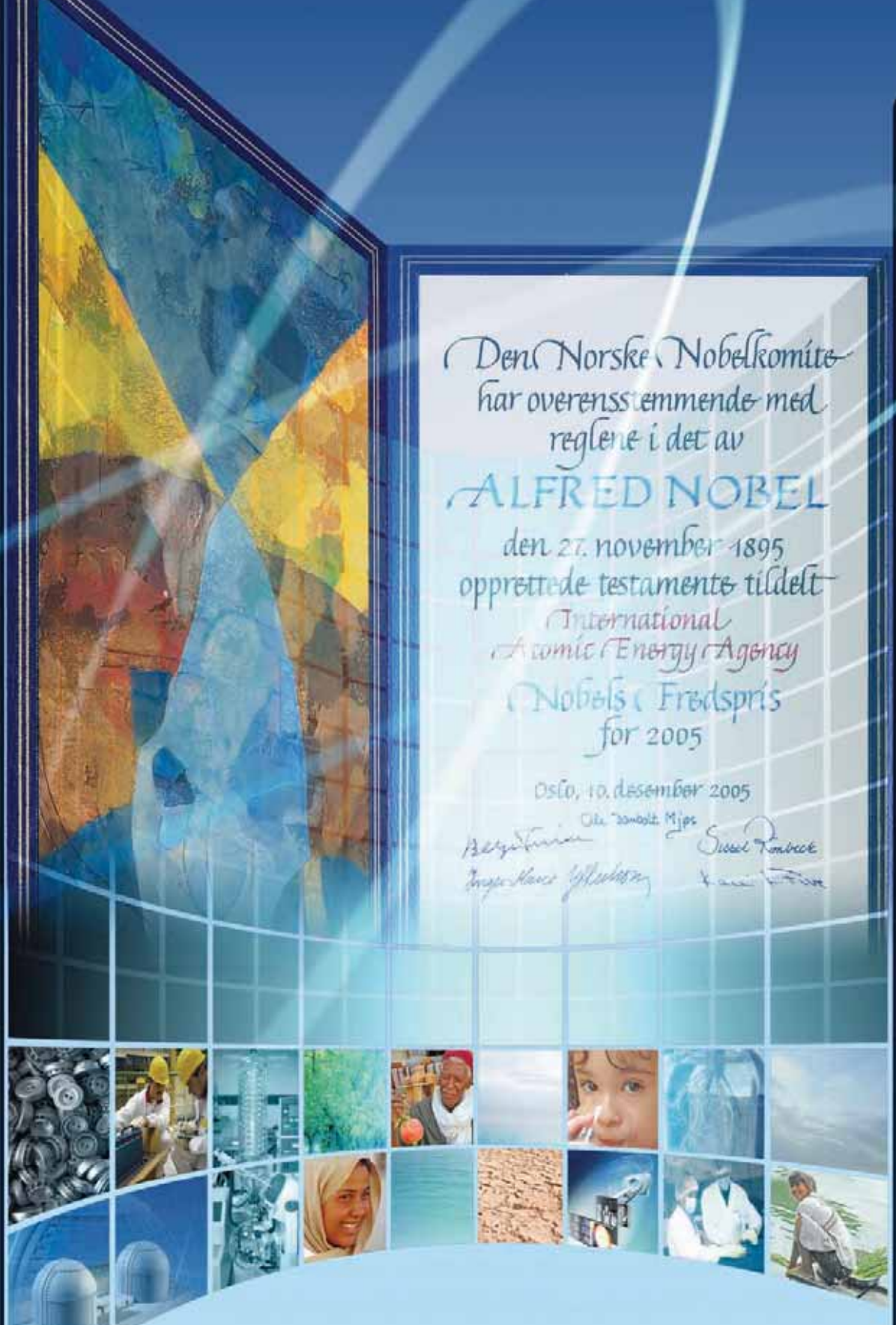
IAEA
International Atomic Energy Agency

ANNUAL REPORT 2005



Annual Report 2005

Article VI.J of the IAEA'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 2005.

IAEA
International Atomic Energy Agency

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Member States of the International Atomic Energy Agency

(designation as of 31 December 2005)

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
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA
MAURITIUS
MEXICO
MONACO
MONGOLIA
MOROCCO
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 AND MONTENEGRO
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 Nobel Peace Prize for 2005

"The Norwegian Nobel Committee has decided that the Nobel Peace Prize for 2005 is to be shared, in two equal parts, between the **International Atomic Energy Agency (IAEA)** and its **Director General, Mohamed ElBaradei**, for their efforts to prevent nuclear energy from being used for military purposes and to ensure that nuclear energy for peaceful purposes is used in the safest possible way."

"At a time when the threat of nuclear arms is again increasing, the Norwegian Nobel Committee wishes to underline that this threat must be met through the broadest possible international cooperation. This principle finds its clearest expression today in the work of the IAEA and its Director General. In the nuclear non-proliferation regime, it is the IAEA which controls that nuclear energy is not misused for military purposes, and the Director General has stood out as an unafraid advocate of new measures to strengthen that regime. At a time when disarmament efforts appear deadlocked, when there is a danger that nuclear arms will spread both to states and to terrorist groups, and when nuclear power again appears to be playing an increasingly significant role, IAEA's work is of incalculable importance."

"In his will, Alfred Nobel wrote that the Peace Prize should, among other criteria, be awarded to whoever had done most for the "abolition or reduction of standing armies". In its application of this criterion in recent decades, the Norwegian Nobel Committee has concentrated on the struggle to diminish the significance of nuclear arms in international politics, with a view to their abolition. That the world has achieved little in this respect makes active opposition to nuclear arms all the more important today."

Oslo, 7 October 2005

Director General Mohamed ElBaradei and Ambassador Yukiya Amano, Chairman of the Board of Governors, at the Nobel Prize award ceremony at the Oslo City Hall, 10 December 2005.
(Copyright: Knudsens Fotosenter 2005; photo: Arne Knudsen.)

The Agency at a Glance

(as of 31 December 2005)

139 Member States.

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

48 years of international service by 2005.

2312 professional and support staff.

$322 million total regular budget for 2005, supplemented by extrabudgetary contributions received in 2005 amounting to **$39 million**.

$77.5 million target in 2005 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **2784** expert and lecturer assignments, **3202** meeting and workshop participants, **1574** participants in training courses and **1436** fellows and visiting scientists.

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 Agreements relating to nuclear science and technology.

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

140 active Coordinated Research Projects involving **1511** approved research contracts and agreements. In addition, **93** Research Coordination Meetings were held.

232 safeguards agreements in force in **156** States involving **2142** safeguards inspections performed in 2005. Safeguards expenditures in 2005 amounted to **$121.1 million** in regular budget and **$14.5 million** in extrabudgetary resources.

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

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

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

200 publications and newsletters issued (in print and electronic formats) in 2005.

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 2005, the Board took note of the Agency's *Medium Term Strategy 2006–2011*, that had been developed through a process of interaction between the Secretariat and a Working Group of the Board.

The Board considered the *Nuclear Technology Review — Update 2005*. It approved the use of the Agency's monetary share of the Nobel Peace Prize for 2005 for human resource development in developing regions of the world in the areas of cancer management and nutrition.

In the area of safety and security it considered the *Nuclear Safety Review for the Year 2004*. It endorsed a number of draft Safety Requirements. It approved the additional functions of the Agency under the Amendment to the Convention on the Physical Protection of Nuclear Material. It approved the *Nuclear Security Plan for 2006–2009*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2004*. It approved modifications to the standard text of the small quantities protocol (SQP) to safeguards agreements and to the criteria for SQPs. It decided to set up the Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute, to consider ways and means to strengthen the safeguards system.

The Board approved the synchronization of the regular programme and technical cooperation programme cycles as of 2012.

The Board decided to appoint Dr. Mohamed ElBaradei as Director General of the Agency by acclamation for a further term of office of four years, until 30 November 2009.

Composition of the Board of Governors
(2005–2006)

Chairperson: H.E. Mr. Yukiya AMANO
Ambassador, Governor from Japan

Vice-Chairpersons: H.E. Mr. Ramzy Ezzeldin RAMZY
Ambassador, Governor from Egypt

Ms. Eva ŠIMKOVÁ
Deputy Minister, Ministry of Economy
Governor from Slovakia

Algeria
Argentina
Australia
Belarus
Belgium
Brazil
Canada
China
Colombia
Cuba
Ecuador
Egypt
France
Germany
Ghana
Greece
India
Indonesia
Japan
Korea, Republic of
Libyan Arab Jamahiriya
Norway
Portugal
Russian Federation
Singapore
Slovakia
Slovenia
South Africa
Sri Lanka
Sweden
Syrian Arab Republic
United Kingdom of Great Britain and Northern Ireland
United States of America
Venezuela
Yemen

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 2005, the Conference — upon the recommendation of the Board — approved Belize for membership of the Agency.

The Conference approved the Board's appointment of Dr. Mohamed ElBaradei as Director General of the Agency for a further term of office of four years, until 30 November 2009.

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 13, generally follows the programme structure as it applied in 2005. The introductory chapter, 'The Year in Review', 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. Information on specific issues can be found in the latest editions of the Agency's *Nuclear Safety Review, Nuclear Technology Review* and *Technical Cooperation Report*. 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 also provided on the attached CD-ROM, and is also available on the Agency's *iaea.org* web site (*http://www.iaea.org/Worldatom/Documents/Anrep/Anrep2005/*).
- 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
ADB	Asian Development Bank
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
BWR	Boiling water reactor
CRP	Coordinated Research Project
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
ESTRO	European Society for Therapeutic Radiology and Oncology
Euratom	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FORATOM	European Atomic Forum
HWR	Heavy water reactor
IAEA-MEL	IAEA Marine Environment Laboratories
ICAO	International Civil Aviation Organization
IEA	OECD International Energy Agency
ICTP	Abdus Salam International Centre for Theoretical Physics
IPCC	Intergovernmental Panel on Climate Change
IIASA	International Institute for Applied Systems Analysis
ILO	International Labour Organization
IMO	International Maritime Organization
INDC	International Nuclear Data Committee
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ISO	International Organization for Standardization
LWR	Light water reactor
NEA	OECD Nuclear Energy Agency
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
OLADE	Latin American Energy Organization
OPANAL	Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean
PAHO	Pan American Health Organization (WHO)
PHWR	Pressurized heavy water reactor
PRIS	Power Reactor Information System
PWR	Pressurized water reactor
RAF	Regional Africa
RAS	Regional East Asia and Pacific
RAW	Regional West Asia
RBMK	High-power channel-type reactor (former USSR)
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SQ	Significant quantity
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNMOVIC	United Nations Monitoring, Verification and Inspection Commission
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UPU	Universal Postal Union
WANO	World Association of Nuclear Operators
WCO	World Customs Organization
WEC	World Energy Council
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WWER	Water cooled water moderated power reactor (former USSR)

The Year in Review

Approaching its fiftieth year, the International Atomic Energy Agency continues to be the global focal point for cooperation in the use of nuclear energy for peace and development. Recognition of its contributions in these areas found its most prominent expression in the award by the Norwegian Nobel Committee in October of the Nobel Peace Prize for 2005 to the Agency and its Director General, Mohamed ElBaradei.

For the Agency to continue to make a meaningful contribution to socioeconomic development, nuclear safety and security, and non-proliferation and arms control, it must remain responsive to the changing needs and goals of its Member States. These needs and priorities were taken into account in the preparation of the *Medium Term Strategy 2006–2011*, which was presented to the Board of Governors in March. This new strategy continues to emphasize the importance of quality management to ensure efficiency and effectiveness in all Agency activities.

During 2005, the Agency continued its work under the three pillars of its mandate — ***technology***, ***safety*** and **verification**. Specifically, the focus was on: facilitating the development and transfer of peaceful nuclear technologies; maintaining and expanding a global nuclear safety regime as well as strengthening the security of nuclear and radiological material and facilities; and preventing the proliferation of nuclear weapons. This chapter reviews some of the major global developments in these areas during the year from the perspective of the Agency.

Technology

The Agency's work under the technology pillar for the peaceful applications of nuclear science and technology contributes to the socioeconomic development of its Member States. Its wide ranging activities under both its regular budget and technical cooperation programme include providing scientific and technological support in the fields of nuclear power, the nuclear fuel cycle, food production, human health, water resources, marine and terrestrial environmental management, and industrial applications.

Nuclear power: Status and trends

For nuclear energy, 2005 was a year of rising expectations, driven by: nuclear power's performance record; the growing need for energy around the world coupled with rising oil and natural gas prices; environmental constraints on the use of fossil fuels; concerns about energy supply security in a number of countries; and expansion plans for nuclear power in some States. In March, high level representatives of 74 governments, including 25 representatives at the ministerial level, gathered in Paris at a conference organized by the Agency to consider the future role of nuclear power. According to the final statement of the President of the Conference, the vast majority of participants affirmed that "nuclear power can make a major contribution to meeting energy needs and sustaining the world's development in the 21st century, for a large number of both developed and developing countries."

The Agency maintains comprehensive databases tracking the status of nuclear power reactors around the world through their construction, operation, shutdown and decommissioning. At the end of 2005, there were 443 power reactors operating worldwide, accounting for about 16% of world electricity production and keeping pace with the steady growth in the global electricity market. Twenty-six nuclear power plants were under construction, the majority (15) being in Asia. Four new plants were connected to the grid during the year: two in Japan and one each in India and the Republic of Korea. One laid-up plant was reconnected in Canada. Overall, there was a net increase in capacity of 2300 MW(e) in 2005, taking into account new nuclear power plants connected to the grid and plant retirements. Licence renewals for nuclear power plants also played an important role in 2005, notably in the Netherlands, the Russian Federation, Sweden, the United Kingdom and the USA.

