance to drought. The technique is based on differences between carbon-12 and carbon-13 isotopes in plant tissues. Building on these results, the technique will be used to develop crop cultivars matching specific environments prevailing in the participating countries.

In plant mutation breeding, the number of officially released mutant varieties reached 2541. One Member State that benefited directly in 2006 from the release of these varieties was Peru. Barley is an important part of the diet for the three million people living on subsistence agriculture in the Peruvian Andes. The harsh and extreme climatic conditions make this environment inhospitable to many crops, and barley is often the only source of nutrients available to the population. High yielding mutant varieties of barley and 'kiwicha' (a type of grain) were released in Peru during the year, adding to the varieties that were introduced in earlier breeding programmes. These varieties now cover 90% of the barley producing area in Peru, which is above 3000 m and extends up to 5000 m above sea level (Fig. 1). The availability of these improved mutant seeds has contributed to increased food security for the local population and to increased income from the sale of the production surplus.

A mutant wheat variety was released in Yemen, which in yield trials was shown to mature earlier than the original variety, thereby avoiding losses imposed by disease. In addition, Botswana and Kazakhstan have, for the first time, introduced mutation induction as part of their crop improvement programmes, while Sierra Leone has re-established its capacity to conduct mutation breeding. The importance of mutation breeding in the Islamic Republic of Iran and Kenya was emphasized by the introduction of this topic in graduate university courses in these States.

Several new techniques to enhance the efficiency of mutation induction in plant breeding and crop

FIG. 1. The barley mutant variety UNA La Molina 95 growing at an altitude of 5000 m in Peru.

improvement were developed by the Agency in 2006, along with pilot testing schemes for further use. In the area of molecular screening, targeting induced local lesions in genomes (TILLING), which allows the rapid identification of plants carrying mutations in genes of interest, has established itself as a powerful functional genomics discovery technique, opening up new perspectives for breeding. It has recently been verified as a proof of concept for crop improvement in bread wheat, and its further development for mutation induction was developed at the Agency's Laboratories, Seibersdorf.

Advances were made in techniques for producing more stable and useful mutant variants of vegetatively propagated crops such as banana and plantain at the Agency's Laboratories, Seibersdorf. Research established protocols for the efficient in vitro irradiation of explants from exotic fruit trees, including litchi, guava, carambola, cherimoya, pitanga and jaboticaba. These mutant trees are undergoing testing for confirmation of the mutation for earliness, seedlessness and resistance to disease, while maintaining their agronomical performances.

The Agency participated in China's Cosmic Ray Treatment programme. The Shijian-8 satellite, specially designed for seed breeding in space, carried over 2000 varieties of plant seeds belonging to 133 species, including rice samples from the Joint FAO/IAEA Programme on Nuclear Techniques in Food and Agriculture, which will be used for both breeding and basic research. The exposure of plant materials to strong cosmic radiation for long periods of time, combined with microgravity and a weak geomagnetic field, has the potential to cause mutagenic effects on plants and induce a range of genetic variations, including higher yield and improved quality. Some useful mutations from space induced mutations are rarely found in crop germplasm and may open up a new road to increase crop yield.

The Sterile Insect Technique (SIT) for the Sustainable Control of Insect Pests

A new sterile insect production facility was established in Bahia, Brazil, where a mass rearing facility started operations dedicated initially to the production of about 100 million sterile Mediterranean fruit flies (medflies) per week. The facility, developed with assistance from the Agency's technical cooperation programme, will service the rapidly expanding commercial fruit production areas in the various irrigation districts around Rio San Francisco in the arid northeast of Brazil. The initial objective is to reduce insecticide applications by suppressing fruit flies in an environmentally friendly manner, with the ultimate goal of eliminating the costly post-harvest treatments by establishing officially recognized low prevalence and fruit fly free areas.

An area-wide integrated pest management programme that includes an SIT component was initiated in Argentina against the codling moth, which is a major pest of apples and pears. A pilot rearing facility was inaugurated in September 2006. The Agency supported human capacity building and an economic feasibility study that compared the current control practices with an SIT based approach for a 100 hectare pilot area. The economic indices showed a return on investment with a benefit to cost ratio of 17:1, which if extrapolated to the entire apple and pear industry in Argentina would result in very large economic benefits.

"The Agency drafted standard operating procedures for the advanced mass rearing of tsetse flies, with particular reference to the needs of technical cooperation projects."

An interregional training course on the use of the sterile insect and related techniques for the integrated area-wide management of insect pests was held at the University of Florida, in Gainesville, USA. Kenya hosted a similar FAO/IAEA regional training course in Nairobi. The Agency provided assistance in the organization of two workshops — in Burkina Faso and Uganda — to develop detailed action plans for the collection of entomological baseline data.

The Agency drafted standard operating procedures for the advanced mass rearing of tsetse flies, with particular reference to the needs of operational technical cooperation projects. In addition, two e-learning modules on SIT relevant irradiation dosimetry and on procedures to test the compatibility of tsetse strains were developed to enhance quality assurance in tsetse SIT procedures.

At the invitation of the Algerian Commission of Atomic Energy, the Agency participated in a regional

conference on 'Approaches for the Integrated Control of the Desert Locust', held in Algiers in July. The participants explored, among others issues, the possible inclusion of nuclear techniques in the arsenal of existing control tactics against the desert locust, a devastating crop pest. The conference concluded that for technical reasons, SIT was not a suitable control tactic for this pest, though other nuclear techniques such as those involving the use of stable isotopes could be considered as supplementary research tools to study certain fundamental processes of desert locust ecology, for example dispersal, distribution and nutrition.

Substantial progress was achieved in a technical cooperation project on implementation of a pilot programme using SIT against the medfly in Tunisia, where a fully equipped and staffed sterile fly packing and holding unit is now operational. The elements for area-wide SIT application are also available. At the rearing plant, located on the premises of the Centre national des sciences et technologies nucléaires, the counterpart organization is implementing quality and process control procedures. It has also provided additional areas for the storage of diet ingredients, as well as a washing room which will help reduce the risk of contamination in the facility.

Sustainable Improvement of Livestock Production Systems

Developing countries have thousands of different breeds of livestock, which need to be properly evaluated and characterized for optimal utilization. One step in the characterization process is DNA analysis. New nuclear and related molecular technologies allow quick and rapid identification of molecular genetic markers to identify differences in genome sequences. It is possible now to 'genotype' animals through a simple DNA test, and to classify those carrying a desired trait before the selection process. Through a CRP, the Agency conducted research with the aim of assisting Member States in carrying out such DNA analysis. The activities of this project succeeded in transferring this technology and skills to eight different countries and have led to the genetic characterization of more than 90 breeds of sheep and goats.

Improving Food Quality and Safety

Improvements in food quality and safety depend on the establishment of reliable sampling and analytical regimes for quantifying potential hazards related to food safety. Agency activities in the area of food quality and safety support analytical laboratories in Member States and include an annual interregional training workshop which helps these laboratories both in the application of methods of analysis for food contaminants and in ensuring the quality of the results produced. In 2006, scientists from 20 Member States were trained in these areas at the Agency's Laboratories, Seibersdorf (Fig. 2). Analytical methods, including radiotracer techniques, for residues of various pesticides and veterinary drugs in food were developed, their performance validated, and the protocols transferred to Member States. These activities assisted Member States in evaluating the impact of good production practices, identifying and using environmental indicators, and enhancing the potential of these States for participating in the international food commodities trade.

"Agency activities in the area of food quality and safety support analytical laboratories in Member States."

Collaborative efforts with international bodies in this regard include the development and adoption of Codex Guidelines on the estimation of uncertainty of results in relation to compliance monitoring of pesticide residues in food. The uncertainty of analytical results is important in evaluating the risk of violating Codex or national pesticide residue limits for food commodities before export, thereby

FIG. 2. A laboratory training exercise at the Training and Reference Centre for Food and Pesticide Control, Agency's Laboratories, Seibersdorf.

avoiding the rejection of consignments by importing countries.

The Agency hosted a technical panel on phytosanitary treatments, where 12 specific irradiation treatments for some of the most important pests in the international trade were discussed and approved. The report of this meeting will go to the Commission on Phytosanitary Measures as part of the process of securing Member State agreement on the adoption of irradiation treatments.

Emergency planning and response to nuclear emergencies and radiological events is of growing importance in the Agency's activities, particularly with regard to increasing the capabilities of FAO as a critical counterpart in defining and implementing agricultural countermeasures in response to such events. These collaborative activities helped to ensure the adoption of the revised *Codex Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency for Use in International Trade* at the 29th Session of the Joint FAO/WHO Codex Alimentarius Commission, held in Geneva in July 2006. These levels provide added assurance to governments that foods are safe and help facilitate international trade in the aftermath of nuclear emergencies. ■

Human Health

Objective

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

The IAEA Nobel Peace Prize Cancer and Nutrition Fund

The IAEA Nobel Peace Prize Cancer and Nutrition Fund was created in response to the Board of Governors' decision that the Agency's share of the 2005 Nobel Peace Prize should be used to fund fellowships and training to improve cancer control and childhood nutrition in the developing world. In 2006, the fund supported two regional special events in support of the Agency's Programme of Action for Cancer Therapy (PACT), on human resources development in radiation oncology in the context of cancer control programmes in the Asia and Pacific region (in Bangkok) and in Africa (in Cape Town).[1] The Agency's 'Schools for Nutrition' — part of the IAEA Nobel Peace Prize Cancer and Nutrition Fund — provide an important opportunity to disseminate information on the use of stable isotope techniques in the development and monitoring of nutritional interventions to combat malnutrition in infants and children. Two of these training and information events were held, in Guatemala City and in Kampala (Fig. 1).

[1] Activities related to PACT are discussed in detail in the chapter 'Issues and Events in 2006' at the beginning of this document.

Quality Assurance in Radiation Medicine

The Agency convened an international conference on Quality Assurance and New Techniques in Radiation Medicine in November in Vienna. Marking the first time that quality assurance (QA) has been discussed in all aspects of radiation medicine — diagnostic radiology, nuclear medicine and radiotherapy — the conference examined QA issues related to the implementation of new technologies, education and staff training. It was recognized that there is a need for a more systematic approach to the adoption of advanced technologies, and the socioeconomic impact of introducing such technologies in settings of limited resources was addressed. The participants felt that milestones were needed to guide the adoption of advanced techniques and equipment in developing Member States.

FIG. 1. Announcement for the IAEA Nobel Peace Prize Fund Schools for Nutrition, held in Latin America and Africa in 2006.

Nuclear Techniques in Nutrition

The use of nuclear techniques, in particular the use of stable isotope techniques, can assist in the development and evaluation of nutritional interventions. During 2006 the Agency contributed to capacity building in the use of stable isotope techniques in nutrition, particularly in Africa. Seven new laboratories were equipped with specialized equipment for analysis of deuterium to assess body composition and to measure intake of human milk in breastfed infants. In addition, three laboratories in Africa and Asia were equipped with isotope ratio mass spectrometers dedicated to studies for nutrition projects. Emphasis was given to the training of young investigators in the application of stable isotope techniques in nutrition; for example, participants from 13 African countries were trained during a one week training course organized by the Agency in collaboration with the Centre for Human Nutrition Research, University of Cambridge, United Kingdom.

"Capacity building in Africa has been strengthened, resulting in nine countries now having the capability of using nuclear techniques to assess body composition."

The Agency continued its collaboration in nutrition with UNICEF, WHO and PAHO, with representatives of these organizations participating in Agency meetings on the preparation of advocacy documents and guidelines on the use of stable isotope techniques in nutrition studies. The Agency contributed to a UNICEF/WHO meeting on programmatic aspects related to the prevention and control of iron deficiency in children.

A regional technical cooperation project for Africa is evaluating the efficacy of supplementary food for people living with HIV/AIDS. A technique known as the deuterium dilution method was used to assess body composition, particularly to estimate fat mass and fat free mass in people living with HIV/AIDS and to validate other field methods for the assessment of nutritional status. Capacity building in Africa has been strengthened through the implementation of this project, resulting in nine participating countries now having the capability of using nuclear techniques to assess body composition. In addition, the isotope ratio mass spectrometer purchased within this project (located in Dakar, Senegal) will increase the analytical capacity in the region significantly.

Nuclear Medicine

The Agency's first major activity on clinical PET, a powerful medical imaging procedure that non-invasively shows the function of organs and tissues, was initiated during 2006. Molecular imaging procedures are a safe, effective means of gathering medical information that would otherwise be unavailable, require surgery or necessitate more expensive diagnostic tests. A new CRP on the application of ^{18}F-fluorodeoxyglucose (FDG)–PET and molecular gene profiling for the treatment of diffuse large B cell non-Hodgkin's lymphoma in different ethnic populations aims to assess the independent prognostic value of two techniques, namely PET and molecular biology gene profiling. Treatment of diffuse large B cell non-Hodgkin's lymphoma has evolved to a point where the disease is curable in many patients, and the availability of PET has made a significant contribution to disease assessment when it is detected and at the end of treatment. The synergistic combination of these sciences and technologies will facilitate understanding of the basic characteristics of the disease.

Changing lifestyles, as well as other factors, are expected to lead to a large increase in diabetes, especially in developing countries. A CRP was started on the 'Role of Nuclear Cardiology Techniques in Ischaemia Assessment with Exercise Imaging in Asymptomatic Diabetes'. Diabetes mellitus is a disorder characterized by varying or persistent elevated blood sugar levels and is a strong risk factor for cardiac disease. This study will contribute to the development of guidelines and to patient management.

To encourage and assist Member States in adopting quality management systems in their nuclear medicine practice, a meeting was convened to develop a publication, *Quality Assurance System in Nuclear Medicine (QANUM)*, as a tool for quality improvement and as a basis for establishing an auditing programme aimed at raising the level of nuclear medicine practices in Member State hospitals.

In related work, the Agency, in cooperation with WHO, began developing 'International

Pharmacopoeia Radiopharmaceuticals Monographs', which aim to improve quality in the preparation of radiopharmaceuticals in Member States, and also enhance the quality of nuclear medicine practice. The monographs will feature specialized studies and descriptions of standard procedures for the preparation of radiopharmaceuticals in hospitals.

Radiotherapy for Cancer Treatment and Palliation

The Agency initiated a CRP for the comparison of two different radiotherapy techniques for patients following mastectomy. This is in response to statistics (Fig. 2) that show that breast cancer is the most common cause of cancer related death in the world among women, accounting for 11% of all female cancer deaths. Post-mastectomy radiotherapy substantially reduces the risk of a recurrence, but the optimal treatment is as yet unknown. The study includes, among other factors, a QA survey of the ability to implement and document the technical guidelines for treatment delivery. The International Network for Cancer Treatment and Research is among the collaborators in this project.

Earlier Agency sponsored research on palliative radiotherapy for oesophageal cancer led to the initiation of a new CRP involving radiotherapy centres in China, Croatia, India, Pakistan, South Africa and Thailand. Patients were randomly selected to receive a treatment that places a radioactive source directly inside the oesophagus (intraluminal brachytherapy), with or without the addition of external beam radiation therapy (EBRT). This trial showed that there was an improvement in the ability to swallow with the addition of EBRT, which is safe and tolerated well by patients. The new trial will explore a resource-saving approach to EBRT.

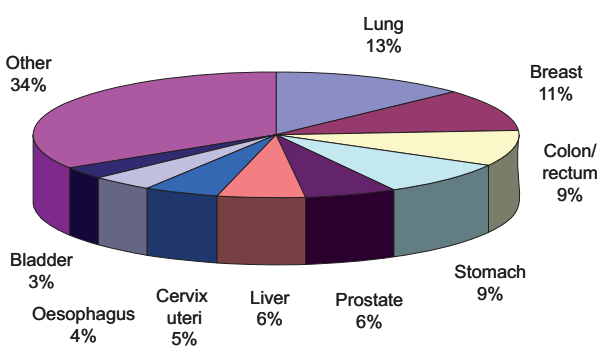


FIG. 2. Incidence of cancer around the world: 11 million new cases per year are predicted (estimates from the Globocan 2002 database).

Educational packages for developing Member States were developed on 'evidence based radiation oncology' for the optimal treatment of common cancers using cost effective modalities. The packages were on clinical research, which describe the methodology and implementation in resource limited settings, education and training guidelines for radiation oncologists, medical physicists, radiation therapy technologists and nurses, and emerging techniques in radiotherapy planning and delivery, which describes clinical advantages and disadvantages, cost–benefit considerations and implementation. Close liaison and coordination were also maintained with other international organizations, including the ICRU for ion beam therapy, the ICRP for deterministic effects in tissues after high radiation doses, and WHO for treatment guidelines.

Medical Physics and Dosimetry

The Agency has created the QUATRO service (Quality Assurance Team for Radiation Oncology) to conduct missions that review and evaluate the quality of the various components of the practice of radiotherapy at a specific cancer treatment centre, with the aim of improving overall quality. QUATRO workshops were organized in Austria, Morocco and South Africa in 2006 both to explain the concept to counterparts from radiotherapy centres and to train experts in the audit methodology through regional technical cooperation projects. Altogether, 12 QUATRO missions were completed in 2006, to Armenia, Bosnia and Herzegovina, China, Cyprus, Indonesia, Malaysia, Mongolia, Poland, Serbia, Sri Lanka, Thailand and Vietnam. Individual radiotherapy centres received recommendations on quality improvement in several areas.

At a technical meeting of medical physicists and radiation oncologists, guidelines were prepared on the development and implementation of intensity modulated radiation therapy (IMRT) to assist developing countries in the use of this technique. IMRT presents challenges that are significantly more complex than traditional forms of radiation treatment, and its implementation requires substantial resources. To facilitate the systematic introduction of IMRT in radiation oncology departments in Member States, a set of guidelines was also prepared.