Although expectations for nuclear power are rising, a recent global public opinion survey commissioned by the Agency — which polled 18 000 people in 18 countries (Fig. 1) — revealed substantial differences of opinion across countries.

Energy assessments and technology transfer

The availability of energy is central to improving the standard of living in developing countries.

FIG. 1. Results of a global public opinion poll on nuclear power commissioned by the Agency. (Source: Global Public Opinion on Nuclear Issues and the IAEA: Final Report from 18 Countries, 2005.)

One of the contributions of the Agency to energy development is its efforts to build Member State capacities for national energy analysis and planning, taking into account economic, environmental and social implications. Its energy planning tools are now used in more than 109 countries around the world. In addition, local experts have been trained to analyse national options for meeting energy demand. In 2005 alone, 272 energy professionals from 51 countries were trained. Analytical studies to complement the Agency's training programmes included reviews of energy supply security in the Baltic States, energy system requirements in India and Mexico, the cost effectiveness of nuclear power for the mitigation of climate change and reducing emissions of greenhouse gases, the contribution of nuclear technologies to economic growth in the Republic of Korea, and the economic impact of early closure of nuclear plants in Bulgaria.

Innovation

National research on innovative and advanced reactor designs continues for all reactor categories — water cooled, gas cooled, liquid metal cooled and hybrid systems. Complementing national initiatives are two major international efforts to promote innovation — the Generation IV International Forum (GIF) and the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO).

In 2005, members of GIF signed a Framework Agreement on International Collaboration in Research and Development on six types of reactor systems that were previously selected. The membership of INPRO grew to 24 with the addition in 2005 of Ukraine and the USA.[1] The INPRO methodology is currently being used by Argentina, China, France, India, the Republic of Korea and the Russian Federation to assess innovative nuclear energy systems and identify the most suitable areas for collaborative development.

Uranium resources and supply

Uranium prices, which generally declined through the 1980s and fluctuated during the 1990s, began to rise in 2001 and increased by over 350% between 2001 and 2005 (Fig. 2).

The 2005 edition of the joint IAEA–OECD/NEA 'Red Book' on uranium resources, production and demand continues to foresee a mixed medium term outlook for the uranium market. Particularly important is uncertainty regarding the continued availability of secondary supply sources, such as civil and military stockpiles, spent fuel reprocessing and the re-enrichment of depleted uranium.

The consensus at an Agency symposium on 'Uranium Production and Raw Materials for the Nuclear Fuel Cycle', held in June in Vienna, was that uranium resources were adequate to fuel the projected expansion of nuclear power. However, it was emphasized that additional investment was needed to ensure that uranium mining and milling activities would be able to meet the anticipated expansion in global nuclear power generation.

In addition to cataloguing resources and trends in the Red Book, the Agency also published guides on environmental impacts and site rehabilitation for uranium mines. It also provided training and expertise to a number of Member States on uranium exploration.

Decommissioning of nuclear facilities

The issue of the decommissioning of nuclear reactors is assuming increasing importance in many States. In this connection, the Agency provides guidance on when to choose decommissioning over licence renewal, and on the decommissioning process itself, in addition to encouraging the exchange of best practices among Member States. Seventy-nine (18%) of the 443 reactors operating at the end of 2005 had been in operation for more

[1] The 24 members of INPRO are: Argentina, Armenia, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Netherlands, Morocco, Republic of Korea, Pakistan, Russian Federation, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the European Commission.

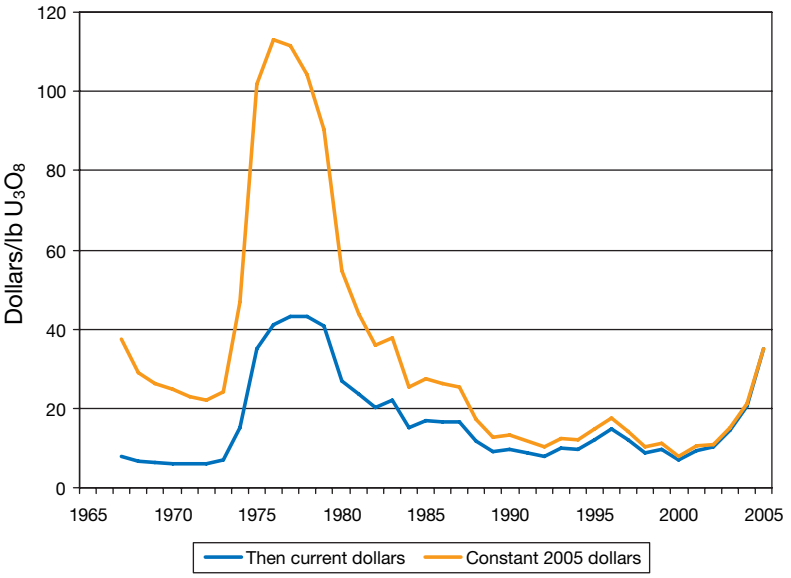

FIG. 2. Uranium prices, 1967–2005.

than 30 years, while a further 63 reactors (14%) had been in operation for more than 25 years. There are two basic decommissioning options — immediate dismantling and long term safe enclosure followed by dismantling. In 2005, decommissioning of the Trojan and Maine Yankee nuclear power plants in the USA was completed, and both sites were released for unrestricted public use. Thus, by the end of 2005, eight power plants around the world had been completely decommissioned, with their sites released for unconditional use. Seventeen power plants have been partially dismantled and safely enclosed, 31 are being dismantled prior to eventual site release, and 30 nuclear power plants are undergoing minimum dismantling prior to long term enclosure.

Spent fuel and waste management

The long term management and disposal of spent nuclear fuel remains a challenge for the nuclear power industry. Indeed, any global expansion of nuclear power will be dependent on public perceptions of the safety of radioactive waste management.

The Agency helps build capacity in geological disposal through its Network of Centres of Excellence on Training and Demonstration of Disposal Technologies in Underground Research Facilities. Sweden recently joined the network's core group of donor countries, which includes Belgium, Canada, Switzerland, the United Kingdom and the USA. Finland, Sweden and the USA are furthest along in developing geological repositories for their spent nuclear fuel.

Regarding the disposal of low and intermediate level radioactive waste, noteworthy developments took place during the year in Belgium, Hungary and the Republic of Korea. In Belgium, two communities voted to become candidate sites for a national low level waste (LLW) repository. In Hungary, residents of Bataapati voted to host the country's final repository for LLW and intermediate level waste (ILW), which was subsequently approved by the Hungarian Parliament. And in the Republic of Korea, Gyeongju offered to host the site for the first national LLW and ILW repository. The Gyeongju siting process was reviewed positively in 2005 by the Agency under its Waste Management Assessment and Technical Review Programme. All of these proposed sites should be licensed and operational within the next decade.

Conversion of research reactors

The Agency has been involved for more than twenty years in reducing the amount of high enriched uranium in civilian use. In 2005, the number of requests for Agency assistance in relation to the conversion of research reactors from using high enriched uranium to low enriched uranium fuel increased considerably, with technical cooperation projects in Bulgaria, Kazakhstan, the Libyan Arab Jamahiriya, Portugal, Romania, Ukraine and Uzbekistan. In addition, a project for the production and qualification of low enriched fuel elements for the conversion of Chilean research reactors was completed, allowing the continued conversion of the La Reina research reactor.

Fusion technology

In June, international efforts in developing fusion technology took a significant step forward with the signing of a joint declaration — by China, the European Union, Japan, the Republic of Korea, the Russian Federation and the USA — to build the International Thermonuclear Experimental Reactor (ITER) in Cadarache, France. This declaration signalled a new stage — the scientific and engineering demonstration of fusion technology for power production. India subsequently became the seventh member of ITER. In December, the ITER Joint Work Site in Cadarache was formally inaugurated.

Nuclear knowledge management

The management of nuclear knowledge has emerged as a growing challenge in recent years. In particular, the ageing of the work force in many areas of nuclear applications is becoming a matter for serious concern for a number of Member States. In these countries new technical staff must be recruited to replace retirees. A new generation of nuclear scientists and engineers is also needed in countries planning to expand the use of nuclear power and non-power applications.

Agency support includes service missions, such as a joint mission with WANO in 2005 to acquire and preserve a range of undocumented information at the Krško nuclear plant in Slovenia. And the first Summer Institute of the World Nuclear University was held in Idaho Falls, USA, in July and August 2005 with the support of the Agency. Courses for the 75 students from 33 countries covered such topics as world energy demand and supply, nuclear technology for sustainable development, nuclear law, radiation protection, waste management and non-proliferation.

One of the Agency's initiatives to preserve and maintain nuclear knowledge is the International Nuclear Information System (INIS), which has been expanding at a record pace. Over 100 000 bibliographic records and more than 250 000 electronic full text documents were added to INIS in 2005 alone. Students at 273 universities now have free access to the INIS database, and the system has grown to nearly 1 million authorized users.

In December 2005, the Agency established *Nucleus*, an information gateway, or 'portal', to provide one common access point for individuals in government, industry, the scientific community and members of the public to the Agency's nuclear knowledge and information resources.

Applications of nuclear science and technology

Promoting better health for children

Out of every ten children born in developing countries, one will die before his/her fifth birthday. This tragic statistic reflects the vulnerability of infants and young children to poor nutrition and calls for urgent actions to reduce this mortality rate.

The Agency's contribution to this goal takes the form of technical guidance and assistance to Member States in the use of stable (i.e. non-radioactive) isotope techniques as part of nutrition intervention programmes to combat under-nutrition of children. Currently, the Agency supports nutrition projects focusing on infants and young children in several African Member States. In Ghana and Madagascar, it is assisting in the evaluation of nutrition interventions and the introduction of complementary foods. In Burkina Faso, it is focusing on nutrition supplementation for children affected by malaria.

These efforts have been further strengthened by the creation of the "IAEA Nobel Cancer and Nutrition Fund" (Nobel Fund) for cancer and nutrition related fellowships in the developing world, as well as the Agency's increasing cooperation with WHO. The aim of the Nobel Fund is to expand human resources capacity and skills in developing regions of the world — through the granting of fellowships and through training courses beyond the scope of regular Agency activities in these areas — in cancer management, radiation oncology and nutrition. Some of these activities will be carried out under the Agency's Programme of Action for Cancer Therapy (PACT).

Strengthening global analytical capabilities

The radiological assessment of areas that might be affected by radioactive releases, including accidental discharges, is vital for developing appropriate remediation strategies. In this regard, the Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) — a global network of expert laboratories to provide worldwide radiological emergency assistance coverage — continued to grow in 2005. With the addition of 31 laboratories, the network now comprises 104 members from 66 countries.

Using mutation induction to produce better food crops

Over 25 new and improved varieties of staple food crops — including eight new varieties of rice in Vietnam, as well as wheat and millet — were released in 2005. This brings the total number of

Programme of Action for Cancer Therapy

Cancer is the second most common cause of death worldwide after cardiovascular disease. Over seven million people died of cancer in 2005, and close to eleven million new cancer cases were diagnosed, according to the WHO. More than 70% of cancer deaths now occur in low and middle income countries — the very countries least able to address this growing burden. Cancer related deaths are projected to increase to more than nine million people annually by 2015.

The Agency spends about $12 million each year through its technical cooperation programme for improving cancer treatment in the developing world. To enhance and expand these efforts, it formally established the Programme of Action for Cancer Therapy (PACT). The immediate goals are to build partnerships with interested parties working in the area of cancer control and to acquire funds from a range of traditional and non-traditional donors. In addition, the Nobel Fund will also be utilized to help developing countries deal with the dramatic rise in cancer.

PACT is establishing a "Cancer Control Alliance" with WHO, the International Agency for Research on Cancer, the International Union against Cancer, the US National Cancer Institute and the American Cancer Society. The aim is to develop and implement comprehensive cancer control programmes in Member States with funding attracted by the Alliance.

varieties released in Member States, using the technique of mutation induction by radiation, to 2300. A mutant rice variety introduced earlier in Vietnam with high quality and tolerance to salinity became the key rice variety for export in 2005, accounting for 28% of the one million hectares export rice area in the Mekong Delta.

Maintaining freedom from rinderpest

Agency cooperation with the Global Rinderpest Eradication Programme in annual serological surveillance continued in 2005, helping to achieve and maintain rinderpest-free status in a number of African countries. The tests used in surveillance involve nuclear related methods and technology involving radioisotopes for differential diagnosis. Mongolia and Yemen used surveillance guidelines for the last stages of their rinderpest eradication campaigns and for the subsequent submission of dossiers for recognition of freedom from this disease by the Office International des Epizootes (OIE). Such recognition means that vaccination has ceased, saving millions of dollars every year for affected Member States.

Managing scarce water resources

A crucial factor in improving living standards around the world is access to safe drinking water — a basic necessity that is unavailable to more than one sixth of the world's population. The transfer of isotope and related nuclear techniques through the Agency's technical cooperation programme has enabled Member States to substantially expand their capacity to map underground aquifers, detect and control pollution, and monitor the safety of dams. In 2005, for the first time, the Global Environment Facility and UNDP provided funds ($1 million) for an initiative that, in parallel with an Agency regional technical cooperation project, will assist Chad, Egypt, the Libyan Arab Jamahiriya and Sudan in improving their management of the Nubian Sandstone Aquifer — one of the world's largest underground sources of water.

Recent technological developments — resulting in easier and cheaper means for measuring isotopes in hydrological samples — combined with partnerships with other agencies and international programmes have allowed the Agency to assist a greater number of Member States in managing their water resources. One example was in Bangladesh, where a joint IAEA–World Bank isotope investigation led to an alternative source of water, eliminating the need for a water treatment system and saving millions of dollars in capital and system operation costs.

Safety and Security

Safety: Status and trends

The operational safety performance of nuclear power plants remained high throughout the world in 2005. Radiation doses to workers and members of the public from the operation of these plants were well below regulatory limits. Personal injury accidents and incidents were among the lowest in industry. There were no accidents that resulted in the release of radiation that could adversely impact the environment. Nuclear power plants in different parts of the world successfully coped with the disruption caused by natural disasters. The Agency continued

its efforts to ensure that nuclear safety remained at high levels, and to guard against complacency by the industry and governmental authorities.

Research reactors also maintained a good record of safe operation during the year. However, in many cases, resources are not available to adequately deal with potential safety challenges. This concern applies to both the operators and regulatory bodies responsible for research reactor safety.

Key occupational radiation protection performance indicators once again showed improvement in 2005. Most Member States now have in place some form of individual and workplace monitoring programmes for occupationally exposed workers. Rapid advances in and the increasing application of medical techniques using radiation continue to challenge radiation protection specialists, both in terms of protecting personnel performing the techniques and patients undergoing treatment. Many Member States, as well as manufacturers and suppliers, are increasingly proactive in their approaches to radioactive source safety. However, serious incidents involving the safety and security of medical and industrial sources continue to occur, emphasizing the need to continue to work to promote the application of safety standards.

The good safety record for the transport of radioactive material was maintained in 2005. Work continued on the issue of ensuring shipments of radioactive material intended for use in medical diagnosis and treatment, as well as on improving communication among governments on the transport of radioactive materials.

The Agency is responding to all of these issues through its extensive range of safety services, by helping to strengthen the global nuclear safety regime — including the provision of assistance for the implementation of international legal instruments and regulatory infrastructures — and by facilitating the exchange between Member States of best practices and lessons learned.

Safety services

Integrated and customized safety services and safety reviews are provided by the Agency at the request of Member States as a means to facilitate the application of the Agency's safety standards and increase the level of nuclear, radiation, transport and waste safety. In 2005, the Agency conducted more than 120 safety review missions to Member States, covering topics as varied as nuclear power plant operational safety, radiation source safety and security, nuclear and radiation safety infrastructure, and transport safety. The Agency also organized four international conferences and a number of training courses, seminars and workshops addressing all aspects of nuclear safety and security. The focus of training continues to be on training the trainers, and a number of new training packages have been developed and made available to Member States.

Strengthening international legal instruments

International safety related legal instruments are essential to establishing and maintaining high levels of safety around the world. The Agency has continued its efforts to promote adherence by States to these instruments.

The competent authorities identified under the Convention on Early Notification of a Nuclear Accident (Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention) met in Vienna in July to review progress and approve proposals relating to strategies for enhancing international assistance and international communication. They also agreed on a proposal for enhancing the existing drill and exercise schedule.

To meet its responsibilities under these conventions, the Agency established an Emergency Response Centre in 1986. Based on the experience gained, an expanded Incident and Emergency Centre (IEC) was set up in 2005. The IEC serves as the focal point for States to report emergencies and other events. It also facilitates the exchange of information between States on preparedness and response, and reporting of nuclear security incidents. In view of the Agency's obligations under the Early Notification and Assistance Conventions, the IEC will need to be upgraded with state of the art equipment that is also compatible with equivalent facilities in Member States and other international organizations

With India's ratification of the Convention on Nuclear Safety (CNS) in 2005, all countries in the world with operating nuclear power plants are now Contracting Parties to the CNS. In April, the Contracting Parties met in Vienna for their 3rd Review Meeting. The participants conducted a peer review of national reports submitted in accordance with the terms of the CNS. They also issued a summary report identifying good practices and progress made.

By the end of 2005, 79 countries had expressed their support for the Code of Conduct on the Safety and Security of Radioactive Sources. The Agency

held a meeting in Vienna in December for States to share experience in implementing the supplementary guidance on the import and export of radioactive sources.

Chernobyl Forum

In 2005, the Chernobyl Forum[2] completed its work and agreed on the findings of two technical reports, one on the environmental consequences of the Chernobyl accident and the other on its health effects. These, as well as the digest report including socio-economic impacts, were presented at a conference entitled 'Chernobyl: Looking Back to Go Forwards', which was organized by the Agency on behalf of the Forum in Vienna in September 2005. The reports concluded that while the accident had significant environmental, public health and socioeconomic impacts, the mitigation measures taken by the authorities — including evacuation of people from the most contaminated areas — substantially reduced radiation exposures and the radiation related health impacts of the accident. Since 1986, radiation levels in the environment have declined several hundred-fold because of natural processes and countermeasures. Therefore, the majority of the "contaminated" territories are now safe for settlement and economic activity.

In addition to assessing consequences of the Chernobyl accident, the Forum also made recommendations for future activities. The major challenge now is to effectively deal with the socioeconomic consequences of the accident, but certain monitoring, remediation and research activities in the health and environmental fields will need to continue. An additional priority, after the construction of the "New Safe Confinement" structure over the destroyed Unit 4, is the decommissioning of the reactor as well as the gradual remediation of the Chernobyl Exclusion Zone.

Nuclear security

The security of nuclear and other radioactive material and associated technologies has taken on heightened significance in recent years. In the process, it has become necessary to re-evaluate the risks of terrorism in all its forms. International cooperation has become the hallmark of these security efforts. Such cooperation is also essential for efforts to build regional and global networks for combating transnational threats.

The Convention on the Physical Protection of Nuclear Material (CPPNM) was substantially strengthened during the year at a conference where States Parties agreed to amend the CPPNM to also protect nuclear facilities and material in peaceful domestic use, storage and transport. The Amendment to the CPPNM adopted at the conference also provide for expanded cooperation between States in locating and recovering stolen or smuggled nuclear material, mitigating any radiological consequences of sabotage, and preventing and combating related offences.

The United Nations General Assembly adopted the International Convention for the Suppression of Acts of Nuclear Terrorism ('Nuclear Terrorism Convention') in April 2005. The Convention details offences relating to unlawful and intentional possession and use of radioactive material or a radioactive device, and use or damage of nuclear facilities. It also requires "States Parties to make every effort to adopt appropriate measures to ensure the protection of radioactive material, taking into account relevant recommendations and functions of the International Atomic Energy Agency". By the end of 2005, 97 States had signed the Convention.

Despite the increased level of attention given to the security of nuclear and other radioactive material and associated facilities since 2001, many countries still lack the programmes and the resources to effectively respond to the threat of nuclear and radiological terrorism. The efforts of the Agency to help Member States increase their nuclear security continued in 2005 on multiple fronts. More than 25 nuclear security missions and 18 nuclear security training events were conducted in States during the year. Also, the implementation of the Plan of Activities to Protect Against Nuclear Terrorism, approved by the Board of Governors in 2002, was completed, resulting in: better trained staff in States; improved radiation monitoring capabilities at border crossings; the recovery of nearly 70 radioactive sources; and an overall improvement in the preparedness of States in addressing the risk of malicious acts involving nuclear and other radioactive material. In September, the Board of Governors approved a new Nuclear Security Plan for implementation between 2006 and 2009.

[2] The Chernobyl Forum was set up in 2003 by the Agency in cooperation with FAO, OCHA, UNDP, UNEP, UNSCEAR, WHO and the World Bank, as well as representatives of Belarus, the Russian Federation and Ukraine.

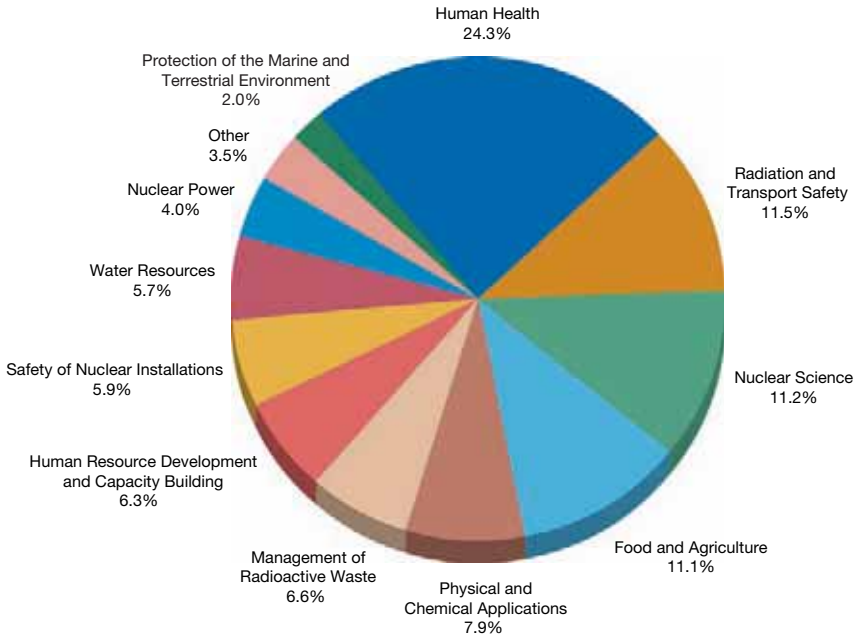

FIG. 3. Technical cooperation disbursements by Agency programme in 2005.

Technology Transfer and Cooperation

The technical cooperation programme is key to fulfilling the Agency's mandate "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". Under this programme, the Agency transfers nuclear science and technology to developing Member States, primarily through the provision of training, expert advice and equipment. The aim is to build, strengthen and maintain capacity in States for using nuclear technology in a safe, secure and sustainable manner. The areas of focus in 2005 were: human health, human resource development, radiation and transport safety, food and agriculture, nuclear science, physical and chemical applications, water resources, and management of radioactive waste (Fig. 3).

The programme is funded by voluntary contributions to the Technical Cooperation Fund, extrabudgetary contributions, cost sharing and contributions in kind. All of these resources are applied directly to development projects. In 2005, $73.6 million were disbursed in over 100 countries; 104 training courses were arranged for 1574 participants; 2433 expert missions were organized, 1011 fellowships were offered, 425 scientific visits were arranged, and $33 million worth of equipment and supplies were disbursed.

Verification

The Agency's activities in the area of verification are at the centre of efforts to curb nuclear proliferation. Agency safeguards agreements are in force in 156 States, comprising comprehensive safeguards agreements (CSAs) in 148 non-nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), voluntary offer safeguards in five NPT nuclear-weapon States, and item specific safeguards in three States not party to the NPT. In all, approximately 900 nuclear facilities in some 70 countries are subject to Agency inspections.

For the year 2005, the Agency concluded that for the 156 States with safeguards agreements, declared nuclear material, facilities or other items or material to which safeguards were applied remained in peaceful activities, with the exception of the Democratic People's Republic of Korea where no verification activities have taken place since 2003 and for which no safeguards conclusions could be drawn. In 24 of these States with both CSAs and additional protocols in force or being otherwise applied, the Agency found no indication of the diversion of declared nuclear material from peaceful activities and no indication of undeclared nuclear material and activities, and concluded, on this basis, that for those States, all nuclear material remained in peaceful activities. The Agency continued its

efforts to verify the correctness and completeness of the declarations for one State that had been found to have been previously engaged in undeclared nuclear activities, which the Board, in 2005, found to constitute non-compliance. The Agency's *Safeguards Statement*, as well as the *Background to the Safeguards Statement* and *Executive Summary*, are available on the CD-ROM attached to the inside back cover of this report, and also on the Agency's public web site at *http://www.iaea.org/OurWork/SV/Safeguards/index.html*.

The Agency cannot draw any safeguards conclusion in respect of 36 non-nuclear-weapon States party to the NPT that do not have CSAs in force.

Strengthening the safeguards system

Safeguards agreements and additional protocols

Safeguards agreements and the measures contained in the Model Additional Protocol to Safeguards Agreements, approved by the Board of Governors in May 1997, provide the essential elements of a significantly strengthened Agency safeguards system. The implementation of CSAs and additional protocols provides the basis upon which the Agency is able to provide credible assurance regarding the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities for a State as a whole. The Secretariat continues to promote and facilitate wider adherence to the safeguards system, bearing in mind the importance of achieving the universal application of that system consistent with the respective safeguards undertakings of States.

In 2005, the Agency continued its activities to encourage and facilitate wider adherence to the strengthened nuclear safeguards system. Agency outreach events were arranged in New York and Rabat, and three States organized national seminars on additional protocols. Significant progress was made during the year in terms of the conclusion of CSAs and additional protocols. Seventeen States signed additional protocols and eight States signed CSAs during the year. In 2005, CSAs entered into force for four States and additional protocols for nine States. The number of States that have yet to bring their CSAs into force, in accordance with their obligations under the NPT, decreased from 40 to 36 by the end of 2005. The number of States with additional protocols in force increased from 62 to 71 by the end of the year, and two States voluntarily agreed to implement such protocols pending their entry into force.

Integrated safeguards

The Agency continued to move towards a more flexible and effective approach to safeguards implementation, taking into account all aspects of a State's nuclear activities. Integrated safeguards — the optimum combination of all safeguards measures available to the Agency under CSAs and additional protocols — were implemented in nine States in 2005 and approved for another two States. At a meeting to discuss progress on integrated safeguards, States with wide experience of integrated safeguards implementation were able to share their experience with other States for which implementation was due to begin in 2005 or 2006. The Agency continued its efforts to improve the effectiveness and efficiency of safeguards implementation through the introduction of a comprehensive quality management system.