A publication entitled *Quality Assurance for Radioactivity Measurement in Nuclear Medicine*

(Technical Reports Series No. 454) was issued to assist in the administration to patients of properly constituted radiopharmaceuticals that are free of impurities and possess the prescribed quantity of radioactivity, both of which are important for the safety and clinical efficiency of diagnostic and therapeutic procedures in nuclear medicine. The publication provides information on the measurement procedures for the routine measurement of radioactivity, including maintaining the necessary documentation, as well as guidance on implementing the ISO/IEC 17025 standard on quality assurance.

The Agency extended its dosimetry calibration and auditing services facilities in response to increased demand from Member States. The newly expanded facilities of the Dosimetry Laboratory, inaugurated in June 2006 in the Agency's Laboratories, Seibersdorf, allow an increase in the training capabilities for fellows. A new cobalt-60 machine for instrument calibration was installed and commissioned, and in October the Agency's quality management system in the Dosimetry Laboratory was formally accepted by the Joint Committee of the International Bureau of Weights and Measures and the regional metrology organizations in accordance with the ISO 17025 standard.

Collaboration with external organizations continues to be a priority. A publication — *Prescribing, Recording and Reporting Proton Beam Therapy* — was prepared in collaboration with the ICRU. Additionally, information exchange with the American Association of Physicists in Medicine and the European Federation of Organisations for Medical Physics was strengthened by the appointment by these organizations of designated liaison staff for promoting closer collaboration with the Agency. ■

Water Resources

Objective

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

Working Together to Meet Common Water Challenges

To address global water challenges, such as water shortage and quality, overexploitation and the impacts of climate change on water resources, Member States need precise information to enable them to make decisions about sustainable water resources management. In this connection, the Agency participated in the Fourth World Water Forum, held in Mexico City in March. The Forum, with a theme of 'Local Actions for a Global Challenge', was attended by ministers from over 80 countries, along with representatives from UN agencies and water programmes. One of the major conclusions of the meeting was that governments have the primary role in promoting improved access to safe drinking water and basic sanitation. It was agreed that this can be best accomplished through the active involvement of all stakeholders, particularly the poorest sections of society.

The Agency assisted the Nile Basin riparian countries in formulating a proposal for joint IAEA–UNDP/GEF funding to improve the understanding of groundwater in the Nile Basin and facilitate equitable sharing of water resources among the countries in that region. Representatives from Egypt, Ethiopia, Kenya, Sudan and the United Republic of Tanzania, as well as from the Eastern Nile Project and the Water Resources Planning Project of the Nile Basin Initiative, participated in this effort. A second proposal under this joint funding initiative was formulated in cooperation with counterparts from Ethiopia to undertake a nationwide assessment of groundwater resources. These proposals build upon an IAEA–UNDP/GEF funded project for the management of the Nubian Aquifer in northern Africa, which held its first meeting in Tripoli, Libyan Arab Jamahiriya, in July 2006.

Isotopic Applications for Addressing Key Water Management Issues

Groundwater dating techniques can be used by Member States to assess their groundwater resources. In 2006, the Agency developed a new helium-3 isotope detection technique that allows for more accurate dating by measuring helium-3 as a product of decaying tritium. The helium-3 system was successfully tested and will now allow Member States to date groundwater from a variety of sources.

Through the Agency's technical cooperation programme over 70 projects in water resources development and management were implemented in Africa, the Middle East, Asia and Latin America. Twelve training courses, workshops and seminars were conducted for developing Member States covering such topics as the assessment of water use and availability, isotope techniques for watershed management, and isotope methods for determining the age of groundwater.

"Through the Agency's technical cooperation programme over 70 projects in water resources development and management were implemented in Africa, the Middle East, Asia and Latin America."

One key objective of the Agency's water resources programme is to increase the contributions by Member State laboratories of analytical data to national and regional technical cooperation projects. To improve the quality of such data, Agency staff assisted laboratories in Egypt, El Salvador, Morocco, Pakistan and South Africa in harmonizing procedures for data handling and developing protocols for quality assurance and control.

In a CRP designed to build a broader knowledge base to improve sustainable management of river basins, research focused on the use of isotopes to improve the understanding of groundwater/river interactions, river water balance and human impacts on river discharge under present and future climate conditions. Seventeen research teams provided a

Improving project implementation using low cost, locally available sample bottles

Water samples for stable isotope and tritium analysis must be collected in bottles that do not allow evaporation or vapour exchange of water during shipping and storage prior to analysis. For over 40 years the Agency has provided high density polyethylene bottles for collecting water samples because appropriate bottles were not readily available in many countries. The procurement and shipment of these bottles was a significant expense for Member States, which also led to delays in project implementation.

To deal with this problem, a number of locally purchased bottle types from countries in Africa, Asia and Latin America were evaluated and selected for their suitability for collecting hydrological samples. Considerable savings are anticipated from this initiative.

set of novel isotope data in rivers and elaborated a rationale for the continuous collection of river isotope data in the Global Network of Isotopes in Rivers. Isotope based monitoring of river hydrology is a cost effective and scientifically sound alternative to the classical method based on measurements of river discharge.

A CRP was initiated on the geostatistical analysis of spatial isotope variability to map sources of water for hydrology, and on isotopic techniques for the assessment of hydrological processes in wetlands. These projects have the objectives of developing protocols for visualizing, integrating and mapping hydrological, hydro-chemical and isotope data, and of improving the understanding of the role of wetlands in influencing water quality and the movement of pollutants from surface to groundwaters. Research groups from over 18 countries in Africa, Asia, Europe, and North and South America are participating in these investigations.

To facilitate the training and education of Member State scientists in the use of isotope techniques, an audiovisual package was produced on the collection of water samples for isotope analysis. This package will help to improve the quality of data collected in technical cooperation projects, build capacity for sample collection, and streamline training by reducing the need for basic level isotope hydrology courses. ■

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.

Contaminant Uptake Studies on Caspian Sea Sturgeon

The presence of contaminants in seafood can endanger valued marine species themselves, their export value, as well as human health. Several types of marine fish are being investigated for their capacity to accumulate contaminants and transfer them to their eggs. In particular, sturgeon (and their seafood products) from the Caspian Sea — a valued natural resource — are under threat from a variety of environmental impacts, including pollutants such as cadmium from industrial facilities, which might also affect their reproduction. A series of radiotracer studies on sturgeon carried out in 2006 by the Agency determined how sturgeon accumulate a range of metals from water under the varying salinities that occur in the Caspian Sea and from foods contaminated by metals in sediments.

Natural Radium Tracers for Coastal Processes

The four radium isotopes found in the ocean — radium-223, radium-224, radium-226 and radium-228 — have half-lives varying from 3.7 days to 1600 years, which match the timescales of coastal, oceanic and climate change processes. They can therefore be used as tracers of estuarine flows, coastal and ocean mixing, submarine groundwater discharge and ocean circulation (see Fig. 1). The shorter lived isotopes (radium-223 and radium-224) can be selectively measured in the environment. Following successful trials in waters around the world, the Agency hosted an international workshop to critically assess the analytical challenges and environmental applications of the use of short lived radium isotopes which will enable Member States to better understand coastal ecosystems.

Climate Change

Oceans cover about 70% of the Earth's surface and play an essential role in regulating the global climate system, particularly through their ability to sequester a significant fraction of atmospheric carbon dioxide. Understanding the mechanisms by which the surface

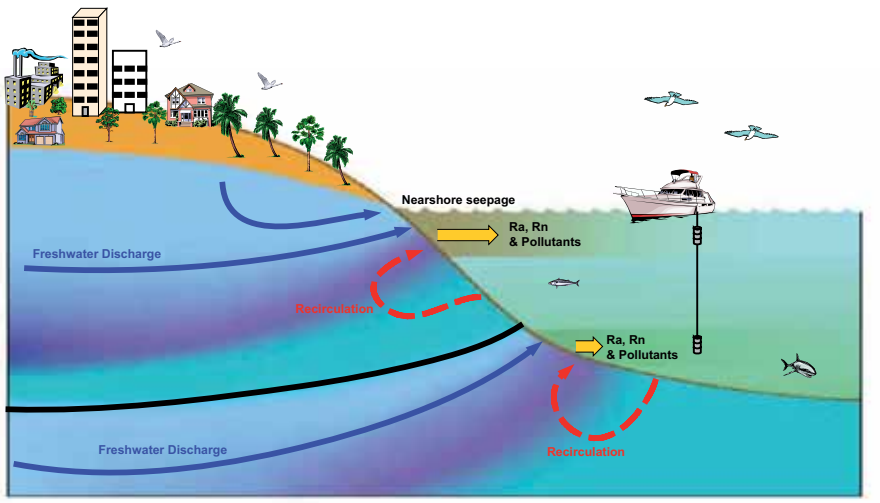


FIG. 1. Radium isotopes can be used as tracers in the study of water flows and circulation (Ra: radium; Rn: radon).

of the oceans absorbs carbon dioxide and transfers it to the depths of the sea is important. The Agency used natural radionuclides and isotopes to study carbon removal by the oceans and to study the role of biology and marine particles on these removal mechanisms.

Using natural radiotracers it could be demonstrated that the carbon-containing fast sinking particles in the ocean contribute more to carbon removal from the atmosphere than do more slowly sinking particles (Fig. 2). These new findings contribute to a more precise understanding of the processes involved in carbon packaging and removal from the ocean's surface, and support efforts for better modelling of future climate change.

The Agency participated in the Japanese Southern Hemisphere Ocean Tracer Studies (SHOTS) project, which aims to quantify the absorption of carbon and heat in this climatically critical region of the world through measurements of radionuclides from past weapons testing since these radionuclides can be used to study ocean mixing and deep sedimentation. Preliminary results show that surface waters are transported from the North to the South Pacific and the Indian Ocean where caesium-137, carbon and some pollutants are stored for decades in large ocean circular flows, while some waters from the Indian Ocean have also been detected in the South Atlantic. New concepts of ocean circulation in these regions are being developed from the study of global fallout radionuclides and the use of global circulation models, which will lead to better insights into the relationships between oceans and climate.

"The Agency participated in the Japanese Southern Hemisphere Ocean Tracer Studies ... project ... to quantify the absorption of carbon and heat in this climatically critical region of the world."

Reference Materials for Trade and Interlaboratory Comparisons

It is necessary to determine accurately radionuclides in many types of samples for a variety of reasons, including the trade of food products, pollution assessments and remediation. The extensive trade in fish and other seafood products, for example, requires the assessment of, among other pollutants, radionuclides. Assistance

FIG. 2. Sampling of seawater and particles for the measurement of natural radiotracers.

to Member States is provided to measure marine radioactivity through the production and launch of a new reference material for radionuclides in fish. This exercise brought together 90 laboratories from 43 Member States, and the material will contribute to quality control/quality assessment for support to radiological assessments of food safety.

In an emergency, Member States may need to provide radionuclide measurements both quickly and with a high degree of confidence in their accuracy. The Agency therefore coordinated an interlaboratory comparison exercise with members of the ALMERA (Analytical Laboratories for the Measurement of Environmental Radioactivity) network, which included 40 laboratories from 32 Member States, that tested capabilities for rapid analysis and reporting of results. The participating laboratories were sent samples containing known activities of radionuclides in three matrices (soil, grass and water), which were tested and the results returned to the Agency within three days of their receipt.

"Approximately 400 laboratories took part in the first worldwide interlaboratory comparison exercise for gamma emitting radionuclides in environmental matrices."

The third coordination meeting of ALMERA members was held in the Republic of Korea in October, at which a proposal for the establishment of three regional groups was discussed by representatives from member laboratories. This development aims to facilitate interactions between the ALMERA network laboratories so that if an event of international significance occurs they will be ready and able to work together.

Approximately 400 laboratories took part in the first worldwide interlaboratory comparison exercise for gamma emitting radionuclides in environmental matrices (soil, water, etc.) and several additional interlaboratory comparisons were conducted at the regional level, which included an exercise for the Gulf region laboratories as part of the Radionuclide Measurements Cross-Calibration Project. Under a technical cooperation project on air pollution monitoring in the Mediterranean region, an exercise on the determination of radionuclides in air filters was carried out in collaboration with the US Department of Energy and the European Commission 'Clean Air Asia' project.

Services of the Agency's Laboratories, Seibersdorf

The Agency's Laboratories, Seibersdorf, support the implementation of the Agency's scientific and technical programmes covering such areas as: applications of radiation and isotopes in food and agriculture; nuclear instrumentation; radiation dosimetry; nuclear techniques for monitoring radioactive and other contaminants in the environment; and nuclear verification. The laboratories are also a training centre for scientists from developing countries. An example of the experimental facilities and services provided is the Safeguards Analytical Laboratory (SAL), which provides for sample analysis for the Agency's safeguards verification activities. In 2006, SAL analysed approximately 900 nuclear material samples, with the Clean Laboratory of SAL analysing 551 routine environmental safeguards samples and eight special samples. In addition, 853 sample kits were prepared and provided to safeguards inspectors.

The laboratories hosted 107 scientific fellows for training in the area of food and agriculture, environment and radiochemistry and received 676 visitors, including governmental and non-governmental representatives (Fig. 3). ■

FIG. 3. Visit of HSH Prince Albert II of Monaco to the Agency's Laboratories, Seibersdorf.

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 capability in Member States for producing radioisotope products and applying/adapting radiation technologies for socioeconomic benefits.

Radiation Processing Technology

Industrial, agricultural and domestic pollution threatens the limited supplies of water in many parts of the world. Electron beam processing, which destroys organic compounds as well as certain dyes and pesticides, and which is effective in reducing a number of microorganisms, offers great promise as a cost effective treatment process. In a CRP completed in 2006 on the remediation of polluted water and wastewater by radiation processing, the utility of radiation processing techniques was demonstrated and models were developed to describe the removal of organic compounds (Fig. 1). The results have helped to guide analytical methodology and the economic evaluation of radiation processing.

The technique of radiation induced controlled degradation of polymers is already in use for the degradation of such materials as cellulose, polypropylene and rubber so that these materials can be reused in other industrial processes. A CRP that ended in 2006 on controlling degradation effects in the radiation processing of polymers provided further information on the importance and potential of radiation processing techniques in a wide range of industrial applications. The research showed that the irradiation of certain marine based polymers and other natural polymers, such as cellulose, resulted in a substantial decrease in molecular weight, leading to degraded products with improved properties that could be used in the manufacture of healthcare products such as hydrogel wound dressing, ingredients for cosmetics, plant growth promoters, soil conditioners, and viscosity modifiers in the food and textile industries. In Vietnam, degradation products were tested in the field for the prevention of infection by a pathogenic fungus for rice plants in the tropics.

Industrial Applications of Computed Tomography and Radiotracers

Computed tomography (CT) is a tool for the design, optimization and fault-finding of industrial process systems in the chemical and food industries, among others. A CRP on industrial process gamma tomography that was completed in 2006 focused on developing and enhancing the use of this technique in a range of applications. Hardware for CT and software for image reconstruction were developed, including portable gamma CT systems for use in industrial environments, designed in the Republic of Korea, Malaysia and Mexico. More advanced gamma CT systems were developed in Brazil, France, Norway and the USA (Fig. 2). Some of these are already being used in industry and in research, helping to refine industrial processes for better resource utilization and greater industrial safety.

The use of radiotracers in investigations of industrial process vessels helps to reliably assess the efficiency of their performance and the possibility

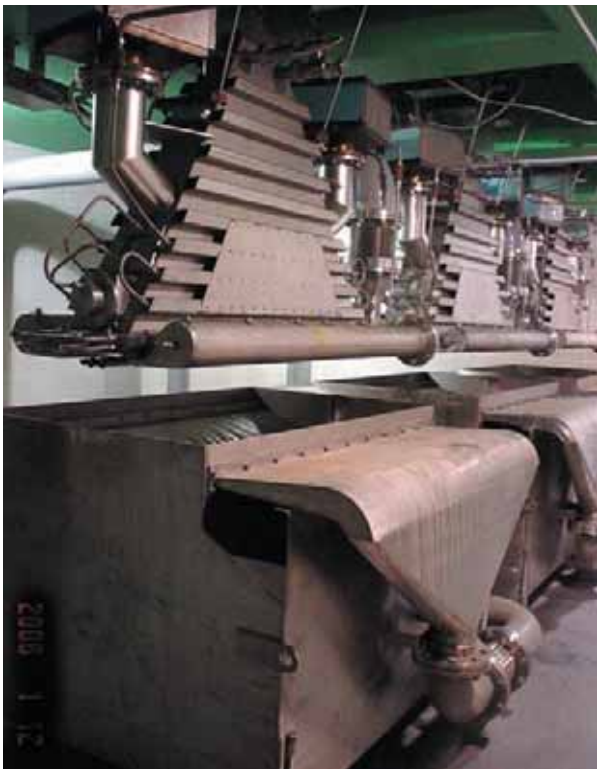


FIG. 1. The first industrial scale electron beam wastewater treatment plant in operation in the Republic of Korea.

FIG. 2. A single photon emission computed tomography system in a French nuclear power plant. The system, installed around the primary circuit of a PWR, improves the estimation of nuclear thermal power in correlation with nitrogen-16 activity produced from oxygen-16 in water.

of any malfunctions. In this regard, the chemical reactors for the production of phosphoric acid in a Tunisian phosphate facility were investigated using an iodine-131 radiotracer as the producer faced problems with the reaction vessels and experienced deterioration in the quality and quantity of the final products. The Agency provided assistance in carrying out tracer tests, which yielded important information on the optimization of the reaction vessels. These vessels were subsequently modified during the shutdown phase.

Radioisotopes and Radiopharmaceuticals in Medicine

Radioisotopes produced with a cyclotron and the radiopharmaceuticals derived from them are extremely valuable in medical applications. Short lived radioisotopes with yields higher than those that are currently available are often required in order to ensure efficient and extensive distribution. A new CRP was therefore started in 2006 to address the need for improving the cyclotron production of radioisotopes, aiming to reliably produce higher yield and higher specific radioactivity for fluorine-18 and carbon-11, which are widely used as positron emission tomography radiotracers for clinical applications.

A CRP completed in 2006 on the comparative evaluation of therapeutic radiopharmaceuticals stimulated collaborative research involving 15 Member State institutions on therapeutic radiopharmaceuticals. The research was successful in establishing several analytical techniques, biological assays, animal tumour models and protocols for the evaluation of such radiopharmaceuticals. In addition, a reliable protocol for the preparation and evaluation of a lutetium-177 labelled peptide for cancer therapy was also developed.

Another CRP focused on the development of technetium-99m (^{99m}Tc) based small biomolecules using novel ^{99m}Tc cores. Researchers developed labelling techniques for the preparation of new technetium complexes with potential application as radiopharmaceuticals. A notable development was the synthesis of a product capable of indicating cancer conditions. Further investigations of this compound will help in the development of a novel radiopharmaceutical for imaging cancer.

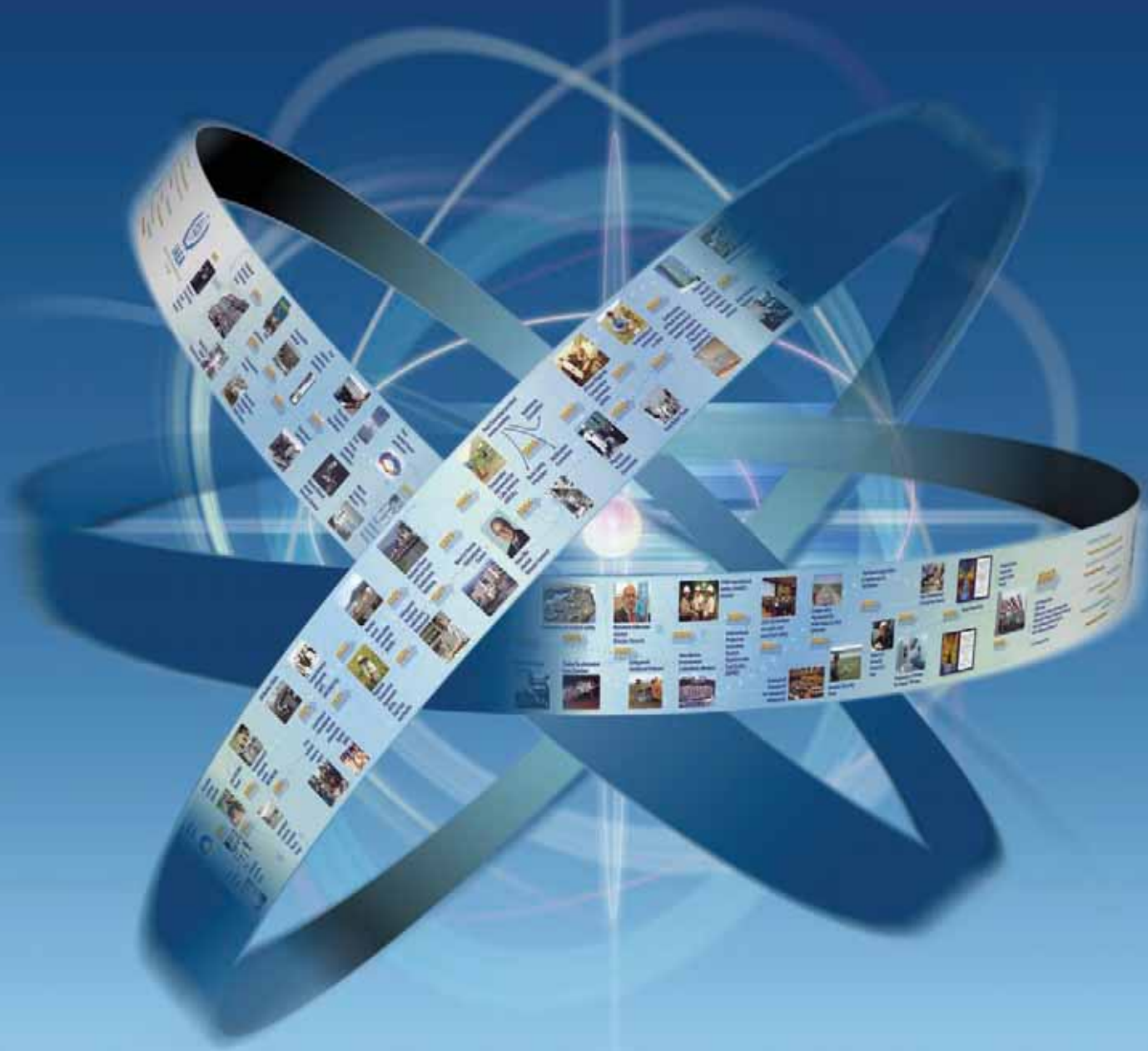
Assisting Member States in building capacity for radiopharmaceutical production is a key area of the Agency's technical cooperation programme. In this connection, support was provided to upgrade radiopharmaceutical production standards for radioactive products through training, and some countries were supported in setting up cyclotron PET radiopharmaceutical production, for example at the Chulabhorn Research Institute in Thailand.

FIG. 3. Analysis using nuclear techniques of a visigothic gold crown in the Louvre, Paris.

Novel Applications of Nuclear Analytical Techniques

Nuclear techniques can help to identify fraud, establish the provenance of and, in some cases, determine the age of artefacts (Fig. 3). Research was carried out on the non-destructive applications of nuclear techniques for the conservation, preservation and investigation of art and cultural heritage objects (for more details of Agency activities in this area, see the chapter 'Issues and Events in 2006' at the beginning of this report). ■

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.

The Agency's Incident and Emergency Centre

The Incident and Emergency Centre, or IEC, underwent a major equipment and infrastructure upgrade in 2006 (Fig. 1). In an emergency the IEC — which is operational around the clock — shifts from 'normal–ready' to 'basic response' to 'full response' operational mode, depending on the severity of the event. Even with the high level of nuclear safety that exists around the world, the IEC continues to receive calls where the situation is severe enough to justify the centre's switch to the 'basic response' mode. This typically involves sending teams to the event site to assist the State concerned.

Agency Fact-finding and Assistance Missions

In December 2005, the Agency received a request for assistance from Chile under the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention) concerning a radiological incident at a cellulose plant. This involved a number of workers being exposed to an unshielded radiography source. Following the request, the Agency organized an assistance mission the same day. Thereafter, it conducted a fact-finding mission to Chile in 2006, which recommended that Chile develop an action plan to improve the national system for emergency management, using as a basis IAEA Safety Standards Series No. GS-R-2, *Preparedness and Response for a Nuclear or Radiological Emergency*.

The Early Notification and Assistance Conventions

Being well prepared is the basis for effective and efficient responses to emergencies. To achieve this,

FIG. 1. The IEC is a 24 hour contact point to respond to nuclear or radiological emergencies.

the Agency — under the Early Notification and Assistance Conventions[1] — organizes and supports various levels of exercises, each referred to as a Convention Exercise (ConvEx). A ConvEx-1 tests communication (i.e. whether State Parties receive a test message); a ConvEx-2 tests response times (how long State Parties take to respond to a test message); and a ConvEx-3 tests the full operation of the information exchange mechanism. During 2006, there were four ConvEx-1 and ConvEx-2 exercises in different parts of the world.

The Action Plan for Strengthening International Preparedness and the Response System for Nuclear and Radiological Emergencies operates under the legal framework of the Early Notification and Assistance Conventions. The Agency coordinates and supports the implementation of the plan by hosting meetings, supporting the drafting of recommendations and facilitating interactions between the various Expert Groups of the Action Plan. In 2006, the International Communications Work Group and the International Assistance Work Group of the Action Plan met and formulated recommendations to be presented for action to the meeting of competent authorities in 2007.

"... the Agency has been providing equipment, conducting training sessions and sending expert missions to the region to enhance emergency preparedness and response capabilities."

Emergency Preparedness Review

In May–June 2006, the Agency conducted an Emergency Preparedness Review (EPREV) mission to Qatar for a peer review of the arrangements regarding preparedness for responding to a radiation emergency. The mission team reviewed and verified the results of a Qatari self-assessment, determining if the arrangements for preparedness and response conformed to IAEA Safety Standards Series No. GS-R-2, and identified good practices and areas for improvement. Team members also observed a full scale rehearsal of a national radiological emergency exercise. Overall, the EPREV team found that Qatar had achieved considerable improvements in its preparedness to respond to radiation emergencies within a relatively short period of time. In this connection, the Agency has been providing equipment, conducting training sessions and sending expert missions to the region to enhance emergency preparedness and response capabilities.

Reporting of Incidents

Through the various reporting mechanisms available to it, the Agency in 2006 was informed of 168 events involving or suspected of involving ionizing radiation. In all cases, the Agency took actions, such as authenticating and verifying information, providing official information or assistance to the requesting party, or offering the Agency's other services. Most of the events were found to have no safety significance and/or no radiological impact to people or the environment. While the majority of the 25 events involving 'dangerous' radioactive sources and 23 events occurring at nuclear facilities were 'near misses' where there was no actual safety impact, the reporting of these near misses allows others to learn from the experience. An event at an irradiation facility in Belgium was the only one rated as high as level 4 ("accident without significant off-site risk") on the IAEA–OECD/NEA International Nuclear Event Scale (INES). In eight events associated with radiography activities, workers received — or were suspected of receiving — doses in excess of regulatory limits.

In 2006, progress was made in expanding the use of INES. In May, the INES National Officers, INES Advisory Committee and representatives from the Agency, the OECD/NEA, the World Association of Nuclear Operators and the European Commission endorsed the 'Additional Guidance for the Rating of Radiation Source and Transport Events'. INES members also reinforced the need for the timely communication of information on events. In other work, INES workshops and training courses were conducted in the Netherlands and South Africa for a wide audience that included regulators, nuclear power plant operators, radiation safety experts and emergency preparedness and response specialists.

[1] The full titles are: Convention on Early Notification of a Nuclear Accident (the Early Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention).

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. To assess the application of these safety standards throughout the world.

Promoting Safety Culture in Member States

The objective of a Safety Culture Assessment Review Team (SCART) mission is to conduct an in-depth, independent review of safety culture at a Member State nuclear facility. The Agency carried out such a mission from 27 February to 10 March at Pebble Bed Modular Reactor (Pty) Limited, in Pretoria, South Africa; this was the first SCART mission to review a design organization. The team reviewed the company's management systems, programmes and procedures, observed work in progress and held interviews with more than 200 of the company's personnel. All major functional areas of the organization were covered. As with all its review missions, performance was assessed using the Agency's safety standards. The team found many signs of a strong safety culture at the company, as well as a commitment to maintain such a culture. An action plan was developed and is being implemented on the basis of the team's recommendations.

"The team found many signs of a strong safety culture at the company, as well as a commitment to maintain such a culture."

The Agency's Incident Reporting Systems

The Incident Reporting System (IRS) is an international system jointly operated by the Agency and the OECD/NEA. Thirty-one participating countries use the IRS to exchange experience to improve the safety of nuclear power plants by submitting event reports on unusual events considered important for safety. In 2006, the Web Based Incident Reporting System replaced the Advanced Incident Reporting System (AIRS) for the preparation, storage, dissemination, searching and retrieval of event reports submitted by IRS participants. One of the major advantages of this new system is that text, graphics and numerical information can now be included in the database, which is updated daily. A companion database, the Incident Reporting System for Research Reactors, grew in 2006 to 48 Member States from 47 in 2005.

Protecting Nuclear Power Plants against Sabotage

While nuclear installations in general, and nuclear power plants in particular, can be considered to be well protected, the potential for sabotage still exists. Recognizing this, the Agency finalized a guidebook entitled *Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage* (IAEA Nuclear Security Series No. 4). This publication, while taking into account the existing robustness of nuclear power plant structures, systems and components, provides methods for evaluating — and proposing corrective actions for reducing — the risk related to any malicious act that could endanger the health and safety of plant personnel, the public and the environment through exposure to radiation or the release of radioactive substances. Training on these guidelines was also provided to a number of Member States.

Nuclear Power Plant Operational Safety

The Agency's Operational Safety Review Team (OSART) programme, which provides advice on selected operational aspects and on the safety management of nuclear power plants, has conducted 138 missions since 1982 and continues to be in great demand In 2006, four OSART, and nine follow-up missions were conducted, in addition to preparatory visits to Belgium, Finland, France, Germany, the Republic of Korea and Ukraine (Fig. 1).

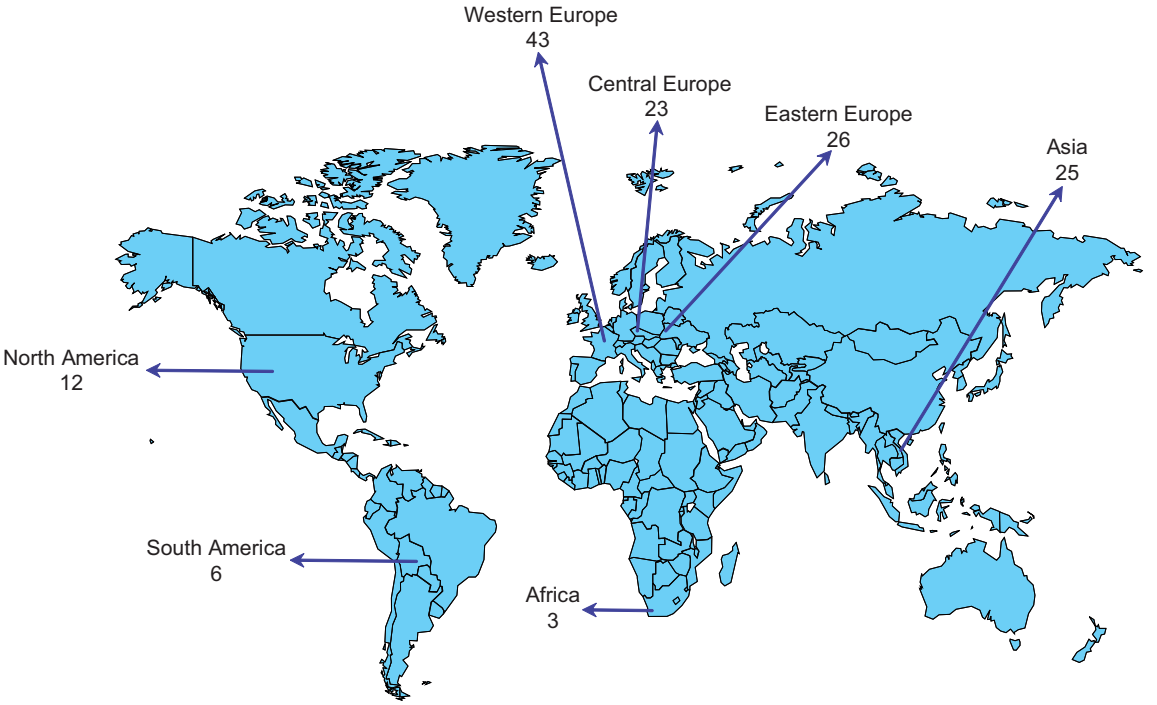


FIG. 1. OSART missions carried out worldwide since 1982.

The IAEA safety standards series of publications serve as the main evaluation criteria and provide a sound basis for each recommendation and suggestion developed by an OSART team. During the four missions in 2006, 47 good practices were identified, the most important of which were the analysis of ion exchange resins at the Mochovce plant in Slovakia, the 'Fire Committee' at the St. Laurent plant in France and an on-line monitoring system for the management and control of maintenance tasks at the Ignalina plant in Lithuania.

In line with the principle that the OSART service is flexible and can be tailored to the needs of a requesting Member State, the Agency developed new optional review areas for consideration as part of an OSART mission. These cover: accident management, long term operation and application of probabilistic safety assessment for decision making.[1]

During follow-up missions, teams evaluate the status of issues raised during the main mission. As Table 1 shows, in recent years the vast majority of issues raised have either been resolved or satisfactory progress has been made in finding solutions.

[1] The latest information on OSART, including the best practices identified, is available on the Agency's web site *(http://www-ns.iaea.org/reviews/op-safety-reviews.htm).*

Ensuring the Safety and Security of Research Reactors

The Agency organized two regional meetings in 2006 — one in Romania for eastern Europe and one in Morocco for Africa — to bring together senior experts in those Member States either having or planning research reactors. The intention was for the Agency to explain the background, content and legal status of the Code of Conduct on the Safety of Research Reactors and to provide the Agency's views

TABLE 1. RESULTS OF OSART FOLLOW-UP MISSIONS, 1989–2006

Year (visits)	Resolved (%)	Satis-factory progress (%)	Insuffi-cient progress (%)	With-drawn (%)
1989–1990 (6)	40	43	14	3
1991–1992 (10)	43	38	17	1
1993–1994 (11)	46	41	13	<1
1995–1996 (5)	59	39	2	0
1997–1998 (6)	45	47	7	1
1999–2000 (7)	38	52	10	0
2001–2002 (6)	61	35	3	0
2003–2004 (7)	58	40	2	0
2005–2006 (14)	56	41	2	<1

on the benefits to be derived from applying it. The meetings also examined the status of research reactor safety in the participating Member States.

Furthermore, the Agency provided assistance to the Democratic Republic of the Congo in developing an action plan aimed at ensuring the safety and security of the CREN-K research reactor, including the safety and security of the fresh and spent fuel present at the reactor. The plan was developed for immediate implementation and will make use of an ongoing technical cooperation project.

Expert Mission to Bulgaria

Following the discovery in March 2006 that 22 out of 61 control rods in Unit 5 of the Kozloduy nuclear power plant would not move when required, the plant conducted an investigation to determine the causes and to propose measures to prevent a recurrence. At the request of the Bulgarian authorities, the Agency conducted an expert mission to assist in assessing the root cause of the event and to evaluate the adequacy of the proposed measures. Having observed testing at the plant, the mission concluded that the event investigation was thorough and that the proposed corrective actions were appropriate. The team also made a number of recommendations to both the regulatory authority and the plant.