Small quantities protocols

The Board of Governors, recalling its conclusion that the small quantities protocol (SQP) to safeguards agreements in its present form constituted a weakness of the safeguards system, decided in September 2005 to retain SQPs as part of the Agency's safeguards system, but subject to modification of the standard text to provide for the submission of initial reports on nuclear material and notification as soon as a decision has been taken to construct or authorize construction of a nuclear facility, and allow for Agency inspections. The Board also decided that SQPs should no longer be made available to a State with a planned or existing nuclear facility. In addition, the Board requested the Secretariat to assist States with SQPs, including non-members of the Agency, to establish and maintain their State systems of accounting for and control of nuclear material. At the end of 2005, the Secretariat conveyed the Board's decision to States with SQPs with a view to giving effect to the modification of their SQPs. One country signed an SQP based on the modified standard text in 2005.

New approaches to the nuclear fuel cycle

In February, a group of experts appointed — in their individual capacity — by the Director General, released a report on multilateral approaches to the civilian nuclear fuel cycle (MNAs).[3] The report cited

[3] *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency*, INFCIRC/640, IAEA, Vienna (2005).

five approaches to strengthen controls over sensitive nuclear technologies of proliferation concern — uranium enrichment and plutonium separation. The expert group reviewed the various aspects of the fuel cycle, identified a number of options for MNAs deserving further consideration and noted a number of pros and cons for each of the options. The group recommended that attention be given by Member States, by the Agency itself, by the nuclear industry and by other nuclear organizations, to multilateral nuclear approaches. Several Member States welcomed the report and encouraged the Agency to take the next steps towards the implementation of its recommendations, as appropriate. In July, the Agency supported an international conference in Moscow, organized by the Russian Federal Atomic Energy Agency, to consider multilateral approaches to the nuclear fuel cycle. The Director General actively pursued efforts to promote the acceptance of MNAs.

Agency Outreach Efforts

Global developments — particularly in the areas of verification and non-proliferation — as well as its own efforts to raise public awareness have transformed the Agency's visibility and public image over the last few years (Fig. 4). In addition, the award of the 2005 Nobel Peace Prize to the Agency greatly increased media interest and attention. The heightened public awareness and interest in the Agency's work was evidenced by nine million hits per month being recorded to its web site *(http://www.iaea.org)* in 2005 — a factor of ten higher than in 2001.

Conclusion

In his Nobel Lecture on 10 December 2005, the Director General stated that the "Nobel Peace Prize is a powerful message for us — to endure in our efforts to work for security and development". There continues to be a range of challenges facing the Agency and its Member States. These include: the problem of energy shortages in developing countries; exploring acceptable waste management strategies; improving human health and food production; enhancing water resources management; raising the level of global nuclear safety and security; and strengthening the international safeguards and non-proliferation and arms control regime. It is clear that these challenges can only be met through the continuing active partnership of Member States and the Agency. ■

FIG. 4. Public and media attention on the Agency has been heightened by various verification and non-proliferation issues.

Technology


Den Norske Nobelkomite
har overensstemmende med
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ALFRED NOBEL
den 27. november 1895
opprettede testamente tildelt
International
Atomic Energy Agency
Nobels Fredspris
for 2005
Oslo, 10 desember 2005

Nuclear Power

Objective

To enhance the capability of interested Member States to implement competitive and sustainable nuclear power programmes and to develop innovative nuclear technologies for the future.

Engineering and Management Support for Competitive Nuclear Power

Nuclear electricity production has grown almost continuously since the inception of the nuclear industry. Part of this growth is due to the construction of new nuclear power plants, part is due to the uprating of existing plants and part is due to energy availability improvements at existing plants. Since the beginning of the 1990s, when new construction slowed, energy availability improvements and power uprates have become, at the global level, increasingly important factors in expanding nuclear electricity production. From 1990 through 2004, global nuclear electricity production increased from 1901 to 2619 TW·h. Installed nuclear capacity rose from 327.6 to 366.3 GW(e), due to both new construction and uprates at existing facilities. The global average energy availability factor improved from 71.6 to 83.3%. The relative contributions of the three factors to the additional 718 TW·h produced in 2004 (compared with 1990) are shown in Fig. 1.

The results presented in Fig. 1 are based on comprehensive worldwide data available in PRIS, the Agency's database on power reactors. Work in 2005 focused on making PRIS a more practical tool for nuclear power plant performance analyses by improving the interface between the system and end-users. This resulted in improved data consistency and completeness and in better applicability of PRIS statistics. External modules containing data from non-electrical applications of power reactors and information from decommissioning processes of shut down reactors were incorporated as an enhancement of PRIS. The extension of PRIS, together with relevant feedback from users, was documented in 2005 in a report entitled *Power Reactor Information System (PRIS) and its Extension to Non-Electrical Applications, Decommissioning and Delayed Project Information*.

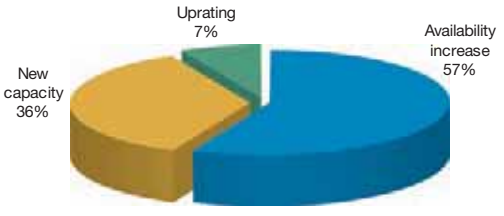


FIG. 1. Contributions to the growth of nuclear electricity production, 1990–2004.

Another effort focused on the modification and enhancement of the Capital Cost Database in the Agency's Nuclear Economic Performance Information System (NEPIS), developed jointly with the Electric Utility Cost Group in the USA, and a pilot project to collect data for the current NEPIS reporting cycle. The database was modified and enhanced by adding detailed cost accounts for significant capital projects on a unit basis, by making the definitions of capital cost accounts consistent with the previous NEPIS definitions (where applicable), and by consolidating all capital cost accounts into one module.

The Asia and Pacific region is one of the most dynamic in the world in terms of nuclear power development. In response to Member State needs, national and regional projects in 2005 under the Agency's technical cooperation programme covered energy planning, infrastructure development, design evaluation for new nuclear power plants, and management improvements to ensure the safe and reliable operation of nuclear power plants. One project study focused on the evaluation of nuclear power and other energy options in achieving sustainable energy development. As a result, Pakistan has adopted a long term development plan to build 8800 MW nuclear power plants over the next 25 years. Indonesia has included nuclear power as an energy option in its National Energy Development Plan, with the possible introduction of the first nuclear power plant in the country by 2016.

An important event in 2005 was the convening of an international ministerial conference on 'Nuclear Power for the 21st Century', organized by the Agency in cooperation with the OECD/NEA, and hosted by the Government of France. The Director General, in his opening remarks, focused on nuclear power's improving global outlook and important role in the world's future energy mix.

The conference included sessions on world energy needs and resources, environmental challenges, driving factors for strategies and choices, and issues of governance. Thirty-two ministerial presentations described different national perspectives and policies on the future of nuclear power. The vast majority of participants who attended the conference affirmed that "nuclear power can make a major contribution to meeting energy needs and sustaining the world's development in the 21st century, for a large number of both developed and developing countries", and that the "IAEA has an essential role to play in facilitating the development and use of nuclear energy for peaceful purposes, in ensuring compliance with peaceful use undertakings, in assisting States in maintaining high levels of safety and security, in fostering international cooperation and in disseminating to the public information on nuclear energy."

After the tsunami of December 2004, the Agency organized a special workshop on external flooding hazards at nuclear power plants. Held in Kalpakkam, Tamil Nadu, together with the Indian Atomic Energy Regulatory Board and Nuclear Power Corporation of India Ltd, the workshop focused on the exchange of experience and the collection of technical information arising from the tsunami.

To increase Member State capabilities in the planning and implementation of nuclear power programmes, and in establishing and enhancing national nuclear power infrastructures, the Agency prepared reports on the minimum infrastructure necessary to establish a nuclear power programme, on sharing nuclear power infrastructure, ranging from joint training and research to grid integration, and management issues related to the early closure or licensing renewal of a nuclear power plant. Another publication, on the application to the nuclear industry of human performance improvement principles in organizations, is designed to enhance the capability of Member States to utilize proven practices accumulated, developed and transferred by the Agency for improving personnel performance.

Technology Development for Additional Applications and Expanding Nuclear Power

The Agency's Technical Working Groups on light water, heavy water, fast and gas cooled reactors bring together experts from developing and industrialized Member States to identify key areas for the Agency to provide assistance, documentation and training, and to pool R&D resources from national organizations towards agreed common goals. In 2005, the Agency conducted a training course at the Abdus Salam ICTP in Trieste on natural circulation in water cooled nuclear power plants. And research began on a new CRP on heat transfer behaviour and thermal hydraulics code testing for supercritical water cooled reactors. Planning for this CRP is being coordinated with the OECD/NEA and the Generation IV International Forum Supercritical Water Cooled Reactor Steering Committee.

Partitioning and transmutation with multiple recycling of actinides and long lived fission products can reduce the radiotoxic inventory of waste by over two orders of magnitude. This will allow the confinement of the residual waste to reach levels equivalent to natural uranium within a few hundred years. To study this issue, the Agency prepared a publication on the *Implications of Partitioning and Transmutation in Radioactive Waste Management*.

Activities organized by the Agency to advance the development of small and medium sized reactors (SMRs) are focused on addressing the needs of countries with small grids or limited infrastructure. These activities bring together designers and technologists working on the challenge of overcoming the general economies of scale in reactor design to improve the overall economy and safety of smaller plants. In 2005, the Agency issued a publication on innovative SMRs which presents a range of water cooled, gas cooled, liquid metal cooled and non-conventional SMR designs developed worldwide and examines the technology and infrastructure development needs that are common to the various concepts of such reactors.

One trend in the design and technology development of SMRs is that of small reactors without on-site refuelling. These reactors could operate without reloading and shuffling of fuel for between 5 and 30 years, and possibly longer. A CRP on such reactors started in 2005 and will focus on key technologies, including long life cores, inherent and passive safety features and systems, and design and regulatory provisions to reduce or eliminate off-site emergency planning.

SMRs are of particular interest for desalination in many developing Member States. In India, a nuclear desalination demonstration plant in Kalpakkam has used reverse osmosis for desalination for several years and will be using the multi-stage flash process starting in 2006. In this connection, representatives

from over 15 Member States regularly share experience and identify future areas for work in the forum provided by the Agency's International Nuclear Desalination Advisory Group (INDAG).

In 2005, the Agency published a report on the results of a CRP that examined optimal coupling and desalination systems for nine water cooled reactor designs. The overall conclusion was that all of them can provide the input energy required for various desalination processes, i.e. distillation, osmosis and low temperature evaporation.

To assist with economic evaluations of site specific cases involving various types of nuclear reactors and desalination systems, the Agency's Desalination Economic Evaluation Program (DEEP) software was upgraded and the latest version released. This program incorporates improved plant performance and cost models in both the software's thermal and reverse osmosis modules. For the assessment of nuclear powered desalination against alternatives, DEEP adds the ability to evaluate alternatives fuelled by renewable resources, such as biomass, as well as fossil resources. A final new feature is that DEEP can be downloaded directly over the Internet under a licence agreement with the Agency. Eighty copies of the new version are already in use outside the Agency.

INPRO

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) added two members in 2005 — Ukraine and the USA — bringing the total membership to 24. Tasks in the second part of Phase IB of INPRO, initiated in 2005, includes finalizing the INPRO methodology user's manual, defining and modelling innovative nuclear energy system (INS) deployment scenarios, facilitating INS assessments by Member States, and identifying possible frameworks and implementation options for collaborative R&D. The terms of reference for Phase 2, which will begin midway through 2006, foresee that INPRO will continue in three directions: R&D, institutional/infrastructure, and methodology oriented activities.

FIG. 2. Construction work on the fast breeder reactor at Kalpakkam, in India.

Over the course of the year, the INPRO user methodology, having been revised on the basis of feedback from a variety of past test projects, was applied in multiple contexts. For example, Argentina applied the INPRO methodology to evaluate the introduction of nuclear power in a system with limited grid capacity, India used it to analyse nuclear systems for hydrogen generation, and China, France, India, the Republic of Korea and the Russian Federation applied INPRO methods in a joint study of a closed fuel cycle using fast reactors. Several States that are members of INPRO have progressed to an advanced stage of development in fast reactor technology (Fig. 2). ■

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 and environmentally sound and secure nuclear fuel cycle programmes.

Uranium Production Cycle and Environment

Uranium, the heaviest naturally occurring element in the Periodic Table, is the basic raw material currently used to produce nuclear fuel. The growth potential of nuclear power will, in fact, depend on the adequacy of uranium resources. To survey the current world situation, the Agency organized an international symposium on Uranium Production and Raw Materials for the Nuclear Fuel Cycle in Vienna in June. The symposium, held in cooperation with the OECD/NEA, World Nuclear Association, Nuclear Energy Institute and the UNECE, was held at a time when the uranium industry is poised for a take-off after a slump of nearly two decades characterized by low prices and mine closures. The increased demand for uranium has led to a near tripling of uranium prices over the last three years. As a result, new exploration and mining activities have been initiated and the major uranium producers have increased their annual production.

The consensus of the participants was that uranium resources, including both primary and secondary supplies, are adequate to meet the immediate projected demand of uranium to fuel expanding nuclear power programmes up to the year 2050 and beyond. However, the gap between uranium in the ground and the availability of yellow cake (uranium concentrate) has to be narrowed. Airborne and ground exploration based on new geophysical techniques could pave the way for discovering deeper uranium deposits that do not have a surface expression. In addition, new mines and mills are required. Expansion of in situ leach (ISL) mining activities and the development of smaller, more efficient equipment for use in deep underground mining were some of the technological pathways that were highlighted to ensure the timely delivery of uranium concentrate to the market place.

The biennial IAEA–OECD/NEA "Red Book" — *Uranium 2005: Resources, Production and Demand* — introduced a new categorization scheme for resources for consistency with the UNECE's terminology for reporting fossil energy and mineral resources (Fig. 1):

- 'Inferred resources' replaces EAR-I ('Estimated Additional Resources Category I');
- 'Prognosticated resources' replaces EAR-II ('Estimated Additional Resources Category II');
- 'RAR (Reasonably Assured Resources) + inferred resources' are now referred to as 'identified resources'.