Engineering Safety Review Services

The Agency's Long Term Operation Safety Review Service was offered for the first time in 2006, and missions were conducted to Hungary and Ukraine. This service assists Member States in implementing Agency guidance for the safe operation of a nuclear power plant beyond the established timeframe originally set forth by the licence, design limits, standards and/or regulations. The guidance requires a specific safety analysis that considers the life limiting processes and features for systems, structures and components and a justification for continued operation.

Advanced Safety Assessment

A Centre for Advanced Safety Assessment Tools was established by the Agency to improve international cooperation and to help eliminate differences in safety assessment capabilities. Through the centre, Member States can gain access to advanced safety assessment tools, including high quality probabilistic and deterministic analysis codes, models, databases, validation and verification information, analytical procedures, standards and guides. ■

Radiation and Transport Safety

Objective

To achieve global harmonization of radiation and transport safety standards and for the safety and security of radioactive 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 international organizations,[1] completed its review of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS). The first technical meeting for the revision of the BSS will be held in July 2007 and will involve all Member States, co-sponsors and international professional organizations so as to allow wide participation. The meeting will consider the new Safety Fundamentals and take account of the latest data from UNSCEAR on the health consequences of radiation exposure, the new recommendations of the ICRP, and recent international instruments such as the Code of Conduct on the Safety and Security of Radioactive Sources and its associated import/export guidance. This will ensure that the BSS continues to be regarded as the global point of reference for standards for protection against ionizing radiation.

Assisting Member States in Improving their Safety Infrastructures

In 2006, the Agency introduced a revised approach for its assistance programmes to Member States seeking to improve their national radiation, transport and waste safety infrastructures. The main aspects of this more proactive approach are the thematic safety areas, the key requirements and their assessment criteria. Tools for facilitating the process include radiation and waste safety infrastructure profiles, now available for more than 100 Member States, a quantitative assessment scheme with performance indicators, generic action plans, and eligibility criteria. This use of this new approach in the technical cooperation programme resulted in the approval of 24 new radiation protection regional projects covering various thematic safety areas in different regions.

Recovery of Radioactive Sources

There are many powerful radioactive sources that are no longer in use in Member States after past applications. During the year, the Agency assisted a number of Member States in decommissioning and transporting these sources to safe and secure storage facilities. For instance, in Bulgaria, sources from three large irradiators of Russian origin were discharged and transported for interim storage at the Novi Han national radioactive storage facility (Fig. 1). In Kyrgyzstan, sources from two temporary source stores were characterized, packaged and transported to the national radioactive storage facility. These operations featured extensive international cooperation and in-kind and financial support from Canada, the European Union and the Russian Federation. Similar projects were completed in Armenia and Croatia.

The Agency also assists countries in developing capabilities to screen and search for orphan radioactive sources, i.e. sources that either have never been under regulatory control or have been abandoned, lost, misplaced, stolen or transferred

FIG. 1. An old irradiator with caesium-137 sources in Bulgaria before decommissioning.

[1] The co-sponsoring organizations are: FAO, ILO, OECD/NEA, PAHO and WHO.

without proper authorization. Through its technical cooperation programme, and also with the support of donors such as the USA and the European Union, 'Orphan Source Search and Secure' projects were initiated in 17 Member States in Europe and Central Asia. For instance, in Bosnia and Herzegovina, the updating and verification of the national source inventory resulted in the verification of more than 1000 sources, of which about 400 were orphans. In Georgia, a search team, which included an Agency technical officer, found a powerful source in a derelict factory and a smaller source in a house. Both of these dangerous sources were recovered and transported to a safe and secure storage facility.

Radiological Protection of Patients

Ionizing radiation is used extensively in medicine. Worldwide, about 2000 million diagnostic X ray examinations and 32 million nuclear medicine procedures are carried out annually. Of about ten million new cancer patients each year, 40–50% receive radiotherapy.

"For the first time a unified action plan on patient dose management and avoidance of accidental exposure in medical procedures was established in more than 78 Member States."

Even so, there is considerable scope to reduce the dose in diagnostic radiology without loss of diagnostic information. In addition, radiation injuries in interventional radiology and accidental exposures in radiotherapy have been reported. The challenge is to ensure that radiological safety regulations and guidance do not impair medical care, while maintaining the focus on performance and flexibility in achieving the desired outcomes. Health professionals involved in diagnosis and treatment are the critical link. To provide the very large number of such professionals with up to date information on the radiological protection of patients, the Agency launched a new web site in September 2006 (*http://rpop.iaea.org*) (Fig. 2). Between the launch and the end of the year, the web site received more than 300 000 visits.

Many doctors, such as urologists, gastroenterologists, orthopaedic surgeons, gynaecologists and surgeons, are increasingly using radiation in fluoroscopic procedures, but do not have training in the specific protection techniques associated with this mode of treatment. Following implementation of training for cardiologists, the Agency in 2006 launched a new training programme for these types of doctors, with the first regional training course being held in Auckland, New Zealand.

For the first time a unified action plan on patient dose management and avoidance of accidental exposure in medical procedures was established in more than 78 Member States. These States were given the option to choose at least two out of seven tasks that pertained to optimization in radiological protection in radiography, interventional procedures, mammography, computed tomography, nuclear medicine and radiotherapy. Preliminary results indicate significant progress in assessing the causes of poor quality and increased patient doses, in designing a quality control programme to suit the local situation and in documenting optimization to achieve patient dose reduction. Some Member States have established, or are establishing, radiation safety offices in their health ministries.

Safe Transport of Radioactive Material

As part of the Action Plan for the Safety of Transport of Radioactive Material, the Agency held a seminar in Vienna in January 2006. Experts discussed various aspects of the transport of radioactive material, including regulatory programmes, transport standards, implementation of these standards at the national and international levels, and cooperation between national competent authorities on international transport matters. There were also reviews of Member State experiences with maritime shipments, risk analyses, emergency response arrangements, and denial of shipments, as well as of the Agency's Transport Safety Appraisal Service (TranSAS) programme.

Denial of Shipments of Radioactive Material

The transport of radioactive material for use in public health and industry is governed by national and international regulations which are based on

the Agency's Regulations for the Safe Transport of Radioactive Material.[2] If applied, these regulations, developed by experts around the world, ensure high standards of safety. However, even when complying with them, there are still instances where shipments have been denied or delayed. In some cases the denial results in hardships to recipients, such as patients who cannot avail themselves of radiotherapy. In other cases, essential commodities from the nuclear fuel cycle and other industries cannot reach their destinations in a timely manner.

To increase transparency, seek effective solutions and permit the participation of interested parties, the Agency in 2006 formed an International Steering Committee on Denials of Shipments of Radioactive Material. The committee's mandate is to coordinate international efforts at determining solutions to issues related to the denial of shipments and to facilitate the coordination of a comprehensive international work plan of activities. The actual work will be done by the organizations represented on the committee. Other tasks for the committee will be to oversee training courses and the publication of information brochures and other mechanisms of public awareness, as well as working with regulatory authorities and industry to minimize the number of denials caused by excessive or duplicative regulations and other requirements. The Agency plans to convene regional workshops to raise public and governmental awareness about problems related to the denial of shipments.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, *Regulations for the Safe Transport of Radioactive Material, 2005 Edition*, IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2005).

Quality Management Systems in Support of Member States

Following implementation of a quality management system in the Agency's Radiation Protection Monitoring Service, it was decided to pursue accreditation of the service to the international standard ISO-17025 for testing laboratories. The Austrian Accreditation Authority issued such accreditation in 2006 — the first for an Agency service — which is recognized worldwide through the mutual recognition agreements with the European Co-operation for Accreditation and the International Laboratory Accreditation Cooperation.

The Agency used the knowledge gained during the accreditation process to create a training course for Member States to help their laboratories implement a quality management system and achieve officially recognized proficiency. An added benefit of this initiative is the harmonization of measurement methods and result reporting schemes worldwide.

Strengthening Radiation Protection

The 50th General Conference encouraged the Agency to support and participate actively in the 12th International Congress of the International Radiation Protection Association (IRPA 12), scheduled to be held in October 2008 in Buenos Aires. Consequently, the Secretariat has become a member of the IRPA 12 Programme Committee, together with representatives from other major international organizations (such as ILO, PAHO, UNSCEAR and WHO) and professional bodies (ICRU and ICRP). In this context, the Secretariat will disseminate information related to radiation, transport and radioactive waste safety. ■

FIG. 2. The Agency's web page on the radiological protection of patients.

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.

Research Reactor Decommissioning Demonstration Project

In 2006, the Agency initiated the Research Reactor Decommissioning Demonstration Project to assist operators and regulators in Member States to plan and implement the safe decommissioning of research reactors. The project will facilitate the exchange of information and experience, education and training, and will serve as a model for decommissioning projects worldwide. The Government of the Philippines has offered the Philippine research reactor PRR-1 (a Triga reactor) in Manila (Fig. 1), which is shut down and for which the immediate dismantling strategy has been selected, to be used as a model for the project. As part of the first phase, the Agency is assisting the regulatory body in developing its capability to review the approach proposed by the operator and to ensure that international safety standards are appropriately applied. Two technical meetings, on legal and regulatory aspects and decommissioning planning, were held in Manila in 2006.

FIG. 1. The Philippine research reactor PRR-1, which will be used as a model for the Research Reactor Decommissioning Demonstration Project.

Database on Radioactive Discharges

The web based version of the Agency's Database on Discharges of Radionuclides to the Atmosphere and Aquatic Environment (DIRATA) — a worldwide centralized repository of data submitted by Member States — was launched in 2006 (*http://dirata.iaea.org*). Each facility data set includes annual discharge and detection limits, regulatory limits (where available) and limited information on the site location. The third technical meeting on DIRATA, held in Vienna in June, initiated the on-line submission of official national records on radioactive discharges.

International Appraisal in Argentina

After reports that underground water in the vicinity of the Ezeiza Atomic Center in Argentina was contaminated with anthropogenic radioactive substances, including enriched and depleted uranium, the Government of Argentina requested that the Agency organize an independent and authoritative expert appraisal with representatives from the competent organizations within the UN system. The Agency invited experts from FAO, PAHO, UNSCEAR and WHO, as well as from the ICRP and IRPA, to participate. The appraisal, released in April 2006, concluded that the uranium in the groundwater is of natural origin and that no radiological risk exists from use of the water.

Second Review Meeting of the Joint Convention

The Second Review Meeting of the Contracting Parties of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive

Waste Management (Joint Convention), in which 41 Contracting Parties — including eight for the first time — participated, was held in Vienna in May 2006. Despite a large diversity of national situations, all Contracting Parties shared the view that progress had been made since the First Review Meeting. There was a demonstrated commitment to improving policies and practices, particularly in the areas of national strategies for spent fuel and radioactive waste management, engagement with stakeholders and the public, and the control of disused sealed sources. Challenges continue to be faced in a number of areas, including the implementation of national policies for the long term management of spent fuel, disposal of high level waste, management of historical waste, recovery of orphan sources, knowledge management and human resources. The need to ensure that Contracting Parties' financial commitments are consistent with the extent of liabilities was also recognized. Many Contracting Parties see the benefit of enhancing international cooperation through the exchange of information, experience and technology. In particular, the need to share knowledge and assistance was emphasized by Contracting Parties with limited radioactive waste management and research programmes.

"Despite a large diversity of national situations, all Contracting Parties shared the view that progress had been made since the First Review Meeting."

Iraq Project

The Government of Iraq requested the Agency's assistance to prepare plans and programmes to decommission contaminated facilities in the country. The project's groundwork was set at an Agency meeting in Vienna in February 2006 that was attended by the Iraqi Minister for Science and Technology and representatives of 16 States and the European Commission.

One of the first steps in this work, which could take many years, was to identify, cordon off and prioritize the contaminated areas that pose the most risk to the public. Some of the challenges facing the clean-up effort include determining now unknown locations where contaminated equipment and material might be buried and recovering lost records about the contents of radioactive material stored in waste containers.

Central Asian Site Remediation Project

Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan are among the countries in Central Asia that are facing the consequences of decades of uranium ore mining and milling. Numerous contaminated sites and large amounts of radiologically contaminated tailings pose a serious threat to both the public and the environment. With funding from international organizations such as the EBRD, NATO and the World Bank, the Agency is providing technical assistance in establishing appropriate institutional capability and expertise in the affected countries to allow them to manage the remediation situation in a systematic manner. The goal is to establish the necessary regulatory framework and decision making processes for mining and milling activities. In 2006, the Agency began to evaluate the remediation and stabilization works already under way to document current conditions and determine if international safety standards are being met.

Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities

An Agency conference on 'Lessons Learned from the Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities', held in Athens in December, enabled participants to identify areas for international harmonization in the decommissioning of different facilities with varying complexity and hazard potential. The main conclusions of the conference dealt with the enhancement of international cooperation and improving national strategic planning for decommissioning. A number of practical considerations, including decommissioning technologies, knowledge management, stakeholder involvement and public confidence, were also discussed. In addition, the Agency submitted a proposal to establish a decommissioning network,

bringing together organizations with specific experience and competence in decommissioning and willing to share their experience with other organizations.

Technical Cooperation Activities in Radioactive Waste Management

The Agency provided assistance to China in retrieving and reconditioning miscellaneous items of radioactive waste, including small quantities of spent fuel from research reactors in old storage facilities, since these items did not meet current safety standards. China has provided funds to the Agency to share the cost of developing a system to assay radioactive waste. The results of this project are expected to assist other countries with similar problems.

Progress was achieved in enhancing national capacity for the management of radioactive waste. This included the establishment in Bangladesh of a central radioactive waste processing and storage facility that is expected to begin its activities after issue by the national regulatory body of the corresponding operating licence. A project in the Philippines focused on preparations for the establishment of a near surface disposal facility for which candidate sites were selected for construction and the draft conceptual design of the facility was developed. Part 23 of the Regulation of the Philippine Nuclear Research Institute, entitled 'Licensing Requirements for Land Disposal of Radioactive Waste', was also completed. ■

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

The Agency assists national efforts to enhance nuclear security through prevention measures — comprising both protection and risk reduction components — and detection and response measures. Its evaluation missions based upon international legal instruments, guidelines and recommendations help States identify security needs. Using mission findings the Agency prepares, in consultation with the relevant State, Integrated Nuclear Security Support Plans (INSSPs) tailored to address each State's specific needs. This provides a tool by which the Agency, the State concerned and potential donors can plan and coordinate their technical activities and financial support. In 2006, 32 INSSPs were in various stages of development and consultation.

Capacity Building

Agency nuclear security capacity building activities continued to focus on education and training, equipment upgrades and technical support. During 2006, the Agency organized 59 international, regional and national training courses and workshops involving over 1500 participants from 80 States. Twenty-eight training courses were devoted to physical protection and the prevention of malicious acts. The topics included security objectives and fundamental principles, physical protection principles and methodologies, and protection of nuclear facilities against theft and sabotage. These training activities also included three design basis threat (DBT) workshops, bringing to 27 the total number of DBT workshops conducted by the Agency.

To assist States in establishing effective radiation detection capabilities at border crossing points and to respond to seizures of nuclear and other radioactive material, the Agency held 26 international, regional and national training courses in 2006. In addition, the Agency supplied detection and border monitoring equipment and also assisted with upgrading the physical protection of eight sites containing nuclear or radioactive material.

First Nuclear Security CRP

The Agency concluded its first nuclear security CRP on the improvement of technical measures to detect and respond to the illicit trafficking of nuclear and other radioactive material. The main achievements of the CRP included: the development of a sensitive, handheld neutron detector for the localization of weak neutron sources; improvements to handheld radionuclide identification devices (RIDs) and research into new scintillator materials to improve their performance; demonstrations of the application of RIDs for characterizing radioactive sources in legal shipments; and the completion of technical specifications for RIDs, personal radiation detectors, fixed radiation portal monitors and handheld neutron search detectors.

Risk Reduction

The Agency provided extensive assistance to States in reducing the vulnerability of a number of high risk radioactive sources (Fig. 1). This includes

FIG. 1. An example of nuclear material encased in a secure structure.

facilitating the recovery and conditioning of approximately 100 high activity and neutron sources in countries in Africa and Latin America. Other risk reduction activities, mentioned in greater detail elsewhere in this report, involved the conversion of research reactors from HEU to LEU fuel under the Reduced Enrichment for Research and Test Reactors (RERTR) programme, the decommissioning of shutdown reactors, and repatriating fresh and spent HEU fuel stocks to the country of origin. These activities make a substantial contribution to nuclear security by reducing the risk that stolen HEU could be used in an improvised nuclear explosive device.

Nuclear Security Guidance for Member States

Guidance publications in the IAEA Nuclear Security Series (INSS) incorporate best practices contributed by experts from around the world and provide a vehicle for disseminating these to the international community. In 2006, the first three reports were published and disseminated on the technical and functional specifications for border monitoring equipment (INSS No. 1), on nuclear forensics support (INSS No. 2) and on guidelines for monitoring of radioactive material in international mail transported by public postal operators (INSS No. 3). An extensive programme is under way to develop further guidance in the IAEA Nuclear Security Series in consultation with experts from Member States. Twenty-seven additional reports were started or were under development in 2006. As guidance publications are completed and issued, a comprehensive structure of internationally accepted recommendations on nuclear security will be constructed.

Financial Support to the NSF

The year saw a significant expansion of the partnership between the Agency and the European Union. Under the auspices of the first and second European Union Joint Actions, the Agency delivered nuclear security assistance to 26 States in Eastern Europe, the Middle East and North Africa. In June 2006, the Council of the European Union adopted a Third Joint Action, which extends the area of support to cover the countries of Africa, with the scope to include the implementation by support States of international legal instruments relevant to nuclear security and verification. By the end of 2006, the European Union had pledged more than $15 million to the Nuclear Security Fund in connection with the three Joint Action Cycles.

Nuclear Security Equipment Laboratory

To ensure that detection and monitoring equipment supplied by, or through, the Agency performs in accordance with to specifications and requirements, the Agency's Nuclear Security Equipment Laboratory (NSEL) carries out tests prior to delivery. Such testing is important as experience has shown that a significant portion of the instruments have deficiencies — approximately 13% failed acceptance testing in 2006. During the year, the NSEL tested 745 nuclear security instruments, the highest number in any year since the laboratory was established.

Security at Major Public Events

In response to a request from the German Government, the Agency provided assistance to the relevant State authorities for the development and implementation of radiological security at the 2006 FIFA World Cup (Fig. 2). Under the project, the Agency provided scientific, procedural and technical support to the German authorities, facilitated the provision of technical equipment and training, and provided information support, drawing on the Illicit Trafficking Database (ITDB).

The Agency further supported Member States by providing advice and assistance in the area

FIG. 2. Equipment used in applying nuclear security measures being examined by experts at the 2006 FIFA World Cup.

of emergency preparedness. Preparations were under way at the end of the year on cooperation arrangements regarding nuclear security measures with the organizers of forthcoming major public events in Latin America and Asia.

International Cooperation

Throughout the year, Member States called for continued and expanded action on nuclear security by the Agency. In February–March 2006, the Agency's International Conference on Effective Nuclear Regulatory Systems, held in Moscow, noted the need for authoritative guidance on nuclear security issues and called for: recognition of the IAEA Nuclear Security Series of publications as a resource for regulators; development of programmes of education and training; and increased cooperation with other international organizations dealing with problems relating to terrorism. The Pan American Meeting on Strengthening Implementation of International Instruments in the Americas for Enhanced Nuclear and Radiological Security, held in Quito in April, called for the Agency to continue to support States requiring assistance in developing and implementing the means for meeting national responsibilities under the legal instruments relevant for nuclear security. The Seminar on Strengthening Nuclear Security in Asian Countries, held in Japan in November 2006, called on the Agency to continue its efforts to ensure that acceptable levels of security are applied to all nuclear and other radioactive material under national jurisdictions, and according to effective national systems and functions.

"Throughout the year, Member States called for continued and expanded action on nuclear security by the Agency."

At the G8 summit in St. Petersburg, Presidents Putin and Bush announced a Global Initiative to Combat Nuclear Terrorism, which will focus on building partnerships. The Initiative underlines the importance of the Agency's Nuclear Security Plan, as well as the need for continued support of the Agency's activities.

The Agency continued to cooperate with other international and regional organizations whose mandates are relevant to nuclear security. A Cooperation Agreement was concluded with Interpol in 2006 that provides the framework for the establishment of a joint database on illicit trafficking and on other unauthorized activities as well as for sharing analyses and evaluations.

Illicit Trafficking Database Programme

Through the ITDB, the Agency continued to collect and analyse information on incidents of illicit trafficking and other unauthorized activities involving nuclear and other radioactive material (Fig. 3), and to facilitate its exchange among the Member States. Participation in the ITDB reached 95 States, growing by eight States during the year. A meeting of ITDB national Points of Contact was convened in May 2006 to review the scope, operation and development of the ITDB.

Of 149 reported incidents occurring in 2006, 15 were seizures of illegally possessed nuclear and radioactive material that some of the individuals involved were attempting to sell or smuggle across national borders. One incident involved the seizure in Georgia of 79.5 g of uranium enriched to 89%. Given the potential consequences of the use of an improvised nuclear device or a radiation dispersal device, all incidents of illicit trafficking in

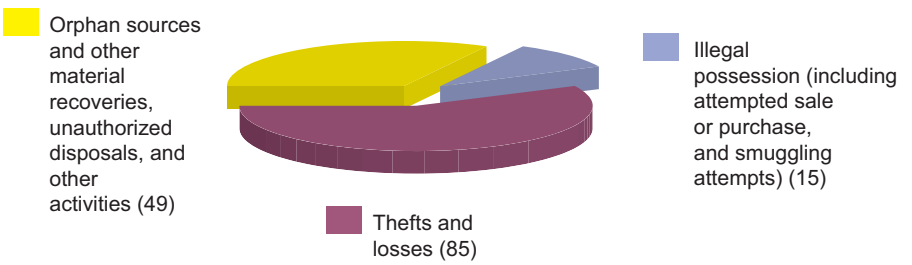


FIG. 3. Distribution of confirmed incidents in 2006 by type of activity.

HEU or plutonium are of major security concern. Of the remaining incidents, over 50% involved thefts and losses of material. In about 75% of the cases, the material has not been recovered, adding to the increasing pool of lost material, some of which is potentially available for malicious use. Recoveries of nuclear and radioactive material not under proper control, such as orphan sources, and unauthorized disposals of material made up the remaining incidents. This included 47.5 g of 80% HEU encrusted on metal found at a scrap processing facility in Germany. ■

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 2006

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 2006, safeguards were applied for 162 States with safeguards agreements in force with the Agency."

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 and evaluation activities under CSAs *and* the results of its verification and evaluation 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 draw safeguards conclusions regarding the absence of undeclared nuclear material and activities for the State as a whole. For such States, the Agency draws conclusions, for a given year, with respect to whether *declared* nuclear material remained in peaceful activities.

In 2006, safeguards were applied for 162 States with safeguards agreements in force with the Agency. Seventy-five States had both CSAs and APs in force. For 32 of these States, the Agency concluded that all nuclear material remained in peaceful activities. For 43 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 78 States with CSAs in force but without APs, the Agency was only able to draw that conclusion.

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 was not withdrawn, except as provided for in the agreements, and remained in peaceful activities.

As of 31 December 2006, 31 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 Austria, Chile, the Czech Republic, Greece, Ireland, Luxembourg, Mali and Portugal, and was reaffirmed for 24 States.

Safeguards Implementation Issues

Democratic People's Republic of Korea (DPRK)

Since December 2002, the Agency has remained unable to perform any verification activities in

the DPRK, and could not, therefore, draw any safeguards conclusion.

Islamic Republic of Iran (Iran)

During 2006, the Director General submitted five reports to the Board of Governors on the implementation of the NPT safeguards agreement in Iran. The Board adopted one resolution on the subject.

> *"... the number of States party to the NPT that had yet to conclude CSAs decreased from 36 to 31."*

Iran continued to implement its CSA and, until 6 February 2006, implemented the AP on a voluntary basis. In a letter dated 6 February 2006, Iran informed the Agency that its voluntary commitment to implement the AP had been suspended as of that date and that the implementation of safeguards measures would be based only on its CSA.

On 4 February 2006, the Board of Governors adopted a resolution in which it, inter alia, underlined that outstanding questions can best be resolved and confidence built in the exclusively peaceful nature of Iran's nuclear programme by Iran responding positively to the calls for confidence building measures deemed necessary by the Board. The Board also requested the Director General to report on the implementation of that resolution and the previous ones to the UNSC.

During 2006, the clarification of certain aspects of the scope and nature of Iran's nuclear programme remained unresolved. The issue of the source(s) of low enriched uranium (LEU) and high enriched uranium (HEU) particles found at locations where Iran declared that centrifuge components had been manufactured, used and/or stored remains unresolved. Iran did not make any new information available to the Agency concerning its P-1 or P-2 centrifuge programmes. Iran has not provided a copy of a 15 page document describing the procedures for the reduction of UF_6 to uranium metal and the casting and machining of enriched and depleted uranium metal into hemispheres. The issue of plutonium experiments has not yet been resolved satisfactorily.

While the Agency was able to verify the non-diversion of declared nuclear material in the State in 2006, Iran's decision to suspend its voluntary commitment to implement the provisions of the AP and its insufficient cooperation and transparency limited the Agency's ability to clarify outstanding issues with a view to drawing a conclusion regarding the absence of undeclared nuclear material and activities in Iran.[1]

On 31 July 2006, the UNSC adopted resolution 1696 (2006), inter alia, demanding that Iran suspend all enrichment related and reprocessing activities, including R&D, to be verified by the Agency; and requesting that the Director General report to the Council by 31 August 2006 on whether Iran had established full and sustained suspension of all activities mentioned in the resolution and on the process of Iranian compliance with all the steps required by the Board. The Director General submitted a report to the Board of Governors on that date, and in parallel to the UNSC. On 23 December 2006, the UNSC adopted resolution 1737 (2006) in which it decided, inter alia, that Iran "shall provide such access and cooperation as the Agency requests" to verify the suspension of nuclear activities as outlined in the resolution and to resolve all outstanding issues identified in Agency reports and requested a report from the Director General of the IAEA within 60 days.

Conclusion of Safeguards Agreements and Additional Protocols

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 36 to 31. APs entered into force for seven States during 2006, so that by the end of 2006, 78 States had APs in force (Fig. 1). Four States signed APs in 2006, and five States had APs approved by the Board of Governors.

Small Quantities Protocols (SQPs)

Following a decision by the Board of Governors in 2005, the Agency initiated exchanges of letters with all States having SQPs in order to give effect to the modifications in the standard text and the

[1] In a letter dated 27 April 2006, Iran "…declare[d] its preparedness to resolve the remaining issues providing timetable, within next three weeks, provided that the nuclear dossier is returned back in full in the framework of the Agency".

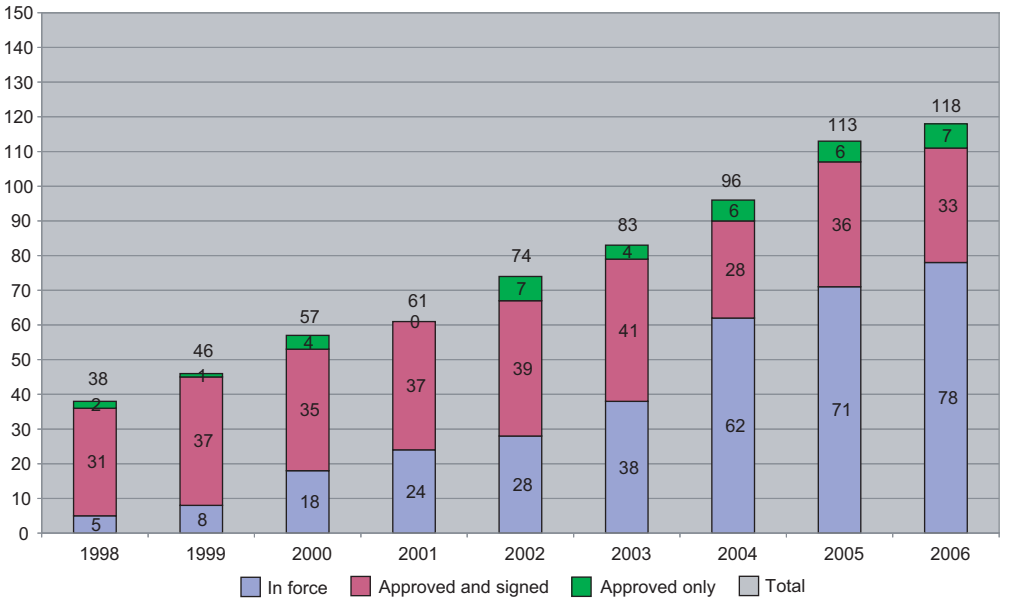


FIG. 1. Number of APs in force and approved by the Board of Governors at the end of 2006.

change in the SQP criteria. During 2006, the SQPs were amended to reflect the modified text for nine States. An SQP was rescinded and one became non-operational. By the end of 2006, there were 73 States with operative SQPs requiring modification in accordance with the Board's decision.

Implementation of Integrated Safeguards

Integrated safeguards (IS) were implemented throughout 2006 in Australia, Bulgaria, Hungary, Indonesia, Japan, Norway, Peru, Slovenia and Uzbekistan, and implementation was initiated in Latvia and Poland. Preparations were being made for implementing the approved IS approach for Canada. In addition, IS approaches were developed and approved for Bangladesh and Ghana.

Technical meetings took place between the Agency and the EC to discuss implementation of safeguards in the EU non-nuclear-weapon States, with particular regard to IS. The Secretariat, the EC and the EU Member States will continue consultations on safeguards implementation.

Significant Safeguards Projects

Japan Nuclear Fuel Limited Project

At the Rokkasho reprocessing plant (RRP), active commissioning involving the reprocessing of irradiated fuel started in March 2006. The inspection regime, which requires the continuous presence of inspectors during normal operation, was implemented at that time.

Initial design information examination and verification were completed with the final verification of the cells immediately prior to their sealing. The active commissioning period enabled the Agency to confirm the performance of safeguards systems in key areas.

The Integrated Inspection Information System (I3S), which collects safeguards data, and the partly automated system used to evaluate such data have been installed at RRP and are routinely used by inspectors. New releases of I3S have expanded its functionalities.

The On-Site Laboratory (OSL), jointly operated by the Agency and the Japanese authorities, has demonstrated its usefulness in treating and analysing a significant number of nuclear material samples in a timely manner. At the same time it has helped to reduce costs in comparison with the shipment of samples to the Agency's Safeguards Analytical Laboratory (SAL), which would have been required without the OSL.

Strengthening of Safeguards in States

Republic of Korea

A less labour intensive safeguards approach for verifying transfers of spent fuel to dry storage installations will substantially reduce the number

of inspector-days required during transfers. Implementation of unattended radiation and surveillance systems to monitor transfers of spent fuel from an on-load refuelled reactor to interim dry storage has started at some reactors in the Republic of Korea, resulting in considerable savings of inspection efforts in 2006.

China

Two flow and enrichment monitors were installed at the Shaanxi enrichment plant. They will provide continuous unattended monitoring of enrichment levels and the quantity of the product.

Chernobyl

The installation of the equipment required by the safeguards approach for the Chernobyl shelter continued. Installation of the gate monitor system at the shelter's personnel access points was successfully completed. The system (comprising neutron/gamma detectors and digital video surveillance) ensures that no undeclared movements of nuclear material take place.

Detecting Undeclared Nuclear Material and Activities

Improved Technological Capabilities and Methodologies

As part of the Agency's project for the identification and development of effective and appropriate advanced techniques, three new tasks were initiated to provide enhanced on-site inspection and verification methods and instruments. Further task proposals, covering semiconductor sensors and equipment for sampling airborne gases, are currently under consideration by two States. In addition, the project received support from 12 Member States and the EC through the acceptance by their respective support programmes of an umbrella task arrangement to facilitate the pursuit of novel technological solutions to meet safeguards needs. Further contact with R&D organizations and experts was supported by Member State support programmes. Recognizing the growing use of laser methods for the rapid on-site analysis of materials, elements and isotopes, a technical meeting was convened on laser spectrometry through the novel technologies project. The experts agreed that laser spectrometry was an effective and cost effective alternative to some existing inspection methods, as well as a novel solution for emerging safeguards verification and detection needs.

"... the Agency implemented an innovative mechanism to diversify the sources of safeguards relevant data."

Environmental Sampling

Environmental sampling continues to be used extensively to confirm the absence of undeclared nuclear material and activities in facilities and locations subject to inspections and complementary access. In 2006, SAL completed the installation of a new room for the chemical treatment of radioactive environmental samples prior to mass spectrometry measurements. The 14 laboratories of the Network of Analytical Laboratories performing environmental sample analysis, including SAL, were used at full capacity in 2006.

Information Analysis and Remote Monitoring

The Agency's project to re-engineer the safeguards information system continued in 2006. By the end of 2006, phase I of the project, on physical architecture and standards, was completed, and phase II, dealing with the installation of the architecture and development of common building blocks, was halfway to completion.

A new approach for the secure transmittal of sensitive correspondence between the Republic of Korea and the Agency was implemented in October 2006.

In 2006, the Agency's Nuclear Trade Analysis Unit analysed available information on covert nuclear procurements. In response to General Conference resolutions, the Agency implemented an innovative mechanism to diversify the sources of safeguards relevant data. Pursuant to this mechanism, a number of Member States have agreed to facilitate the provision of safeguards relevant information to the Agency by their nuclear related industries.

By the end of 2006, there were 130 surveillance and radiation monitoring systems operating in remote monitoring mode in 14 States.[2] The application of this technology has resulted in

[2] And in Taiwan, China.

enhanced effectiveness and efficiency of safeguards implementation.

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

State systems of accounting for and control of nuclear material (SSACs) are fundamental to effective and efficient safeguards implementation. To help States establish and strengthen their SSACs, IAEA SSAC Advisory Service (ISSAS) missions were conducted in Serbia and Singapore during 2006. An invitation from Switzerland to conduct an ISSAS mission in 2007 was accepted by the Agency.

Ten national, regional and international training courses were conducted for State personnel where assistance was provided to enable States to fulfil their obligations under safeguards agreements and APs.