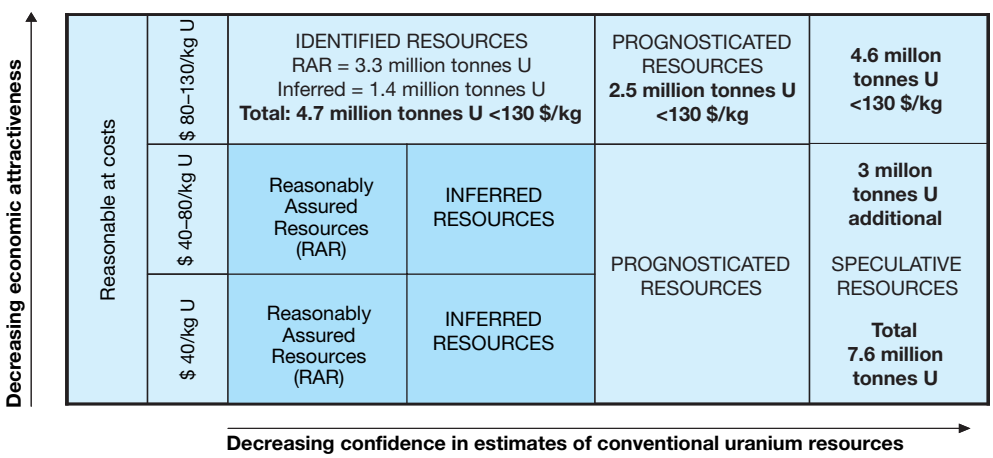


FIG. 1. Classification scheme for conventional uranium resources.

Beginning in the early 1990s, the worldwide exchange of information on uranium resources and production began to improve dramatically. The Agency took the lead in providing forums, particularly for developing countries, to discuss uranium resources and production capabilities. The proceedings of two such forums were published in 2005: *Developments in Uranium Resources, Production, Demand and the Environment* (IAEA-TECDOC-1425) and *Recent Developments in Uranium Exploration, Production and Environmental Issues* (IAEA-TECDOC-1463).

Given the increasing importance of ISL mining, the Agency also published a *Guidebook on Environmental Impact Assessment for In Situ Leach Mining Projects* (IAEA-TECDOC-1428). Aimed at both companies planning uranium development and the authorities that will assess such developments, the report provides advice on each of the three main guidelines for an environmental impact assessment: justifying the proposed practices, limiting effluents and optimizing protection and safety.

In addition to sharing information and giving advice and guidance to Member States, the Agency provides assistance through its technical cooperation programme. For example, in 2005, expert teams visited three Member States and provided:

- Assistance on exploration techniques and prospecting for sandstone-type uranium deposits;
- Training for personnel in the use of special software for the digital documentation of drill holes;
- Training for personnel in mineralogy and the geochemistry of uranium deposits.

Nuclear Fuel Performance and Technology

The trend of increasing fuel burnup, with higher ratings and longer dwell time in nuclear power plants, requires improved modelling of fuel behaviour (Fig. 2). A CRP which studied fuel modelling at extended burnup (FUMEX-2) was concluded. Its central accomplishment was to significantly extend the capability of fuel codes used in Member States to accurately predict fuel performance at high burnups, both for normal operation and under transient conditions.

Another CRP completed in 2005 — 'Data Processing Technologies and Diagnostics for Water Chemistry and Corrosion Control in Nuclear Power Plants' (DAWAC) — provided a better understanding of water chemistry control for efficient and safe plant operation with increased fuel burnup, longer fuel residence times and fewer failures. Specifically, the CRP led to improvements in both analytical models and operational practice using the information developed on water chemistry control techniques, plant chemistry, corrosion diagnostics and plant monitoring of corrosion, chemistry and coolant activity.

To assist Member States in developing tools to assess fuel reliability, the Agency launched a new CRP on delayed hydride cracking (DHC) in

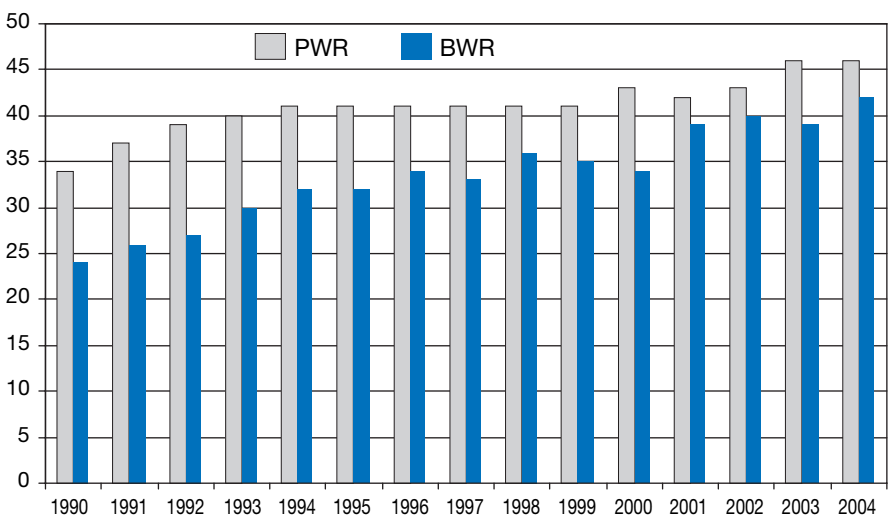


FIG. 2. Average discharge burnup (in GW·d/tonnes uranium) at nuclear power plants in the USA, 1990–2004.

zirconium alloy cladding materials. In 2005, the pin loading tension testing methodology for the CRP was established and pre-hydrided zircaloy-4 samples were distributed to ten participating laboratories for round robin measurements of DHC velocity. The study will apply comparable procedures for studies of a variety of cladding materials of different origins.

Management of Spent Fuel from Power and Research Reactors

Half a century of experience with the storage of spent fuel, together with continuing technical advances, means that political and public deliberations on its ultimate disposition can be thorough and informed. At the beginning of 2005, 190 000 t HM (tonnes heavy metal) of spent fuel were in storage facilities around the world; capacity must be provided for an additional 8000 t HM per year for the immediate future. An accelerated global expansion of nuclear power will add to that estimate.

The Agency plays a central role in building up the technical knowledge base for the long term storage of power reactor spent fuel. Its efforts have included a series of CRPs on spent fuel performance assessment and research. The latest CRP held its initial Research Coordination Meeting in 2005 to review national activities on long term spent fuel storage and specific research proposals. Other important meetings convened by the Agency addressed advances in applications of burnup credit to enhance spent fuel transport, storage, reprocessing and disposition, and the handling of damaged fuel. The latter reviewed past experience and existing practice, and prepared recommendations for handling damaged spent fuel. A further meeting, in the Republic of Korea, on spent fuel treatment options reviewed alternative technologies and applications.

A new publication — *Technical, Economic and Institutional Aspects of Regional Spent Fuel Storage Facilities* (IAEA-TECDOC-1482) — elaborates on one of the options in the report of the Director General's Expert Group on Multinational Approaches to the Nuclear Fuel Cycle (see the Safeguards chapter). States that have small nuclear power programmes or only research reactors, and hence no possibility for early disposal, face the challenge of arranging extended interim storage of their spent nuclear fuel. Access to an interim storage facility provided by a third country would be a desirable solution, and the report concludes that the regional concept is technically feasible and economically viable.

Argentina, Brazil, Chile, Mexico and Peru share the problem of adequately managing the spent fuel from their research reactors which have been in operation for several decades. The fuel from these reactors has been in temporary storage in reactor pools and there are no final disposal facilities in these countries at the moment. In response to these concerns, the Agency implemented a regional technical cooperation project on the management of spent fuel from research reactors. Some of the major achievements of this project were the establishment of national capabilities for the characterization and monitoring of spent fuels, and publication of a report on options for the back end and management of spent fuel.

Information Systems and Related Issues

The Agency's NFCIS web site (*http://www-nfcis.iaea.org/*) consists of the Nuclear Fuel Cycle Information System (NFCIS), World Distribution of Uranium Deposits (UDEPO), Post-Irradiation Examination Facilities (PIE) and the Nuclear Fuel Cycle Simulation System (VISTA). Another database on Material Properties of Minor Actinides (MADB) is currently being developed. An example of the information contained in NFCIS is shown in Fig. 3. The database also includes facilities that are shut down, in standby or being planned.

A Technical Committee Meeting on 'Fissile Material Management Strategies for Sustainable Nuclear Energy' was organized in Vienna in September. Three key issues papers were presented: uranium demand and supply through 2050; fissile material management strategies for sustainable nuclear energy, including backend fuel cycle options; and sustainable nuclear energy beyond 2050. The meeting provided a comprehensive review of global uranium resources, emphasized the need for augmenting uranium exploration, mining and milling, and highlighted the relative merits of different fuel cycle options.

The reprocessing of spent fuel in several countries has generated large inventories of reprocessed uranium (RepU) and plutonium. The Agency initiated activities to provide Member States with information on the status of RepU and viable options for its use, and the status and viability of recycling plutonium in the form of inert matrix

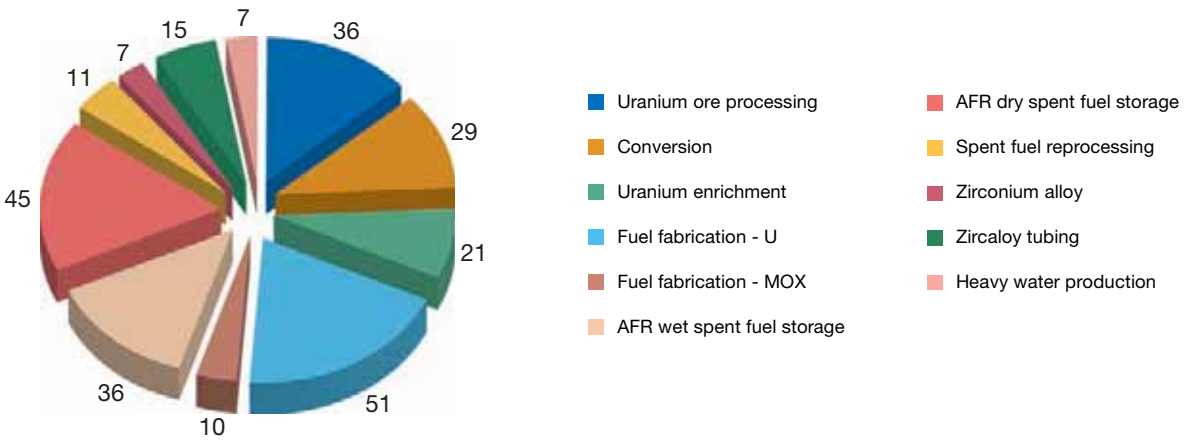


FIG. 3. Number of operating nuclear fuel cycle facilities in 2005. (AFR: away from reactor; MOX: mixed oxide.)

fuels (IMFs) for burning plutonium and reducing inventories. The inert matrixes under consideration are aluminium, zirconium, magnesium and their oxides and mixed oxides, silicon carbide, zirconium alloys and stainless steel. Reports on RepU and IMF are in the final stages of review and publication.

The liquid metal cooled fast reactor (LMFR) and its fuel cycle can play an important role in ensuring efficient use of uranium and thorium raw materials, and in reducing radiotoxicity in the final waste for geological disposal. To promote information exchange and collaboration, the Agency organized a technical meeting in Obninsk, the Russian Federation, on LMFR fuels and fuel cycle options. The status of mixed uranium plutonium oxide conventional fuel and advanced LMFR fuels, namely mixed uranium–plutonium monocarbide, mixed mononitride, and U–Pu and U–Pu–Zr metallic fuels, and their reprocessing by aqueous and pyro-routes, were discussed. One of the conclusions of the participants was that for the short term, i.e. through 2030, mixed oxide fuel was the preferred option. For the longer term, advanced fuels with higher heavy metal density (for better breeding) are under consideration, including metal and nitride fuels. Inert matrix fuels are being considered for burning actinides, in general, and for the disposition of plutonium, in particular.

Thorium is three to four times more abundant than uranium. In the early years of nuclear energy generation, there was considerable interest in thorium to supplement uranium reserves, but interest waned with the discovery of new uranium deposits and as nuclear expansion slowed. More recently, interest has revived due to such issues as proliferation resistance, longer fuel cycles, higher burnup, improved waste form characteristics, reducing plutonium inventories and in situ use of bred-in fissile material.

Over the past years, a number of States have embarked on national programmes to reduce the use of high enriched uranium (HEU) in their civilian nuclear fuel cycle. An Agency publication — *Management of High Enriched Uranium for Peaceful Purposes: Status and Trends* (IAEA-TECDOC-1452) describes the conversion of 31 research reactors from HEU to LEU fuel, the Russian Federation's programme to reduce research reactor fuel to less than 20% uranium-235, and fuel repatriation programmes of the Russian Federation and the USA. ■

Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development

Objective

To enhance the capacity of Member States to perform their own analyses regarding electricity and energy system development, energy investment planning and energy–environment policy formulation; to maintain and enhance the information and knowledge resources concerning the peaceful uses of nuclear energy; and to keep the nuclear option open for Member States who wish to retain it.

Capacity Building and Energy Economics Environment (3E) Assessments

Agency projections of global nuclear power development, published in 2005, show a considerable increase in world nuclear power capacity by 2020 and beyond. Most of the development is expected in the Far East and South Asia. Table 1 shows low and high projections. The low projection considers only firm plans announced by governments and power utilities for: (a) construction of new nuclear power plants; (b) licence renewals for existing plants; and (c) the retirements of old plants. The high projection includes the additional nuclear power plants indicated in the long term plans of governments and utilities that were judged plausible at an expert meeting convened by the Agency. The updated projections are available on the Agency's web site at *http://www.iaea.org/OurWork/ST/NE/Pess/RDS1.shtml*.