Tenth Safeguards Symposium

A symposium on international safeguards, the tenth since 1965, was held in Vienna in October. More than 500 experts from over 60 countries addressed safeguards issues in sessions organized under five topics: current challenges to the safeguards system; further strengthening of safeguards practices and approaches; improving the collection and analysis of safeguards information; advances in safeguards techniques and technology; and future challenges. Participants emphasized the importance of strengthening the overall framework of safeguards, including inter alia: encouraging States to bring APs into force; developing tools to help identify clandestine transfers of sensitive nuclear technology; and fostering greater understanding of safeguards through better education. ■

Verification in Iraq Pursuant to UNSC Resolutions

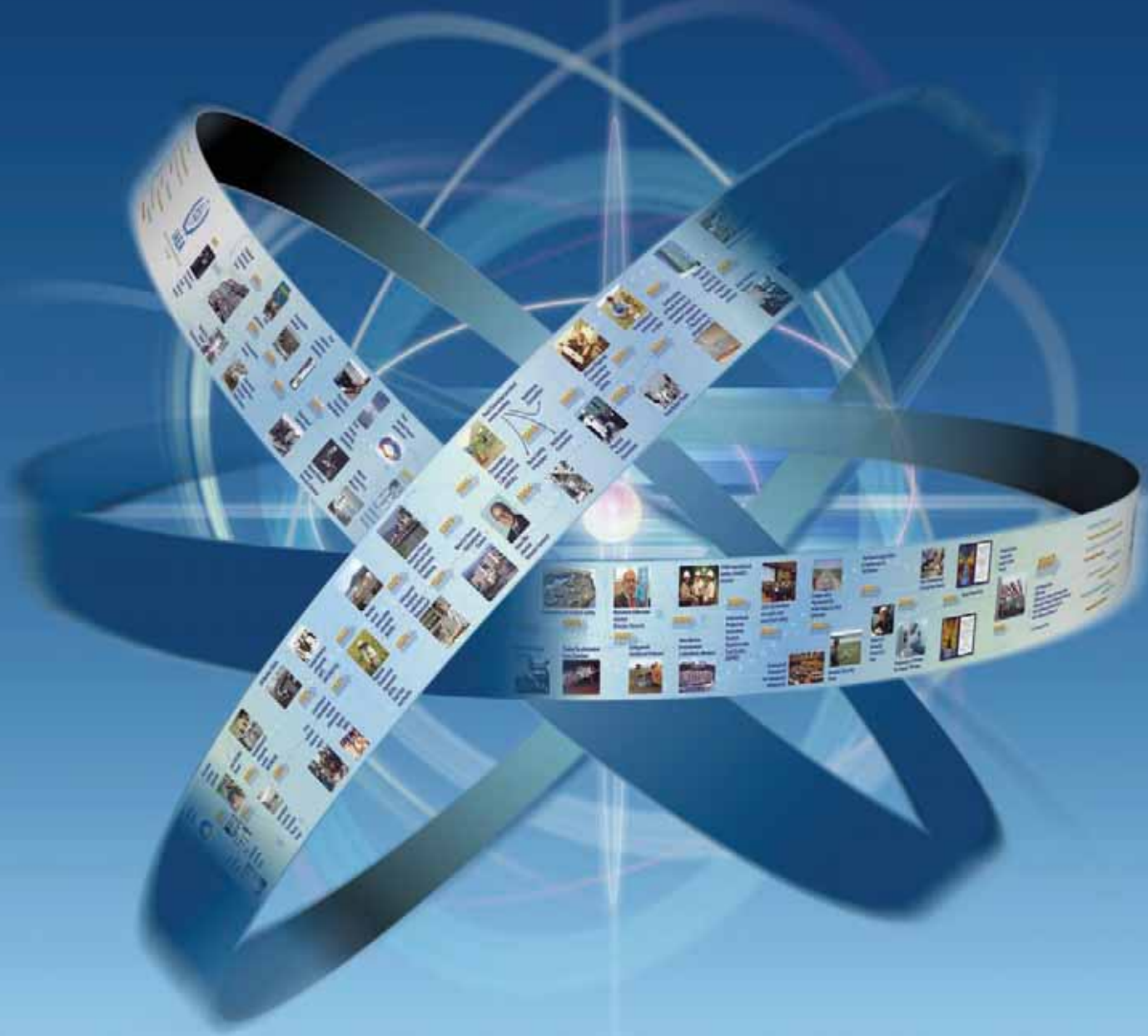
Objective

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

Since 17 March 2003, the Agency has not been in a position to implement its mandate in Iraq under the relevant UNSC resolutions. In resolution 1546 (2004), the UNSC reaffirmed its intention to revisit the Agency's mandate in Iraq. During 2006, the Agency continued to: consolidate its information assets; collect and analyse a range of new information, including satellite imagery; and update its knowledge of the formerly relevant facilities in Iraq. ■

Management of Technical Cooperation



Management of Technical Cooperation for Development

Objective

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

Further Strengthening of the Technical Cooperation Programme

One of the major tasks of the Agency in 2006 was the design of the technical cooperation programme for the 2007–2008 cycle, which was approved by the Board of Governors in November. This task was realized in parallel with the ongoing implementation of the programme and the development of new programme management tools. Another important milestone in 2006 was the agreement by Member States on a target of $80 million per year in the coming biennium for the Technical Cooperation Fund (TCF).

"For the first time, the technical cooperation programme was designed using the PCMF, a new approach to managing the programme supported by a web based platform."

Programme Cycle Management Framework (PCMF)

For the first time, the technical cooperation programme was designed using the PCMF, a new approach to managing the programme supported by a web based platform. The screening and design of projects was accomplished in a transparent and interactive manner, with Member States made aware of the details of their national programmes that would be discussed with the Secretariat at the time of the General Conference.

Country Programme Frameworks

The Secretariat assisted Member States in the preparation of their Country Programme Frameworks (CPFs) following the release of the new CPF guidelines. Altogether, 100 CPFs have been prepared: 78 have been signed by Member States and the Agency, while 22 are still in the draft stage.

NLO Working Group

The National Liaison Officer (NLO) is the principal interlocutor between the Secretariat and governments regarding the technical cooperation programme. Following a recommendation of the Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC), guidelines have been drafted for Member States on the roles and responsibilities of NLOs. These guidelines are intended to improve the quality of communication between stakeholders and the Secretariat, and contribute to the smooth delivery of the technical cooperation programme.

Framework for Regional Programming

In recognition of the importance of regional programmes, and following recommendations from SAGTAC, working groups were established to review regional programming from the strategic, operational and management perspectives. The groups recommended the development of strategies, reflecting the needs, interests and priorities of Member States in each region, to provide direction in line with the Technical Cooperation Strategy.

Gender Policy

Agency efforts to develop a policy that promotes gender considerations in all of its programme work has been accompanied by an initiative, in cooperation with the Vienna based Permanent Missions, to identify actions designed to attract more well qualified women as candidates for recruitment in the Professional and higher categories. In addition, within the technical cooperation programme, a provisional gender policy and action plan were established aimed at highlighting gender considerations in the development and implementation of the programme.

Financial highlights

The technical cooperation programme is growing rapidly, with new obligations in 2006 totalling

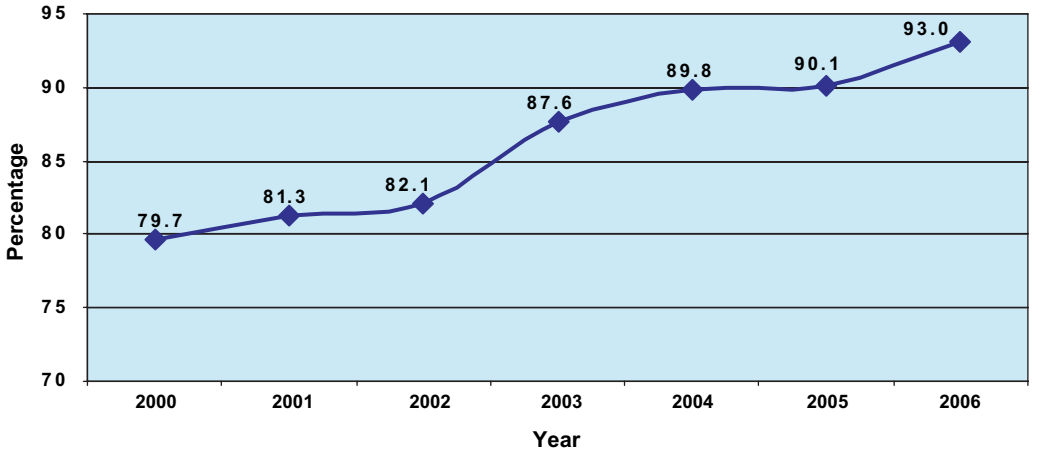


FIG. 1. Rate of attainment of the TCF between 2000 and 2006.

$105 million, compared with $80 million in 2005. This growth reflects increasing Member State support, through both the TCF and extrabudgetary contributions. In 2006, extrabudgetary contributions climbed to nearly $22.5 million, compared with $15 million for 2005. Of this amount, government cost sharing also showed significant growth, from over $5 million in 2005 to more than $9.4 million in 2006. Finally, the rate of attainment (i.e. Member State payments towards the TCF target), which exceeded 90% for the 2005 target, reached 93% for 2006 (Fig. 1).

Legislative Assistance to Member States

During 2006, the Agency provided assistance to 12 Member States through written comments and advice in drafting national nuclear legislation. In addition, at the request of Member States, individual training on issues related to nuclear legislation, was also provided to 17 fellows. As a new initiative to provide further legislative assistance to Member States in Africa, a fellowship programme was established in 2006 for individuals from these States to receive training at the Agency in order to acquire experience in international nuclear law.

A number of training courses and workshops were held during the year on nuclear law and legislation. For example, a training course for lawyers, held in April 2006, provided information on the Agency's nuclear security activities, as well as the relevant international nuclear security instruments, with the aim of establishing a pool of nuclear legal experts available for the Agency's nuclear security advisory, evaluation and response missions and reviews. At a workshop held in October, diplomats were given an introduction to nuclear law that included presentations on international law for nuclear safety and security, and safeguards and non-proliferation, as well as an overview of the Agency's legislative assistance programme in these areas. A meeting for senior government officials from the Asia–Pacific region was held in November in Kuala Lumpur. Among other things, the meeting provided information on the international instruments dealing with nuclear safety, security and safeguards, including recent developments in these areas. And a seminar for the African region, held in December in Vienna facilitated an in-depth self-assessment of the national nuclear legislation of the participating Member States.

A new IAEA International Law Series was established in 2006. The first two publications in this series bring together in a more convenient format the official records and other relevant documents relating to the negotiations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and the Amendment to the Convention on the Physical Protection of Nuclear Material. ■

Annex

Note: Tables A20–A23 are available on the attached CD-ROM

Table A1. Allocation and utilization of regular budget resources in 2006 (unless otherwise indicated, the amounts in this table are given in euros)

Major Programme/Programme	2006 original budget (at $1.0000) (1)	2006 adjusted budget (at $1.2495) (2)	Total expenditure Amount (3)	Total expenditure % of adjusted budget (3)/(2) (4)	Unused (overexpended) budget (2) – (3) – (5) (6)
1. Nuclear Power, Fuel Cycle and Nuclear Science					
1. Overall Management, Coordination and Common Activities	686 000	657 200	634 711	96.58%	22 489
A. Nuclear Power	5 087 800	4 807 600	4 568 049	95.02%	239 551
B. Nuclear Fuel Cycle and Materials Technologies	2 412 100	2 284 700	2 259 891	98.91%	24 809
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	9 924 700	9 507 200	9 407 223	98.95%	99 977
D. Nuclear Science	8 568 400	7 772 300	7 609 725	97.91%	162 575
Subtotal – Major Programme 1	**26 679 000**	**25 029 000**	**24 479 599**	**97.80%**	**549 401**
2. Nuclear Techniques for Development and Environmental Protection					
2. Overall Management, Coordination and Common Activities	746 600	717 200	1 165 134	162.46%	(447 934)
E. Food and Agriculture	11 850 100	11 016 300	11 046 440	100.27%	(30 140)
F. Human Health	7 614 700	7 034 200	6 733 968	95.73%	300 232
G. Water Resources	3 278 200	3 108 200	3 046 193	98.01%	62 007
H. Assessment and Management of Marine and Terrestrial Environments	5 060 700	4 873 200	4 787 047	98.23%	86 153
I. Radioisotope Production and Radiation Technology	1 885 700	1 733 900	1 702 015	98.16%	31 885
Subtotal – Major Programme 2	**30 436 000**	**28 483 000**	**28 480 797**	**99.99%**	**2 203**
3. Nuclear Safety and Security					
3. Overall Management, Coordination and Common Activities	946 000	900 500	888 285	98.64%	12 215
X. Incident and Emergency Preparedness and Response	913 700	874 700	864 992	98.89%	9 708
J. Safety of Nuclear Installations	8 066 000	7 724 400	7 700 103	99.69%	24 297
K. Radiation and Transport Safety	5 007 900	4 784 800	4 782 272	99.95%	2 528
L. Management of Radioactive Waste	5 993 400	5 685 600	5 690 147	100.08%	(4 547)
M. Nuclear Security	1 344 400	1 289 000	1 288 963	100.00	37
Subtotal – Major Programme 3	**22 272 000**	**21 259 000**	**21 214 762**	**99.79%**	**44 238**
4. Nuclear Verification					
4. Overall Management, Coordination and Common Activities	983 500	949 400	1 024 673	107.93%	(75 273)
N. Safeguards	105 352 500	100 727 600	92 037 481	91.37%	8 690 119
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)					
Subtotal – Major Programme 4	**106 336 000**	**101 677 000**	**93 062 154**	**91.53%**	**8 614 846**
5. Information Support Services					
P. Public Information and Communication	3 264 700	3 139 600	3 031 772	96.57%	107 828
Q. Information and Communications Technology (ICT)	7 494 600	7 282 300	6 889 952	94.61%	392 348
S. Conference, Translation and Publishing Services	5 232 700	5 074 100	5 111 635	100.74%	(37 535)
Subtotal – Major Programme 5	**15 992 000**	**15 496 000**	**15 033 359**	**97.01%**	**462 641**
6. Management of Technical Cooperation for Development					
6. Overall Management, Coordination and Common Activities	538 300	519 900	666 258	128.15%	(146 358)
T. Management of Technical Cooperation for Development	14 857 700	14 366 100	13 866 689	96.52%	499 411
Subtotal – Major Programme 6	**15 396 000**	**14 886 000**	**14 532 947**	**97.63%**	**353 053**
7. Policy and General Management					
U. Executive Management, Policy-Making and Coordination	13 411 600	12 749 700	11 923 448	93.52%	826 252
V. Administration and General Services (excluding V.6 – Security Enhancement)	36 059 500	35 358 200	36 213 166	102.42%	(854 966)
W. Oversight Services and Performance Assessment	1 787 900	1 712 100	1 303 409	76.13%	408 691
Subtotal – Major Programme 7	**51 259 000**	**49 820 000**	**49 440 023**	**99.24%**	**379 977**
8. Special Appropriation for Security Enhancement					
V6. Special Appropriation for Security Enhancement	2 430 000	2 430 000	2 276 348	93.68%	153 652
Subtotal – Major Programme 8	**2 430 000**	**2 430 000**	**2 276 348**	**93.68%**	**153 652**
TOTAL – Agency Programmes	**270 800 000**	**259 080 000**	**248 519 989**	**95.92%**	**10 560 011**
9. Reimbursable Work for Others	2 819 000	2 703 000	2 651 699	98.10%	51 301
TOTAL	**273 619 000**	**261 783 000**	**251 171 688**	**95.95%**	**10 611 312**

Table A2. Extrabudgetary funds in support of the regular budget 2006 (including the Nuclear Security Fund) (unless otherwise indicated, the amounts in this table are given in euros)

Major Programme / Programme	Extrabudgetary budget figures GC(47) /3	Resources			Total resources as at 31 Dec. 2006 (2) + (3) + (4)	Total expenditures as at 31 Dec. 2006	Unused balance as at 31 Dec. 2006 (5) – (6)
		Unused balance as at 1 Jan. 2006	Receipts[a] as at 31 Dec. 2006	Adjustments as at 31 Dec. 2006			
	(1)	(2)	(3)	(4)	(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	1 923 000	1 007 909	1 685 968	8 830	2 702 707	1 181 338	1 521 369
B. Nuclear Fuel Cycle and Materials Technologies	586 000	480 280	363 242	0	843 522	499 550	343 972
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	0	164 556	101 068	701	266 325	100 740	165 585
D. Nuclear Science	11 000	268 125	255 229	0	523 354	305 744	217 610
Subtotal – Major Programme 1	**2 520 000**	**1 920 870**	**2 405 507**	**9 531**	**4 335 908**	**2 087 372**	**2 248 536**
2. Nuclear Techniques for Development and Environmental Protection							
2. Overall Management, Coordination and Common Activities	0	187 156	2 237 279	25 567	2 450 002	588 456	1 861 546
E. Food and Agriculture (excl. FAO)	0	20 237	5 852	0	26 089	13 178	12 911
FAO	2 819 000	0	1 560 560	0	1 560 560	1 422 637	137 923
Total Programme E	2 819 000	20 237	1 566 412	0	1 586 649	1 435 815	150 834
F. Human Health	65 000	58 648	48 996	(1 520)	106 124	50 797	55 327
G. Water Resources	0	0	202 520	0	202 520	4 876	197 644
H. Assessment and Management of Marine and Terrestrial Environments	650 000	490 727	613 744	(61 553)	1 042 918	695 766	347 152
I. Radioisotope Production and Radiation Technology	0	4 647	4 225	0	8 872	4 226	4 646
Subtotal – Major Programme 2	**3 534 000**	**761 415**	**4 673 176**	**(37 506)**	**5 397 085**	**2 779 936**	**2 617 149**
3. Nuclear Safety and Security							
3. Overall Management, Coordination and Common Activities	192 000	1 217 996	1 752 009	220 232	3 190 237	1 369 902	1 820 335
X. Incident and Emergency Preparedness and Response	570 000	885 834	831 083	313	1 717 230	992 721	724 509
J. Safety of Nuclear Installations	3 768 000	2 075 069	1 253 122	(212 119)	3 116 072	1 474 768	1 641 304
K. Radiation and Transport Safety	3 248 000	3 269 170	2 028 635	87 898	5 385 703	2 674 928	2 710 775
L. Management of Radioactive Waste	802 000	1 028 189	718 020	10 314	1 756 523	605 377	1 151 146
M. Nuclear Security	13 250 000	15 359 483	3 424 130	58 789	18 842 402	9 066 174	9 776 228
Subtotal – Major Programme 3	**21 830 000[b]**	**23 835 741**	**10 006 999**	**165 427**	**34 008 167**	**16 183 870**	**17 824 297**
4. Nuclear Verification							
4. Overall Management, Coordination and Common Activities	0	578 282	626 992	535	1 205 809	532	1 205 277
N. Safeguards	13 574 000	24 405 597	10 047 702	(132 455)	34 320 844	8 417 650	25 903 194
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)	12 295 000	226 172	151 800	2	377 974	224 173	153 801
Subtotal – Major Programme 4	**25 869 000**	**25 210 051**	**10 826 494**	**(131 918)**	**35 904 627**	**8 642 355**	**27 262 272**
5. Information Support Services							
P. Public Information and Communication	735 000	430 273	622 064	5 071	1 057 408	522 625	534 783
Q. Information and Communications Technology (ICT)	0	3 376	0	0	3 376	0	3 376
S. Conference, Translation and Publishing Services	0	0	2 020	0	2 020	2 015	5
Subtotal – Major Programme 5	**735 000**	**433 649**	**624 084**	**5 071**	**1 062 804**	**524 640**	**538 164**
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	216 000	256 250	311 910	0	568 160	230 416	337 744
Subtotal – Major Programme 6	**216 000**	**256 250**	**311 910**	**0**	**568 160**	**230 416**	**337 744**
7. Policy and General Management							
U. Executive Management, Policy-Making and Coordination	0	249 180	127 803	6 020	383 003	298 417	84 586
V. Administration and General Services	0	545 365	402 883	226 031	1 174 279	492 547	681 732
W. Oversight Services and Performance Assessment	136 000	175 727	0	(40 603)	135 124	111 784	23 340
Subtotal – Major Programme 7	**136 000**	**970 272**	**530 686**	**191 448**	**1 692 406**	**902 748**	**789 658**
Total Extrabudgetary Programme Fund	**54 840 000**	**53 388 248**	**29 378 856**	**202 053**	**82 969 157**	**31 351 337**	**51 617 820**

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

[b] Includes €15 520 000 proposed annual budget for Nuclear Security Fund.