The Agency regularly updates and enhances its energy–environment analysis tools on the basis of feedback from users in Member States and the recommendations of experts. In this regard, a new version of the Agency's Model for Analysis of Energy Demand (MAED) was completed in 2005. The most prominent feature of the new version is its flexibility in analysing the structure of energy use on the basis of a particular economy and energy

Table 1. Agency Projections for Global Nuclear Power Development

Country group	2004			2010 [a]			2020[a]			2030[a]		
	Total elect. GW(e)	Nuclear		Total elect. GW(e)	Nuclear		Total elect. GW(e)	Nuclear		Total elect. GW(e)	Nuclear	
		GW(e)	%		GW(e)	%		GW(e)	%		GW(e)	%
North America	1055	111.3	10.6	1099	116	11	1194	118	10	1318	115	8.7
				1155	117	10	1279	128	10	1422	145	10
Latin America	264	4.1	1.6	303	4.1	1.4	383	6.1	1.6	483	5.8	1.2
				350	4.1	1.2	543	6.1	1.1	828	15.0	1.8
Western Europe	724	125.1	17.3	762	119	16	842	97	11	940	79	8.5
				816	125	15	951	130	14	1118	145	13
Eastern Europe	466	49.4	10.6	469	48	10	505	64	13	543	66	12
				496	51	10	605	78	13	736	97	13
Africa	105	1.8	1.7	115	1.8	1.6	143	2.1	1.5	181	2.1	1.2
				135	1.8	1.3	207	4.1	2	316	9.3	3
Middle East and South Asia	284	3	1	331	9	2.8	430	15	3.6	556	18	3.2
				370	10	2.8	555	27	4.9	811	43	5.3
South East Asia and the Pacific	143			169			213	0.9	0.4	264	0.9	0.3
				184			270	0.9	0.3	391	3	0.8
Far East	651	72.8	11.2	685	82	12	804	113	14	937	131	14
				840	85	10	1167	142	12	1589	183	11
World total Low estimate	**3693**	**367.5**	**10**	**3934**	**380**	**10**	**4515**	**416**	**9.2**	**5223**	**418**	**8**
World total High estimate				**4347**	**395**	**9.1**	**5576**	**516**	**9.3**	**7210**	**640**	**8.9**

[a] Nuclear capacity estimates take into account the scheduled decommissioning of the older units at the end of their lifetime.

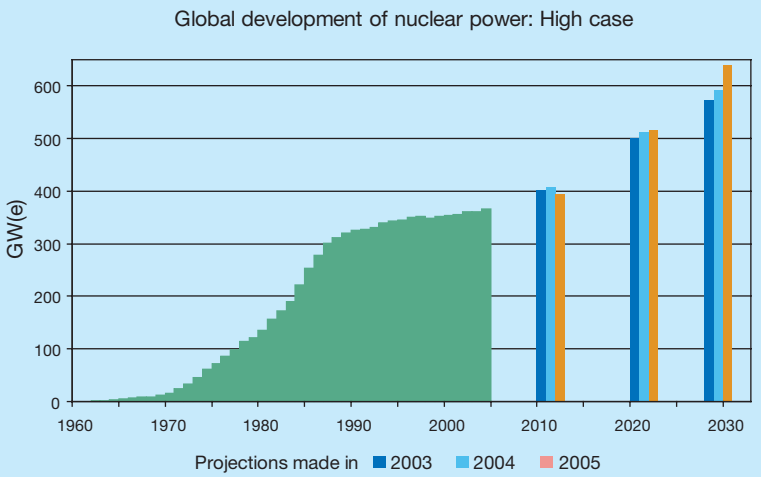
system, making it now more suitable for widely diverse country situations. Enhancements to two other Agency models — MESSAGE (Model of Energy Supply Systems and General Environmental Impacts) and SIMPACTS (Simplified Approach for Estimating Environmental Impacts and External Costs of Electricity Generation) — were also incorporated. The user interface of SIMPACTS was further developed so that SIMPACTS is now available in Arabic, English, French, Spanish and Russian. Enhancements to MESSAGE include the analysis of the nuclear fuel cycle and carbon dioxide capture and storage. A total of 109 Member States are now users of the Agency's energy models. Many international and regional organizations, such as the European Union, OLADE, UNDP, USAID and the World Bank, are also using these models for their energy projects in developing countries.

Capacity building in Member States, for sustainable energy development and energy planning, remained a central focus of Agency efforts in 2005. Driven partly by rising expectations around the world for nuclear power, the Agency received numerous requests from Member States for assistance in conducting energy studies to evaluate future energy options. In 2005, the Agency organized 18 training courses, including interregional, regional and national courses and workshops on energy issues and analytical tools.

Prior capacity building efforts, including training in the use of Agency tools for 3E analysis, were used in a series of national energy system modelling

Building Analytical Capacity in Member States to Meet Future Energy Needs

Governments and industry around the world are considering increased investments in nuclear power. This is reflected in the latest high projection for the global development of nuclear power, prepared by the Agency in 2005 on the basis of government plans and expert estimates.



In this regard, the Agency expanded its capacity building activities for national energy studies, including analyses of the potential role of nuclear power in meeting future energy needs and training. A total of 272 energy professionals from 51 States received such training in 2005.

exercises and analyses, including a study of energy supply security in the Baltic States and studies of energy system requirements in India and Mexico. Further assessments included studies of the cost effectiveness of nuclear power for greenhouse gas mitigation, and an economic assessment of the contribution of nuclear technologies to the economic growth of the Republic of Korea over the last 20 years. An integrated assessment of the economic impacts of an early closure of nuclear power plants in Bulgaria was also completed.

The Agency's project on developing indicators for sustainable energy development resulted in the interagency publication, *Energy Indicators for Sustainable Development: Guidelines and Methodologies*, published jointly with the European Environment Agency, Eurostat, OECD/IEA and UNDESA. The CRP on applying these indicators in several Member States was completed, and the reports of the participating countries are being published by UNDESA, which has been an active partner in this project. A joint IAEA–UNDESA publication containing the seven country reports from the CRP is also being prepared for publication by UNDESA, which intends to distribute both reports at the 14th Session of the UN Commission on Sustainable Development (CSD-14) in May 2006.

The Agency was also active during the year in 'UN-Energy', the new mechanism established after the 2002 World Summit on Sustainable Development (WSSD) to promote coherence among UN agencies in the area of energy. In 2005, UN-Energy published *The Energy Challenge for Achieving the Millennium Development Goals* for the September World Summit in New York. Under the umbrella of UN-Energy, the Agency led a joint project with FAO, UNDESA and UNEP to apply the Agency's models to specific WSSD recommendations. The project includes case studies in Africa and China, with initial results to be presented at CSD-14. The focus on Africa coincides with the growing number of participants from African Member States in the Agency's capacity building activities — 41 in 2005 compared with only 13 in 2001.

The Agency continued its active participation in the activities of the Intergovernmental Panel on Climate Change (IPCC), and also in the 11th Session of the Conference of the Parties to the UN Framework Convention on Climate Change. For example, it contributed to the *Special Report on Carbon Dioxide Capture and Storage*, published by the IPCC in December 2005, and to the IPCC expert meetings on uncertainties and on emission scenarios.

Nuclear Information Management

The Agency's International Nuclear Information System (INIS), celebrating its 35th anniversary, expanded in 2005 at a record pace, adding 116 000 abstracted records and 15 000 electronic documents to its database. This brought the total to over 2.6 million records and 600 000 documents, the greatest annual growth in the history of INIS. The INIS system has grown to nearly 1.3 million authorized users with 438 subscriptions.

Six new members joined INIS in 2005: Burkina Faso, Kyrgyzstan, Haiti, the Middle Eastern Radioisotope Centre for the Arab Countries (MERRCAC), the World Nuclear Association (WNA) and the World Nuclear University (WNU), bringing the total number of participating members to 136 (114 countries and 22 international organizations). A new INIS centre was established in Azerbaijan. In addition, two new technical cooperation projects were started, one to establish an INIS centre in the United Republic of Tanzania and one to upgrade the National Information and Documentation Centre of the Egyptian Atomic Energy Authority.

The Agency is taking a proactive approach in supporting the use of INIS by Member States. For example, in the INIS Training Seminar held in autumn 2005, participants from 28 national INIS centres were trained in INIS operation. Such training is also provided through the INIS Distance Learning Programme. The Agency granted free access to INIS to an additional 33 universities in 2005, bringing the total number to 283.

In cooperation with the national INIS centres, the first electronic version of the *INIS Multilingual Thesaurus* was developed. The number of OECD/NEA computer codes provided over the past 35 years to IAEA Member States reached 10 000.

The Agency is also active in the preservation of information, mainly by digitizing printed information. In 2005, over 1.5 million pages were digitized in close cooperation with the Russian and French INIS centres. In addition, all available materials related to INIS were digitized and published as *INIS Historical Materials*.

The Agency has been assisting African Member States in establishing national and regional capabilities for using information communication technology (ICT) in training and education. Particular emphasis was paid in 2005 to the training of nuclear engineers, computer scientists and technicians. This work was supplemented by train-the-trainer programmes, as well as the provision of

Helping Member States Manage Nuclear Knowledge

Many Member States, confronted with ageing workforces in their nuclear industries, have begun to set up mechanisms to preserve information and knowledge for use by future generations. The Agency has a range of activities focused on the preservation and management of nuclear knowledge. Key areas of work include:

- Providing guidance for policy formulation and for implementation of nuclear knowledge management;
- Pooling, analysing and sharing nuclear information to facilitate creation of knowledge banks;
- Implementing effective knowledge management systems;
- Preserving and maintaining nuclear knowledge;
- Securing sustainable human resources for the nuclear sector;
- Enhancing nuclear education and training.

ICT tele-centres, for the Democratic Republic of the Congo, Mauritius, Morocco and Zambia.

Nuclear Knowledge Management

The maintenance and preservation of nuclear knowledge have continued to be key Agency objectives. In 2005, the focus was on the development of methodology and guidance, on creating a "knowledge management culture" involving governments, industry and academia, and on dedicated projects in knowledge management.

In the area of development of guidance and methodologies for nuclear knowledge management, a workshop was held in August 2005 at the Abdus Salam ICTP, in Trieste, Italy, to share best practices in supporting young nuclear professionals. Two publications were finalized, one on *Knowledge Management for Nuclear Industry Operating Organizations* and the other on *Risk Management of Knowledge Loss in Nuclear Industry Organizations*. In addition, the Agency conducted missions to support the nuclear power plants in Krško, Slovenia, together with WANO, and Kozloduy, Bulgaria, to help develop a strategy for knowledge management.

As part of its work in knowledge management, the Agency helped to organize a regional meeting with AFRA Member States. The meeting focused on national strategies for human resources development, including retention of skills, succession plans, and management and preservation of nuclear science knowledge and technology.

Agency activities in the area of preservation of knowledge included the production of a DVD containing documents on experience and the lessons learned from the Chernobyl accident. Under the Fast Reactor Knowledge Preservation (FRKP) Initiative, a structured process for collecting data and knowledge on fast reactors was established, and fast reactor taxonomies are being developed, together with specifications for the FRKP Internet portal that will eventually make the collected data and knowledge accessible to all members of this initiative.

Tools and services are being developed for better access to information and knowledge. For example, two new web services, 'Find-An-Expert' and 'Ask-An-Expert', were started. In December, a new information and knowledge portal — *Nucleus* — was set up by the Agency to facilitate access to a range of nuclear information.

Nuclear Science

Objective

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

Atomic and Nuclear Data

The year 2005 was declared as the "World Year of Physics", in part to commemorate the 100th anniversary of Albert Einstein's groundbreaking papers on the theory of relativity, the photoelectric effect and the theory of Brownian motion. To mark this occasion, the Agency examined the contributions of nuclear physics towards sustainable development during the Scientific Forum of the General Conference in September. There was agreement that applications of nuclear science continue to grow. The entire spectrum of nuclear science and technology is deeply rooted in atomic and nuclear physics data, with the Agency being the main source of up to date information in this area. For example, evaluated nuclear reaction data standards and a separate file for thorium-232 have evolved from Agency projects, and have been adopted for the US Evaluated Nuclear Data File (ENDF/B-VII) library. The Agency's thermal scattering law library for major moderators and the iron-58 resonance evaluation were included in the Joint Evaluated Fission and Fusion (JEFF-3.1) library that was released in 2005. In response to user requests in Member States, updated libraries were released for reactor lattice calculations in WIMS-D format for neutronics calculations of fusion devices, and a pilot library for accelerator driven systems was also prepared.

Plans to build a code centre network of database resources were formulated after a technical discussion between specialists with extensive expertise in computational methods for the generation of data for atomic and molecular (A+M) physics. The specialists agreed to make their resources available in support of this Agency based fusion research activity. Two CRPs, one on data for molecular processes in edge plasmas and another on plasma diagnostics for fusion research, were also concluded in 2005. Review articles are being published in separate issues of the journal Atomic and Plasma-Material Interaction Data for Fusion, and electronic data files were submitted for inclusion in the Agency's A+M databases. The new data generated from both of these CRPs have also been used to model fusion plasmas using several internationally developed computer codes.

The Agency provides data users in Member States with cost free access to the most important basic numerical data needed in a wide range of energy and non-energy applications. The strong increase in requests for these nuclear data services continued in 2005 (Fig. 1).