Table A3. Technical cooperation disbursements by Agency programme and region in 2006

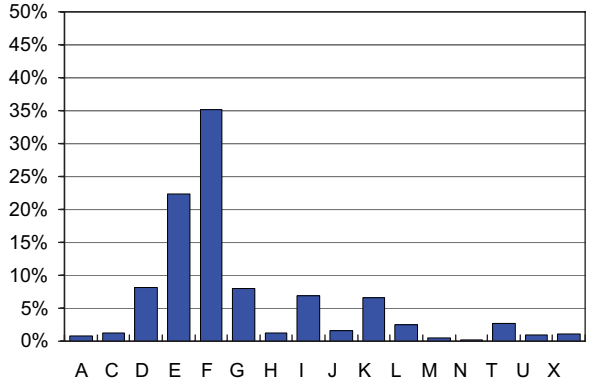
I. Summary of all regions
(in thousands of dollars)

	Programme	Africa	Asia and the Pacific	Europe	Latin America	Global/ Interregional	Total
A	Nuclear Power	179.3	929.5	1 002.8	236.3	250.4	2 598.3
B	Nuclear Fuel Cycle and Materials Technologies	15.6	153.9	0.0	117.3	11.7	298.5
C	Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	298.2	258.0	389.2	289.6	46.9	1 281.9
D	Nuclear Science	2 052.6	1 291.4	9 130.8	1 250.9	0.0	13 725.7
E	Food and Agriculture	5 603.6	2 726.1	496.6	1 990.3	343.1	11 159.8
F	Human Health	8 792.4	3 812.7	9 534.2	5 656.8	78.6	27 874.6
G	Water Resources	1 996.0	542.6	80.8	1 013.6	4.3	3 637.3
H	Assessment and Management of Marine and Terrestrial Environments	296.9	598.3	622.1	447.6	30.2	1 995.1
I	Radioisotope Production and Radiation Technology	1 724.2	2 392.8	1 295.4	1 603.3	36.4	7 052.0
J	Safety of Nuclear Installations	404.4	1 469.2	2 811.6	43.3	21.2	4 749.6
K	Radiation and Transport Safety	1 651.3	2 609.5	2 731.2	1 327.8	82.1	8 401.9
L	Management of Radioactive Waste	622.1	819.5	4 417.3	218.9	376.5	6 454.2
M	Nuclear Security	131.1	15.6	2 111.3	150.4	0.0	2 408.4
N	Safeguards	56.6	0.0	2.3	0.0	4.9	63.9
P	Public Information and Communication	4.9	0.0	0.0	4.7	0.0	9.7
Q	Information and Communication Technology (ICT)	16.2	0.0	0.0	0.0	0.0	16.2
T	Management of Technical Cooperation for Development	683.2	827.2	721.2	1 204.0	1 032.0	4 467.5
U	Executive Management, Policy-Making and Coordination	245.1	74.7	30.6	21.4	0.0	371.8
X	Emergency Preparedness	267.7	406.5	183.9	196.8	0.0	1 055.0
Total		**25 041.4**	**18 927.2**	**35.561.4**	**15 773.0**	**2 318.4**	**97 621.4**

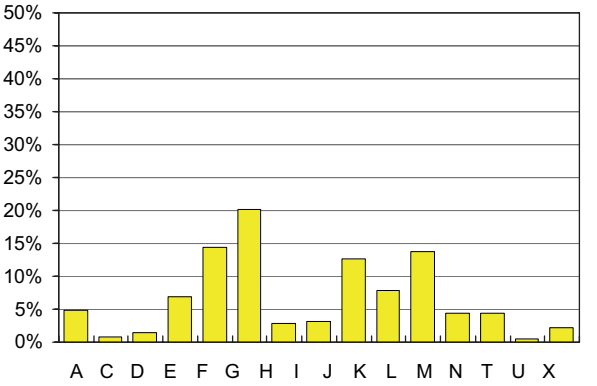
Table A3. Technical cooperation disbursements by Agency programme and region in 2006 (cont.)

II. Distribution by region
(in thousands of dollars)

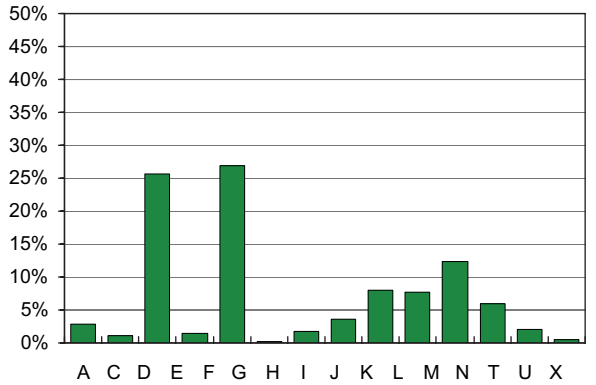
Africa: $25 041.4



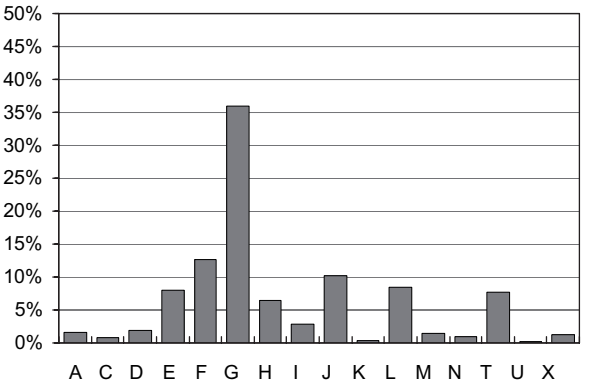
Asia & the Pacific: $18 927.2



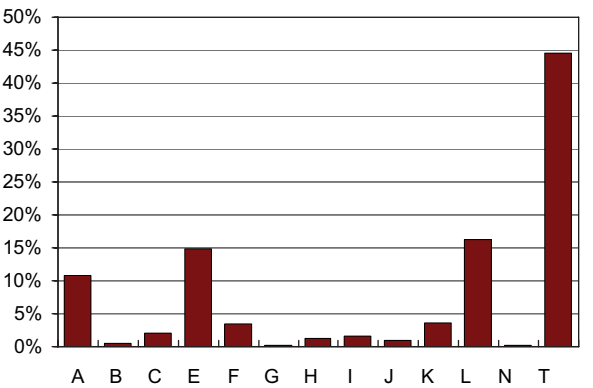
Europe: $35 561.4



Latin America: $15 773.0



Interregional: $2 318.4



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 2006

Type of material	Quantity of material (t)			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b]	Nuclear weapon States	Quantity in SQs
Nuclear material				
Plutonium[c] contained in irradiated fuel	759.5	8.5	109.5	109 690
Separated plutonium outside reactor cores	9.7	0.040	78.4	11 019
Separated plutonium in fuel elements in reactor cores	14.6	0.45	0	1887
HEU (equal to or greater than 20% ^{235}U)	20.2	0.036	0	640
LEU (less than 20% ^{235}U)	52 602	652	5164	14 927
Source material[d] (natural or depleted uranium and thorium)	117 131	1129	23 133	8817
Non-nuclear material[e]				
Heavy water	0.7	452	0	
Total significant quantities				**146 980**

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

[b] Excluding installations in nuclear weapon States.

[c] The quantity includes an estimated 89 t (11 090 SQs) of plutonium in irradiated fuel, which is not yet reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountancy and containment/surveillance (C/S) measures are applied).

[d] This table does not include material within the terms of subparagraphs 34(a) and (b) of INFCIRC/153 (Corrected).

[e] Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2-type agreements.

Table A5. Number of facilities under safeguards or containing safeguarded material on 31 December 2006

Facility type	Number of facilities (number of installations)			
	CSA[a]	INFCIRC/66[b]	Nuclear weapon States	Total
Power reactors	193 (229)	5 (8)	1 (1)	199 (238)
Research reactors and critical assemblies	144 (153)	3 (3)	1 (1)	148 (157)
Conversion plants	19 (19)	0 (0)	0	19 (19)
Fuel fabrication plants	38 (41)	2 (2)	0	40 (43)
Reprocessing plants	7 (7)	1 (1)	0	8 (8)
Enrichment plants	11 (11)	0	2 (3)	13 (14)
Separate storage facilities	87 (89)	2 (2)	6 (7)	95 (98)
Other facilities	69 (81)	0 (0)	1 (1)	70 (82)
Subtotals	**568 (630)**	**13 (16)**	**11 (13)**	**592 (659)**
Other locations	335 (447)	1 (2)	0	336 (449)
Non-nuclear installations	0	0 (0)	0	0 (0)
Totals	**900 (1075)**	**14 (18)**	**11 (13)**	**925 (1107)**

[a] Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other CSAs, including installations in Taiwan, China.

[b] Excluding installations in nuclear weapon States.

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a, b] and small quantities protocols[c] (as of 31 December 2006)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Afghanistan	×	In force: 20 February 1978	257	In force: 19 July 2005
Albania[1]		In force: 12 Sept. 1990	359	Signed: 2 December 2004
Algeria		In force: 7 January 1997	531	Approved: 14 Sept. 2004
Andorra	×	*Signed: 9 January 2001*		*Signed: 9 January 2001*
Angola				
Antigua and Barbuda[2]	×	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]	×	In force: 12 Sept. 1997	544	
Bahrain				
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados[2]	×	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]	×	In force: 21 January 1997	532	
Benin	×	*Signed: 7 June 2005*		*Signed: 7 June 2005*
Bhutan	×	In force: 24 October 1989	371	
Bolivia[2]	×	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	×	In force: 4 November 1987	365	
Bulgaria		In force: 29 February 1972	178	In force: 10 October 2000
Burkina Faso	×	In force: 17 April 2003	618	In force: 17 April 2003
Burundi				
Cambodia	×	In force: 17 December 1999	586	
Cameroon	×	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				
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
Comoros	*Signed: 13 December 2005*	*Signed: 13 December 2005*		*Signed: 13 December 2005*
Congo, Republic of the				
Costa Rica[2]	×	In force: 22 November 1979	278	Signed: 12 December 2001
Côte d'Ivoire		In force: 8 September 1983	309	
Croatia	×	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	×	In force: 26 January 1973	189	In force: 19 February 2003

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
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]	×	In force: 3 May 1996	513	
Dominican Republic[2]	Amended: 11 October 2006	In force: 11 October 1973	201	Approved: 23 November 2006
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]	×	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	×	*Approved: 13 June 1986*		
Eritrea				
Estonia[11]		Accession: 1 December 2005	193	Accession: 1 December 2005
Ethiopia	×	In force: 2 December 1977	261	
Fiji	×	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
	×	Signed: 26 September 2000[13]		
Gabon	×	*Signed: 3 December 1979*		*Signed: 8 June 2005*
Gambia	×	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 December 1981	193	In force: 30 April 2004
Grenada[2]	×	In force: 23 July 1996	525	
Guatemala[2]	×	In force: 1 February 1982	299	Signed: 14 December 2001
Guinea				
Guinea-Bissau				
Guyana[2]	×	In force: 23 May 1997	543	
Haiti[2]	×	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
Honduras[2]	×	In force: 18 April 1975	235	Signed: 7 July 2005
Hungary		In force: 30 March 1972	174	In force: 4 April 2000
Iceland	×	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

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
Japan		In force: 2 December 1977	255	In force: 16 December 1999
Jordan	×	In force: 21 February 1978	258	In force: 28 July 1998
Kazakhstan		In force: 11 August 1995	504	Signed: 6 February 2004
Kenya				
Kiribati	×	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	×	In force: 7 March 2002	607	In force: 2 June 2003
Kyrgyzstan	×	In force: 3 February 2004	629	Approved: 23 November 2006
Lao People's Democratic Republic	×	In force: 5 April 2001	599	
Latvia		In force: 21 December 1993	434	In force: 12 July 2001
Lebanon	×	In force: 5 March 1973	191	
Lesotho	×	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	×	In force: 14 June 1973	200	In force: 18 Sept. 2003
Malawi	×	In force: 3 August 1992	409	Approved: 23 November 2006
Malaysia		In force: 29 February 1972	182	Signed: 22 November 2005
Maldives	×	In force: 2 October 1977	253	
Mali	Amended: 18 April 2006	In force: 12 September 2002	615	In force: 12 September 2002
Malta	×	In force: 13 November 1990	387	In force: 12 July 2005
Marshall Islands		In force: 3 May 2005	653	In force: 3 May 2005
Mauritania	×	*Signed: 2 June 2003*		*Signed: 2 June 2003*
Mauritius	×	In force: 31 January 1973	190	Signed: 9 December 2004
Mexico[16]		In force: 14 September 1973	197	Signed: 29 March 2004
Micronesia, Federated States of				
Monaco	×	In force: 13 June 1996	524	In force: 30 September 1999
Mongolia	×	In force: 5 September 1972	188	In force: 12 May 2003
Montenegro				
Morocco		In force: 18 February 1975	228	Signed: 22 September 2004
Mozambique				
Myanmar	×	In force: 20 April 1995	477	
Namibia	×	In force: 15 April 1998	551	Signed: 22 March 2000
Nauru	×	In force: 13 April 1984	317	
Nepal	×	In force: 22 June 1972	186	
Netherlands	×	In force: 5 June 1975	229[13]	
		In force: 21 February 1977	193	In force: 30 April 2004
New Zealand[17]	×	In force: 29 February 1972	185	In force: 24 September 1998
Nicaragua[2]	×	In force: 29 December 1976	246	In force: 18 February 2005
Niger		In force: 16 February 2005	664	Signed: 11 June 2004
Nigeria		In force: 29 February 1988	358	Signed: 20 September 2001
Norway		In force: 1 March 1972	177	In force: 16 May 2000
Oman	×	In force: 5 September 2006	691	

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
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 Approved: 23 November 2006	34 116 135 239 248 393 418	
Palau	Amended: 15 March 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[8]	×	In force: 23 March 1984	316	In force: 11 December 2001
Papua New Guinea	×	In force: 13 October 1983	312	
Paraguay[2]	×	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		In force: 11 October 1972	179	In force: 5 May 2000
Portugal[18]		Accession: 1 July 1986	193	In force: 30 April 2004
Qatar				
Republic of Moldova	×	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*	Signed: 22 March 2000
Rwanda				
Saint Kitts and Nevis[5]	×	In force: 7 May 1996	514	
Saint Lucia[5]	×	In force: 2 February 1990	379	
Saint Vincent and the Grenadines[5]	×	In force: 8 January 1992	400	
Samoa	×	In force: 22 January 1979	268	
San Marino	×	In force: 21 September 1998	575	
Sao Tome and Principe				
Saudi Arabia	×	*Signed: 16 June 2005*		
Senegal	×	In force: 14 January 1980	276	Signed: 15 December 2006
Serbia[19]		In force: 28 December 1973	204	Approved: 14 Sept. 2004
Seychelles	Amended: 31 October 2006	In force: 19 July 2004	635	In force: 13 October 2004
Sierra Leone	×	*Signed: 10 November 1977*		
Singapore	×	In force: 18 October 1977	259	Signed: 22 September 2005
Slovakia[20]		Accession: 1 Dec. 2005	193	Accession: 1 December 2005
Slovenia[21]		Accession: 1 September 2006	193	Accession: 1 September 2006
Solomon Islands	×	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	×	In force: 7 January 1977	245	
Suriname[2]	×	In force: 2 February 1979	269	
Swaziland	×	In force: 28 July 1975	227	
Sweden[22]		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

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Additional protocol status
The Former Yugoslav Rep. of Macedonia	×	In force: 16 April 2002	610	Signed: 12 July 2005
Timor-Leste				
Togo	×	*Signed: 29 November 1990*		*Signed: 26 September 2003*
Tonga	×	In force: 18 November 1993	426	
Trinidad and Tobago[2]	×	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	×	In force: 15 March 1991	391	
Uganda	×	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	×	In force: 9 October 2003	622	
United Kingdom		In force: 14 December 1972	175[23]	
		In force: 14 August 1978	263*	In force: 30 April 2004
	×	Approved: 16 September 1992[13]		
United Republic of Tanzania	×	In force: 7 February 2005	643	In force: 7 February 2005
United States of America	×	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	
Yemen, Republic of	×	In force: 14 August 2002	614	
Zambia	×	In force: 22 September 1994	456	
Zimbabwe	×	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.

---

[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 quantity protocol", 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 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 21 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), 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 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.

[17] Whereas the NPT safeguards agreement and SQP 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.