The experimental atomic and nuclear databases obtained from the most recent measurements performed at nuclear physics laboratories

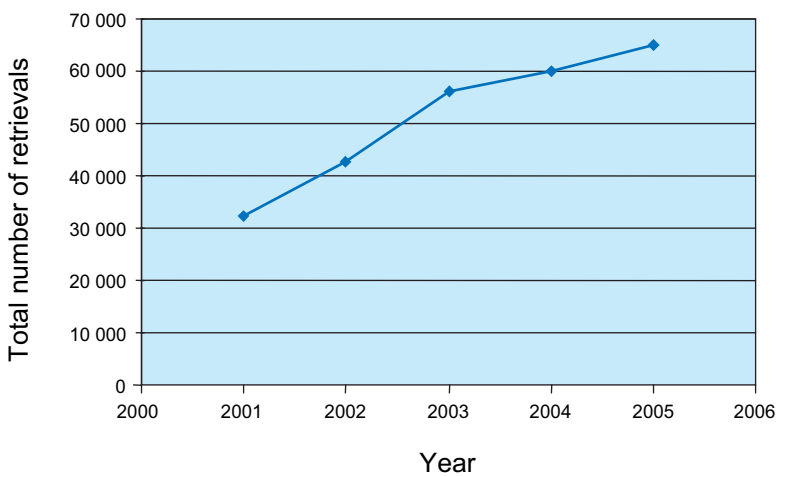


FIG. 1. Requests for the Agency's nuclear data services, 2001–2005.

worldwide were updated in 2005. This work has been undertaken through direct collaborations with research laboratories, as well as with established networks of nuclear data centres in Europe, Japan, the Russian Federation and the USA. Proper interfaces to these libraries were developed by the Agency and made available to users in Member States.

At the end of May 2005, an upgraded mirror server was commissioned by the Agency at the Instituto de Pesquisas Energéticas e Nucleares, in São Paulo, Brazil. This server hosts the new relational nuclear data services for users in the Latin American region, and is updated automatically every 24 hours from the main server in Vienna. Considerable work was also undertaken to optimize the retrieval codes for the major nuclear structure and decay data files to improve services to users in Member States. A framework was developed in conjunction with the National Institute of Standards and Technology and the Oak Ridge National Laboratory in the USA encompassing data representation methods for structure properties, such as energy levels, coupling schemes and radiative properties, and for particle collisions including excitation and ionization processes. This framework can also be used for A+M processes and is now evolving into a global structure for A+M data, which is of direct interest to the astrophysics community.

Training activities organized by the Agency included workshops on nuclear data for neutron activation analysis, on nuclear structure and decay data and on nuclear data processing for Monte Carlo particle transport calculations. One of these workshops also provided the impetus for the induction of newly trained scientists into the International Nuclear Structure and Decay Data Evaluators' Network at a crucial time when the number of qualified staff has been in decline.

Research Reactors

The Agency's main focus of activities during the year in the field of research reactors was on promoting regional collaboration and networking as part of efforts to strengthen the development of strategic utilization plans. The first phase was initiated by providing guidance through regional workshops. In the second phase, technical and consultants meetings were organized to cover the Mediterranean, Southeast Asia and the Pacific, and Latin America to facilitate discussions among the stakeholders of the participating Member States. Three areas for collaboration were identified: radioisotope production, education and training, and neutron beam applications. The preliminary plan aims at facilitating collaboration among countries with research reactors and associated facilities and those which do not have such facilities.

Critical facilities have played an important role in testing reactor physics codes, modelling, teaching and training. At a meeting of reactor designers and critical assembly experts, the modalities of using critical facilities to facilitate the development of specific innovative reactor designs were discussed. There was also agreement that information needed to be shared between various experimental groups in the interests of preserving knowledge for the future. In addition, the feasibility of using LEU instead of high enriched uranium for the sub-critical core of accelerator driven systems was explored.

In 2005, the Agency continued to support Member States, at their request, in returning research reactor fuel to the country of origin. Within the framework of the Russian Research Reactor Fuel Return Programme, fresh fuel was shipped to the Russian Federation from the Czech Republic and Latvia.

The number of requests for Agency assistance in relation to research reactor conversion increased considerably in 2005. At present, the Agency's technical cooperation programme is managing research reactor conversion projects in Bulgaria, Kazakhstan, the Libyan Arab Jamahiriya, Portugal, Romania, Ukraine and Uzbekistan. A project for the production and qualification of LEU fuel elements was completed, allowing the conversion of the La Reina Research Reactor in Chile. In addition, new conversion project proposals were presented for Jamaica and Poland.

On the issue of the adoption of low enriched uranium (LEU) targets for molybdenum-99 production, the Agency organized a workshop in Buenos Aires. A CRP was also initiated to assist countries interested in the small scale production of molybdenum-99 using LEU targets or neutron activation to meet local requirements.

Accelerators

Another activity organized in conjunction with the World Year of Physics in 2005 was a course on pulsed neutron sources, held in cooperation with the Abdus Salam ICTP in Trieste. One of the goals was to impart to young scientists the

technology and potential of pulsed neutron sources in materials science, and to make them aware of the complementary nature of the various accelerator generated probes.

At an Agency symposium on the utilization of accelerators, scientists from developing countries were brought together to acquire and share knowledge across a broad spectrum of research interests, from basic and applied nuclear physics research to analytical applications, to radiation processing, and to accelerator driven systems. The increasing use of accelerators for material characterization and modification and multi-disciplinary efforts of several accelerator centres were notable features of the papers discussed at this symposium.

To enhance the exchange of information and knowledge, the Agency organized thematic technical meetings during the year. Experts on applications that utilize accelerator based technologies and techniques were brought together to present the latest results and innovations. The need to promote and foster networks of accelerator facilities was highlighted with the aim of enabling Member States to increase their participation in accelerator based science and technology. Areas identified included high energy accelerators for the production of special radioisotopes and accelerator driven neutron source facilities.

An example of regional collaboration was the Agency assistance in 2005 through its technical cooperation programme to Nigeria in establishing an accelerator facility at the Centre of Energy Research and Development in Ile-Ife. The facility will be used for research and training and for the promotion of nuclear science and technology in various key areas such as health, agriculture, environment, mineral development and oil production.

Collaboration with research institutions in Austria, Croatia, Germany and South Africa resulted in the development of a new portable X ray fluorescence instrument and a micro-beam X ray scanning spectrometer, as well as new methodologies and applications of X ray micro-fluorescence and micro-tomography based on synchrotron sources. These instruments are intended to support research in environmental pollution monitoring, the study of cultural heritage objects, entomology and human health.

Thirteen fellows received training in methodology and applications of X ray spectrometry at the Agency's Laboratories, Seibersdorf. Four regional training courses on applications of nuclear analytical techniques for air pollution monitoring and the study of cultural heritage objects were organized in Member States under various technical cooperation projects.

Member States require suitable software for accelerator based nuclear analytical techniques and for ensuring the accuracy of the outputs. An intercomparison and validation exercise of all available software was completed, establishing that the underlying system was sound and capable of producing reliable and accurate results. In this connection, an updated database of accelerator based analytical techniques *(http://www-naweb.iaea.org/napc/physics/AccelSurv/index.html)* was developed and distributed to Member States.

Nuclear Instrumentation

Nuclear instrumentation is indispensable for the development and application of nuclear techniques. In 2005, a number of national and regional activities were completed to improve the capacity of laboratories in developing countries to utilize, maintain and repair nuclear instruments. A CRP on the development of harmonized quality assurance and quality control procedures for the maintenance and repair of nuclear instruments was initiated to build and strengthen capacity in developing Member States.

New instruments continue to enter the marketplace, making older instruments obsolete and unserviceable in a relatively short time. Member States and their technical work force need to keep abreast of these changes. To support them, interactive distance learning modules and training tools for nuclear instrument maintenance were developed and made available through regional training courses. In particular, more than 250 training kits for nuclear instrumentation were distributed to fellows trained at the Agency's Laboratories, Seibersdorf, and in Member States. Training efforts included instruction to 20 fellows in nuclear instrumentation, and two regional and two national training courses in nuclear instrumentation under various technical cooperation projects.

Nuclear Fusion Research

A major step forward in the path to the future use of fusion energy was taken on 28 June 2005 with the signing of a joint declaration of all parties to the

FIG. 2. Signing of the ITER declaration in June.

International Thermonuclear Experimental Reactor (ITER) (Fig. 2).[1] The partners agreed on future arrangements and on the construction of ITER at Cadarache, in France.

Agency activities in the area of nuclear fusion focus on promoting international collaboration and facilitating the exchange of information. In this regard, 11 technical meetings were held on plasma physics and fusion research. Altogether, 735 scientists from some 40 countries and international organizations participated in these meetings. The proceedings have either been published by the Agency or have been submitted to international journals. A course on plasma physics was conducted at the Abdus Salam ICTP to review the experimental observations and theoretical descriptions of plasma instabilities.

The tokamak is the main device used to demonstrate the phenomenon of nuclear fusion. As part of a CRP on research using small tokamaks, the Agency — through the Abdus Salam ICTP —helped to coordinate a plasma physics experiment at the Institute of Plasma Physics, in Prague. Involving 25 scientists from 10 States, the objective was to promote a networking culture within the small tokamak community, thereby enhancing their contribution to mainstream fusion research. ■

[1] The ITER partners are China, the European Union and Switzerland (represented by Euratom), India, Japan, the Republic of Korea, the Russian Federation, and the United States of America.

Food and Agriculture

Objective

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

Sustainable Intensification of Crop Production Systems

Up to 80% of a plant's yield can be lost because of drought and salinity. This problem is particularly severe in developing countries — especially in arid and semi-arid regions — resulting in damage to the livelihoods of people in the short term, and in long term effects on food security. The Agency has helped introduce plant breeding and selection methods that can lead to new, better adapted varieties of basic food and industrial crops, which are also higher yielding. Its activities have focused primarily on Asia, but also on Africa and Latin America.

Eight new high quality rice mutant varieties have been produced and adopted by farmers in Vietnam, where rice export is a major source of revenue. One new mutant rice variety, registered as a national variety with a quality suitable for export, is of short growth duration (100 days), meaning that three rice harvests a year are possible in the Mekong Delta (Fig. 1). Another mutant rice variety with high quality and tolerance to salinity became the key rice variety for export in 2005, occupying 28% of the one million hectare export rice growing area in the Mekong Delta. In addition, salt tolerant rice mutants were developed through gamma irradiation at the Agency's Laboratories, Seibersdorf. Four mutants developed by the Agency were introduced into nine breeding programmes by the International Rice Research Institute, in the Philippines. The salt tolerant rice cultivar target area for Bangladesh, India, the Philippines and Vietnam is estimated at 4.3 million hectares.

Use of a new mutant variety of wheat that is tolerant to drought — produced through the application of nuclear and in vitro techniques — is expanding in Kenya. It has led to an improvement in the quality and quantity of harvests and to enhanced incomes for local farmers. The demand for the new variety is rising sharply because of the rapid increase in population, preference for wheat products and growing urbanization. Following the success of this project, mutation induction is now being actively promoted in Kenya for the improvement of other staple and cash crops.

In the northern provinces of Zambia, the Agency has developed two high yielding finger millet varieties, which in pre-release trials showed between two and three times higher yield than local traditional varieties. The improved mutant varieties have been tested in areas where people are heavily affected by HIV/AIDS. The intention is to improve local cash earnings, as well as the health and nutrition condition of the residents.

Results of research from a CRP on sustainable crop production in agroforestry systems have shown that trees, when grown with crops, significantly enhance their productivity, plant nutritional quality and livestock nutrition. Such agroforestry systems can improve the physical properties of the soil and plant nutrient uptake, while reducing nutrient, topsoil and water losses in deep drainage. Evidence from China and Malaysia indicates that once agroforestry systems have become established, water is made available from deeper soil layers and thus improves water availability for the associated crops.

Approximately 64% of potentially arable land worldwide is composed of acid soils, 1700 million hectares being located in the humid tropics. As part of a CRP, the Agency assisted 11 countries in Latin America and Africa in the use of nuclear and related techniques to identify acid-tolerant and phosphorus efficient genotypes and develop optimum management practices for correcting soil acidity constraints. The CRP's findings also resulted in the

FIG.1. Harvesting of a high yield rice variety in Vietnam.

drafting of a publication on the Use of Phosphate Rocks for Sustainable Agriculture.

Using SIT to Improve Health and Improve Food Production

To facilitate fruit and vegetable exports from Central America and Panama, an area-wide integrated fruit fly pest management approach that includes the sterile insect technique (SIT) was started in 2001. Four international organizations, two donor government institutions from Mexico and the USA and the ministries of agriculture of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, joined the effort under the umbrella of a regional technical cooperation project. The five year project has culminated in a number of officially recognized areas in each of the participating countries that became either free of fruit flies or had low prevalence of these insects. As a result, fresh fruits and vegetables can now be exported from these areas, resulting in a very significant economic and social impact on the region. In addition, Member States have developed the regulatory, human and physical infrastructure to be able to sustain the status of these areas.

A major success in 2005 was the complete eradication of fruit flies from the Patagonia region of Argentina. This very positive development represents the culmination of ten years of technical support provided by the Agency and FAO in efforts to implement SIT as part of an area-wide integrated pest management approach. Crucially, this achievement — which was officially recognized by the USA — will allow Patagonia to export fresh fruits and vegetables to the USA without any quarantine treatments, representing annual savings of millions of dollars. It also opens the possibility of exporting other fresh fruit crops. It follows the establishment of similar pest free zones, with Agency support, in Argentina's Mendoza Province. The Ministry of Agriculture has now agreed to fund a new fruit fly management programme over an area of 56 000 hectares comprising the main citrus producing provinces of Entre Ríos and Corrientes in northeastern Argentina.