[18] 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.

[19] 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.

[20] 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.

[21] 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.

[22] 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.

[23] 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 2006)

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		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														
	BAHRAIN														
*	BANGLADESH			P		P	P		P				S		

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	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		
	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														
*	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														
	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
	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		

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	EGYPT	P	P			Pr	Pr	P	S				S		
*	EL SALVADOR					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											
	GUINEABISSAU														
	GUYANA														
*	HAITI			S									S		
*	HOLY SEE	P				S	S							P	P
*	HONDURAS			P											
*	HUNGARY	Pr	P	P		P	P	P	P	P	S		S	P	P
*	ICELAND			P		P	P		S	P			S		
*	INDIA	P		Pr		Pr	Pr		P						
*	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									S		
	KIRIBATI														

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	KOREA REP.	Pr		Pr		P	Pr		P	P			S	P	P
*	KUWAIT	P		Pr		P	P		P				S		
*	KYRGYZSTAN												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		
*	LIECHTENST			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		S	S		P				S		
*	MALTA			P									S	P	P
*	MARSHALL ISL.			P											
*	MAURITANIA														
*	MAURITIUS	P				Pr	Pr						S		
*	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														
*	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		S				S		
*	NORWAY	P		Pr		P	Pr	P	P	P					

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	OMAN			Pr											
*	PAKISTAN	Pr		Pr		Pr	Pr		P				S	P	P
	PALAU														
*	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		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		Pr	Pr	P	P	P	P	CS	S	P	P
*	RUSSIAN FED.	Pr	P	Pr		Pr	Pr		P	P					
	RWANDA														
	SAINT LUCIA														
	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		Sr		Pr	Pr		P				S		
*	SPAIN	P	S	Pr		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

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	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	S	P				S	P	P
	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														
*	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 2006, Portugal and Senegal became party to the Agreement. By the end of the year, there were 75 Parties.
- *Convention on the Physical Protection of Nuclear Material* (reproduced in document INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2006, Andorra, Cambodia, Georgia, Togo and the United Republic of Tanzania became party to the Convention. By the end of the year, there were 121 Parties.
- *Amendment to the Convention on the Physical Protection of Nuclear Material*. Adopted on 8 July 2005. In 2006, Austria, Bulgaria, Croatia, the Libyan Arab Jamahiriya and Seychelles adhered to the Amendment. By the end of the year, there were 6 Contracting States.
- *Convention on Early Notification of a Nuclear Accident* (reproduced in document INFCIRC/335). Entered into force on 27 October 1986. In 2006, Cameroon and Euratom became party to the Convention. By the end of the year, there were 99 Parties.
- *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency* (reproduced in document INFCIRC/336). Entered into force on 26 February 1987. In 2006, Cameroon, Iceland and Euratom became party to the Convention. By the end of the year, there were 97 Parties.
- *Convention on Nuclear Safety* (reproduced in document INFCIRC/449). Entered into force on 24 October 1996. In 2006, Estonia, Kuwait and The Former Yugoslav Republic of Macedonia became party to the Convention. By the end of the year, there were 59 Parties.
- *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (reproduced in document INFCIRC/546). Entered into force on 18 June 2001. In 2006, Brazil, China, Estonia, Iceland, Italy, the Russian Federation, Uruguay and Euratom became party to the Joint Convention. By the end of the year, there were 42 Parties.
- *Vienna Convention on Civil Liability for Nuclear Damage* (reproduced in document INFCIRC/500). Entered into force on 12 November 1977. In 2006, the status of the Convention remained unchanged with 33 Parties.
- *Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage* (reproduced in document INFCIRC/566). Entered into force on 4 October 2003. In 2006, the status of the protocol remained unchanged with 5 Parties.
- *Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention* (reproduced in document INFCIRC/402). Entered into force on 27 April 1992. In 2006, the status of the protocol remained unchanged with 24 Parties.
- *Convention on Supplementary Compensation for Nuclear Damage* (reproduced in document INFCIRC/567). Opened for signature on 29 September 1997. In 2006, the status of the convention remained unchanged with 3 Contracting States.
- *Optional Protocol Concerning the Compulsory Settlement of Disputes* (reproduced in document INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2006, the status of the protocol remained unchanged with 2 Parties.
- *Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA).* In 2006, Belize, Botswana, Kyrgyzstan, Seychelles, Slovenia and South Africa concluded an RSA Agreement. By the end of the year, there were 107 Member States that concluded an RSA Agreement with the Agency.
- *African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (Third Extension)* (reproduced in document INFCIRC/377). Entered into force on 4 April 2005. In 2006, Sudan and Zimbabwe became party to the Third Extension. By the end of the year, there were 26 Parties.
- *Third Agreement to Extend the 1987 Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA)* (reproduced in document INFCIRC/167/Add. 20). Entered into force on 10 January 2002 with effect from 12 June 2002. In 2006, the status of the agreement remained unchanged with 16 Parties.

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) (cont.)

- *Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL)* (reproduced in document INFCIRC/582). Entered into force on 5 September 2005. In 2006, Bolivia and Brazil became party to the agreement. By the end of the year, there were 13 Parties.
- *Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA)* (reproduced in document INFCIRC/613/Add.1). Entered into force on 29 July 2002. In 2006, the status of the agreement remained unchanged with 7 Parties.
- *Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project*. China, India, Japan, the Republic of Korea, the Russian Federation, the United States of America and Euratom signed the agreement on 21 November 2006.
- *Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project.* China, India, Japan, the Republic of Korea, the Russian Federation and Euratom signed the Agreement on 21 November 2006.

Table A9. Integrated Regulatory Review Service (IRRS) missions in 2006

IRRS (full scope): France; **IRRS (limited scope):** United Kingdom; **Follow-up IRRS:** Romania

Table A10. Peer review of radiation safety infrastructure missions in 2006

Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA):

Albania; Bangladesh; Brazil; Brunei Darussalam; Burkina Faso; Colombia; El Salvador; Ghana; Kyrgyzstan; Latvia; Qatar; Sudan; Tajikistan; United Republic of Tanzania; United Arab Emirates; Uruguay; Vietnam; Zambia.

Table A11. Safety Culture Assessment Review Team (SCART) missions in 2006

SCART — PBMR (Pty) Limited, South Africa.

Table A12. Operational Safety Review Team (OSART) missions in 2006

Preparatory-OSART
Tihange, PWR, Belgium; Loviisa, WWER, Finland; Chinon, PWR, France; Neckarwestheim, PWR, Germany; Yonggwang, PWR, Republic of Korea; Khmelnitski, WWER, Ukraine.

OSART
St. Laurent, PWR, France; Ignalina, LWGR, Lithuania; Mochovce, WWER, Slovakia; South Ukraine, WWER, Ukraine.

Follow-up OSART
Qinshan III, PHWR, China; Blayais, PWR, France; Penly, PWR, France; Philippsburg 2, PWR, Germany; Kashiwasaki-Kariwa, BWR/ABWR, Japan; Chashma, PWR, Pakistan; Cernavoda, PHWR, Romania; Zaporozhe, WWER, Ukraine; Brunswick, BWR, USA.

Table A13. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2006

Follow-up PROSPER — EDF Corporate, France

Table A14. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2006

Pre-INSARR: Buenos Aires, Argentina; Tehran, Islamic Republic of Iran

INSARR: Rabat, Morocco

Follow-up INSARR: Dalat, Vietnam

Table A15. Safety Evaluation during Operation of Fuel Cycle Facilities (SEDO) missions in 2006

Preparatory-SEDO: Brazil

Table A16. Safety Review Service and Expert Missions in 2006

Fact-finding mission	Afghanistan
Education and training appraisal mission on radiation protection and safety of radiation sources	Argentina
Expert mission to assess the safety aspects of experimental device and status of equipment	Argentina
Seismic safety review: Interim review of Safety Upgrading Programme progress and follow up of SSI and FRS calculations	Armenia
Seismic safety review: Review of the probabilistic seismic hazard assessment for the Armenia nuclear power plant site	Armenia
Expert mission to support Azerbaijan to comply with international requirements in predisposal activities	Azerbaijan
Expert mission to support Bulgarian regulatory authority to review the event-control rod drives	Bulgaria
Mission under the Assistance Convention to assist authorities in evaluating the emergency management system following a radiological incident in December 2005	Chile
Expert mission to review severe accident analysis and preventive and mitigative accident management measures	China
Deterministic safety analysis	China
Expert mission to strengthen the regulatory authority	China
Expert mission on waste disposal project	China
Educational and training appraisal mission	China
Expert mission to provide assistance in preparing a decommissioning plan and evaluating the decommissioning of the TRICO I research reactor	Democratic Republic of the Congo
Site safety review: Review proposal of a local seismological network for the El-Dabaa nuclear power plant site	Egypt

Table A16. Safety Review Service and Expert Missions in 2006 (cont.)

Site safety review: Review proposal of environmental impact assessment and monitoring programmes for the El-Dabaa nuclear power plant site	Egypt
Site safety review: Follow-up review of geological seismology and oceanographic aspects of El-Dabaa nuclear power plant site evaluation	Egypt
Expert mission to implement and manage radiological surveillance programme and advise on remedial actions	Gabon
Expert mission to assist the regulatory authorities to prepare country specific work plan	Guatemala
Long term operation safety review: Review of the completeness of the licence renewal programme scope and objective	Hungary
Site safety review: Review of the status of site evaluation studies for the Muria Peninsula nuclear power plant site	Indonesia
Expert mission on assessment of the heat exchanger of RSG-GAS, radiation protection and management of safety	Indonesia
Review of the Bushehr nuclear power plant organization from the perspective of interfaces among operational departments.	Islamic Republic of Iran
Review of FSAR Bushehr, chapters14, 17	Islamic Republic of Iran
Deterministic safety analysis	Islamic Republic of Iran
Deterministic safety analysis	Republic of Korea
Expert mission to develop regulatory framework and decision-making process to assess the radiological impact of radioactive residues at previous uranium mining sites	Kyrgyzstan
Expert mission to review draft strategy for the management of radioactive waste	Lebanon
Expert mission to review project activities, assess implementation extent of previous mission recommendations and discuss and approve the final version of specifications for the instrumentation and control system to be acquired from INVAP	Libyan Arab Jamahiriya
Follow-up on the implementation of the recommendations resulting from previous IAEA missions and those formulated by the regulatory body concerning the TRIGA PUSPATI reactor, and assist the counterpart in reviewing and completing Chapter 16 of the SAR	Malaysia
Expert mission to review the capacity in environmental impact assessment and develop project workplan	Mongolia
Review of PSAR Chashma 2 NPP Chapter 2 and oversee preparation of the Standard Review Plan”	Pakistan
Review of PSAR Chashma 2 Chapters 5, 8, 9 and 10	Pakistan
Review of PSAR Chashma 2 Chapters 11 and 12	Pakistan
Review of PSAR Chashma 2 Chapter 17	Pakistan
Review of FSAR Chashma 2 Chapters 13, 14, 16	Pakistan
Expert mission to pre-review accident management programme	Pakistan
Deterministic safety analysis	Pakistan
Expert mission to discuss PNRA strategic plan for 2006–2011	Pakistan
Follow-up expert mission of establishment and implementation of the integrated management system for the Philippine research reactor operating organization	Philippines
Expert mission to assist regulatory authority with review of safety cases for disposal of radioactive waste	Romania

Table A16. Safety Review Service and Expert Missions in 2006 (cont.)

Expert mission to discuss needs for decommissioning the research reactor at Magurele and to develop a 2006 workplan	Romania
Expert mission to assist in the development of the incident reporting system for nuclear research facilities	Russian Federation
Expert mission to review the draft cost estimate methodology for the decommissioning of nuclear power plants	Russian Federation
Expert mission for safety assessment of carbon steel removal from the Vinča Institute spent fuel storage	Serbia
Expert mission for safety assessment of the VIND project	Serbia
Expert mission to review status of regulatory body organization and provide technical assistance to regulatory body staff on licensing and inspection process	Serbia
Expert mission to evaluate the outcome of safety assessment and site characterization work for repository development programme	Slovenia
Expert mission on strengthening the regulatory body	Thailand
Seismic safety review: Geological and meteorological studies for the Sinop nuclear power plant site evaluation	Turkey
Long term operation safety review: Periodic safety review requirements for the Ukraine generic nuclear power plant	Ukraine
Long term operation safety review: Review of Ukraine SE NNEGC Energoatom	Ukraine
Expert mission to assist the Zaporozhe nuclear power plant implement a spectrum of risk-informed integrated decision making applications	Ukraine
Expert mission to assess progress of the Zaporozhe nuclear power plant Unit 5 probabilistic safety analysis and implementation programme for applications	Ukraine
Expert mission to provide technical assistance on the development of decommissioning plant for Units 1, 2 and 3 of the Chernobyl plant	Ukraine
Expert mission to evaluate the installation of radiation monitoring system	Uzbekistan
Expert mission to strengthen the regulatory functions, including the infrastructure needed for new research reactors	Vietnam

Table A17. International Nuclear Security Advisory Service (INSServ) missions in 2006

INSServ: Ghana; Jordan; Kuwait; Kyrgyzstan; Lebanon

Table A18. International Physical Protection Advisory Service (IPPAS) missions in 2006

IPPAS: Kazakhstan; Mexico; Serbia and Montenegro[1]; Slovakia; Uzbekistan

International Team of Experts mission: Georgia; Republic of Moldova

[1] Mission conducted prior to Montenegro's independence.

Table A19. National strategies missions in 2006 for regaining control over radioactive sources

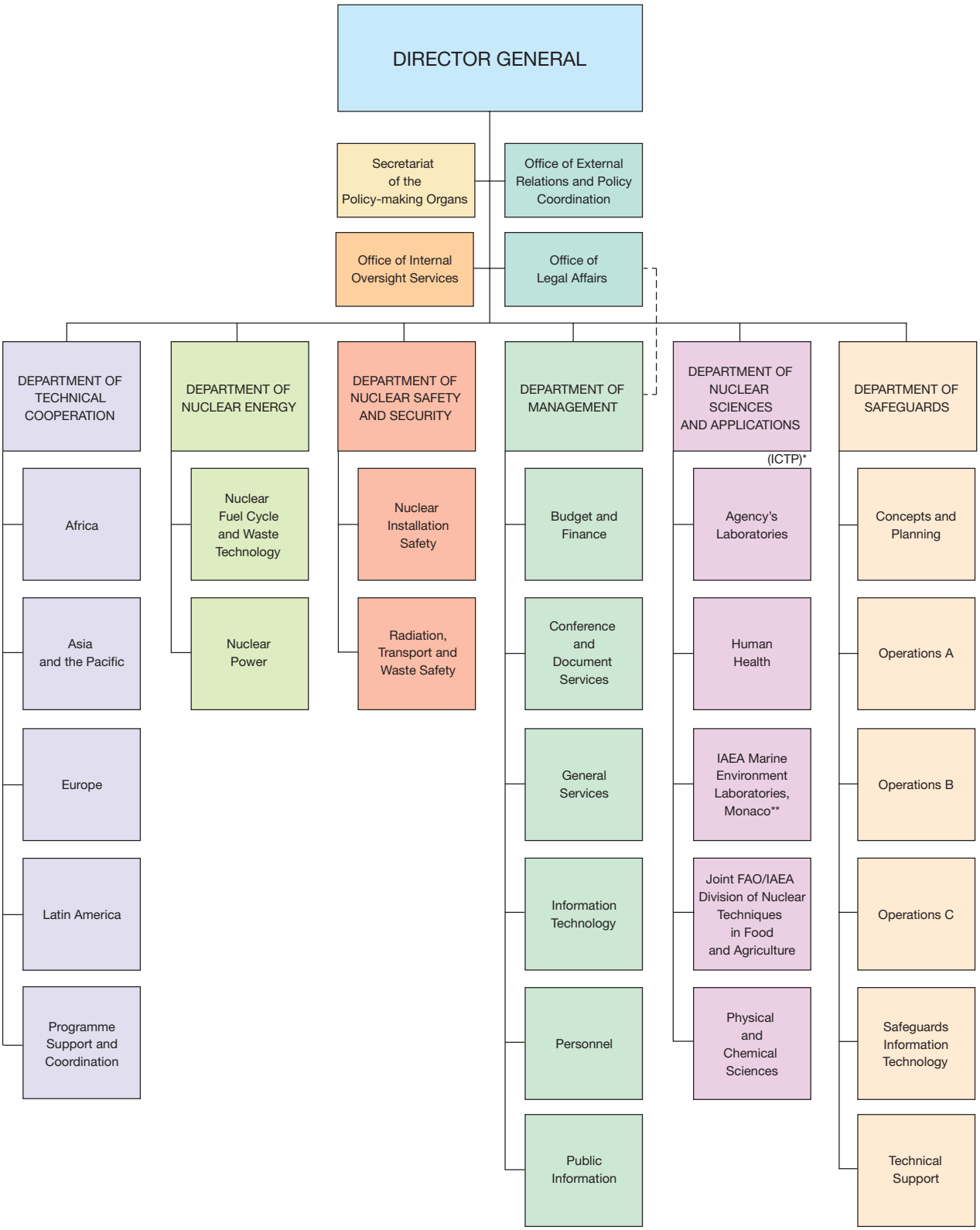
Fact-finding mission for the dismantling and transport of sealed radioactive sources: Belarus; Jordan; Lebanon; Ukraine; Uzbekistan

Technical mission to plan a source dismantling and transport operation: Azerbaijan

Orphan Source Search and Secure Mission: Albania; Armenia; Bosnia and Herzegovina; China; Montenegro; Serbia; Uzbekistan; Vietnam

Organizational Chart

(as of 31 December 2006)



* 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

www.iaea.org

International Atomic Energy Agency
P.O. Box 100, Wagramer Strasse 5
1400 Vienna, Austria
Telephone: (+43-1) 2600-0
Fax: (+43-1) 2600-7
Email: Official.Mail@iaea.org

GC(51)/5