To assist tsetse SIT projects in Africa, the Agency provided support for the establishment of a tsetse rearing facility at the Institute of Zoology of the Slovak Academy of Sciences. The facility is expected to provide seed tsetse colonies to large facilities in Africa such as the one being constructed in Ethiopia

FIG. 2. A tsetse mass rearing facility under construction in Ethiopia.

(Fig. 2). This transfer will accelerate the development of large mass reared colonies needed for field releases. Three different tsetse species are currently being reared and the completed facility now maintains a colony of about 120 000 female tsetse. It is planned that shipments to Africa will begin in the middle of 2006.

The first comprehensive textbook on SIT — Sterile Insect Technique: Principles and Practice in Area-Wide Integrated Pest Management — was published in 2005. Compiled by the Agency and FAO, with contributions by 50 authors worldwide, the textbook is being provided to many counterparts and institutions in Member States to help them understand the potential of SIT.

An ongoing project was expanded in 2005 to assess the feasibility of using SIT to control malaria transmitting mosquitoes. The species targeted in the project is *Anopheles arabiensis*, the second most important malaria carrier in Africa. Research is aimed at identifying a radiation strategy that will lead to sterility in male mosquitoes without compromising their mating performance in the field.

Sustainable Intensification of Livestock Production Systems

Artificial insemination (AI), used as a biotechnology for livestock production, can decrease disease transmission, increase the rate of genetic improvement, and provide a significant cost advantage compared with traditional breeding methods. Nuclear techniques such as radioimmunoassay (for example to measure hormones) can identify and mitigate constraints to efficient livestock production, improve the delivery of national AI services and provide diagnostic

services to farmers. The Agency work in 2005 focused on improving the management of AI, mainly by coordinating the work of laboratories in Africa and Asia and their local farmers, veterinarians and AI technicians. One result has been that milk production from yaks in northwest China, for example, has significantly increased. In addition, improved monitoring of the reproductive cycle and application of approved practices for AI have significantly increased conception rates.

Nuclear and related methodologies for the measurement of tannins and strategies for enhancing the utilization of tannin-containing feed resources, such as tree leaves and agroindustrial by-products, were transferred to nine Member States, and further disseminated through a special issue of the journal *Animal Feed Science and Technology*. In addition, strategies for decreasing the emission of methane (a greenhouse gas) and enhancing livestock productivity are being evaluated in 15 Member States. In order to strengthen this programme, a training workshop on the 'Determination of Methane Emission from Ruminants' was conducted for teams from eight Member States. These efforts have enabled the development of novel, efficient and environmentally friendly feeding strategies using locally available feed resources. The results developed from a CRP and from Agency technical cooperation projects have substantially increased the income of farmers. In one case, nitrogen-15 based characterization of tree leaves and aquatic plants as suitable feed for pigs decreased the cost of raising pigs by 15%, resulting in an additional profit of $19 per pig for farmers.

Reagents for detecting antibodies against the non-structural proteins of the foot and mouth disease virus — to permit the discrimination of vaccinated and field infected cases — were further validated. The process for the import and irradiation of sera by the Agency's Laboratories, Seibersdorf, to act as foot and mouth disease reference standards, was finalized; sera were received for three different serotypes of the virus from two Member States.

Quality assured procedures and implementation guidelines were developed for enhancing the proficiency of veterinary diagnostic laboratories and introduced to 30 Member States through an interregional project. In addition, several publications on improving the technical understanding in Member States of nuclear and nuclear related methods and their applications to animal production were produced, including books on the polymerase chain reaction and gene based technologies.

Improving Food Quality and Standards

In its activities related to a comprehensive approach to food production systems, the Agency assisted Member States in strengthening compliance with food and environmental safety standards through good agricultural practices. This assistance included a training workshop on quality assurance/quality control measures in pesticide residue analytical laboratories at the Joint FAO/IAEA Agriculture and Biotechnology Laboratory in Seibersdorf.

Agency work on the application of irradiation for sanitary and phytosanitary purposes included the completion of a project on the effectiveness of irradiation to ensure hygienic quality of fresh, pre-cut fruits and vegetables and minimally processed food of plant origin. This resulted in the analysis of more than 30 types of vegetables and sprouts and eight types of fruits for the evaluation of the effectiveness of irradiation in ensuring the microbiological safety of foods related to 12 pathogenic bacteria. ■

Human Health

Objective

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

Nuclear Medicine

Therapeutic applications of nuclear medicine were addressed in two CRPs, both of which showed the medical and financial advantages of the new techniques. In one CRP, single dose therapeutic radiopharmaceuticals were effective in haemophilic and rheumatoid arthritis patients. The other CRP, on liver cancer, focused on the safety and efficacy of a new therapeutic radiopharmaceutical and provided data from a multinational, multi-centre clinical trial involving 12 countries. Existing patient management strategies were reviewed as a result.

Under a technical cooperation regional project and national projects in Thailand and Philippines, a programme on neonatal screening for diagnosis of hypothyroidism was extended to cover rural areas. The progress of these projects has made it possible to increase the number of babies screened, resulting in more cases of hypothyroidism being detected and treated. More than 300 newborns were diagnosed with hypothyroidism in the last five years in Thailand. In this connection, preparation of a guidebook entitled *Newborn Screening for Congenital Hypothyroidism: Guidance for Developing Programmes* was completed.

An AFRA project, using in most cases expertise available in Africa, carried out management audits of nuclear medicine centres in Algeria, the Libyan Arab Jamahiriya, South Africa, Tunisia and the United Republic of Tanzania. These audits provided valuable information to managers of the centres to improve their clinical, safety and managerial services to patients, strengthen their nuclear medicine capabilities and enhance their contribution to national health care objectives.

Training programmes were strengthened through the revision of distance assisted course material for nuclear medicine technologists, and collaboration with the European Association of Nuclear Medicine for training fellows. In addition, a *Nuclear Medicine Resource Manual* was prepared. The manual sets out the prerequisites for the establishment of a nuclear medicine service and for optimization of performance. It also contains sections on practical clinical protocols that are important for the accurate interpretation of results.

Radiotherapy and Radiation Biology[1]

Upgrading the skills of medical practitioners in nuclear medicine and radiotherapy is a priority for many regions. Through two technical cooperation projects in Europe, more than 160 nuclear medicine physicians, radiation oncologists, medical physicists and radiotherapy technicians received training in 2005.

To further improve Agency activities in the field of cancer control, a cancer management meeting was organized for the first time in Vienna in which ministers of health, their deputies and leading medical professionals from 27 European Member States participated. Representatives from WHO and ESTRO were also present. The participants recognized the role of the Agency in the framework of cancer control programmes, in particular the contribution of nuclear technologies to treatment and palliation, and recommended future activities to further strengthen knowledge in cancer control.

A CRP investigating the possibilities of a shorter than conventional course of radiotherapy for cancers of the head and neck has shown that tumour control was improved markedly (by 32%). These results were featured as one of the 'Best of Oncology' presentations at the European Cancer Conference in Paris during October–November. The Agency's distance learning course in oncology, which has the objective of promoting radiotherapy expertise in developing countries, comprises modules in additional topics that trainee radiation oncologists should be taught, for example aspects of radiobiology, pharmacology and medical physics which may not be readily available from teachers in developing countries. These materials

[1] The Agency's Programme of Action for Cancer Therapy (PACT) is discussed in the chapter 'The Year in Review' at the beginning of this document.

FIG. 1. Treatment of a cancer patient using a cobalt teletherapy machine.

will substantially reduce the costs incurred by the Agency and Member States in training physicians specializing in radiotherapy.

In a WHO report on cancer control, the Agency contributed information on the planning and practical implementation of radiotherapy services in low to middle income countries (Fig. 1). The Agency, WHO and other partners will encourage countries to integrate cancer treatment into their national health agenda and facilitate the dissemination of the WHO report.

Technical cooperation activities in 2005 in the field of cancer management focused on supporting AFRA countries in enhancing their response to the increasing incidence of cancer, particularly HIV related cancers, through the provision of training to key personnel involved in cancer management. In addition, financial and administrative support was provided for the organization of the Third African Radiation Oncology Group Congress, which was held in South Africa in November 2005. The congress attracted more than 100 participants from Africa and other regions and allowed radiation oncologists and medical physicists to discuss treatment techniques and the region's strategy to combat cancer.

The Agency participated in a joint working group with the International Commission on Radiation Units and Measurements on the use of ions in applications of advanced radiation technologies in cancer treatment. Research on the biological effectiveness of ion beams as compared with conventional photon based radiotherapy focuses on the selection and definition of the involved quantities and units. The recommendations will help standardize dose reporting procedures in those centres using this particular type of radiation.

Dosimetry and Medical Physics

The Agency launched a new programme to build capacity in dosimetry through the creation of guidelines and teaching material to sustain the safe and effective use of ionizing radiation in medicine. In particular, a handbook entitled *Radiation Oncology Physics* was published as the first in a series of educational materials for teachers and students that defines an international curriculum for the academic training of medical physicists. Two countries in Africa have modelled their national curriculum on the handbook and centres in North America and Scandinavia are using it as resource material for their students. Clinical training in medical physics is being defined and developed through regional and national technical cooperation projects in Latin America, Europe, Africa and Asia. The training material developed by the Agency will be disseminated through a collaborative partnership set up during the World Conference on Physics and Sustainable Development, held in November in South Africa.

A new service, Quality Assurance Team for Radiation Oncology (QUATRO), was established by the Agency to assist cancer therapy centres in assessing and testing their readiness to adopt new technology. This was well received, resulting in four QUATRO missions during the year. By repeating a QUATRO mission after the implementation of new technology, it should be possible to gather information demonstrating the impact of the technology and thus to contribute to measuring results based performance indicators. In some cases, the outcome of a QUATRO audit may also identify the participating radiotherapy department as a 'Centre of Competence', enabling it to serve as a model and future reference centre for training professionals from other institutes in the country.

Proper application of radiotherapy procedures on a patient requires regular control of dosimetry and mechanical parameters of radiotherapy machines. This is achieved by implementing quality assurance and quality control (QA/QC) programmes. Under a technical cooperation project, Thailand received assistance in performing calibrations for cobalt-60 teletherapy and linear accelerator machines. In Yemen, Agency assistance resulted in the establishment of the first radiation oncology centre in Sana'a — as of March 2005, the centre was treating an average of 100 patients per day. In Jordan, the Al Bashir Hospital in Amman acquired single photon emission computed tomography capability for

increased accuracy and diversification of clinical investigations of patients. In Mongolia, the facilities and human resources in nuclear medicine and radiotherapy have been improved, resulting in a strengthening of routine services to patients and a tripling in the number of patients benefitting from these services compared with those treated in 1997.

Construction work to expand the Agency's Dosimetry Laboratory was initiated and neared completion in 2005. The expanded facilities will meet the increasing demands of Member States for dosimetry calibration and measurement services.

Nutritional and Health Related Environmental Studies

The prevalence of micronutrient deficiencies — also called "hidden hunger" — is very high in many developing countries, in particular in vulnerable population groups such as infants, young children and women of child bearing age. A CRP, aimed at contributing to the development and evaluation of different strategies to combat micronutrient deficiencies, neared completion in 2005. This CRP, the first of its kind, supports post-graduate students in developing countries.

Combating HIV/AIDS

Of the more than 40 million people living with HIV/AIDS worldwide, nearly 30 million are living in sub-Saharan Africa. The situation is exacerbated by limited health care, food shortages and the high prevalence of undernutrition. An integrated approach, including strategies for prevention of transmission of the virus as well as the treatment and care of HIV infected individuals is urgently needed. During 2005, the Agency — together with WHO and UNAIDS — supported two regional projects in Africa, one on nutrition and the other in support of the UNAIDS–WHO African AIDS Vaccine Programme, and implemented three CRPs in nutrition, cancer treatment and the diagnosis of opportunistic infections. Research focused on the advantages of using nuclear techniques in improving nutrition, health and the well being of HIV infected individuals in developing regions.

Nutrition and HIV/AIDS

The importance of an adequate diet, and integrating nutrition into a comprehensive response to HIV/AIDS, were highlighted by WHO. In particular, as antiretroviral (ARV) treatment becomes readily available in poorer areas, the associations between nutrition, HIV/AIDS and ARV treatments need special attention. There is an urgent need to evaluate the effect of locally appropriate and sustainable food-based strategies on nutritional status and the potential impact of nutritional supplementation on delaying the initiation of ARV treatment and/or on the response to ARV treatment. In conjunction with a regional technical cooperation project in Africa, a new CRP on nutrition and HIV/AIDS will evaluate the efficacy of nutrition interventions in people living with HIV/AIDS, based on changes in body composition (muscle mass) measured by stable isotope techniques.

Cancer treatment and AIDS patients

Certain types of cancer often develop in HIV infected individuals, for example cervix cancer. However, information is limited about the optimal treatment of this particular patient group, particularly in developing countries. Preliminary data indicate that HIV infected women with cervix cancer may respond differently to radiotherapy than non-infected women. Well established, standardized treatment protocols might therefore need to be modified to maximize benefits and minimize risks related to the treatment. The potential benefit of a modified treatment schedule is currently being evaluated in a CRP in several African countries and in India. As part of this project, a combination of external beam radiation therapy with high dose or low dose rate brachytherapy will be evaluated, together with the potential benefits of chemotherapy. Laboratory experiments in China will provide an insight into the mechanism of how HIV infection influences the response to radiotherapy so as to better understand the outcome of this clinical study.

AIDS vaccine

An effective vaccine against HIV offers the best long term approach to control the HIV/AIDS pandemic. Unfortunately, the development of an effective vaccine is complicated by the large differences between strains, in particular in Africa. An Agency regional project in Africa is supporting the UNAIDS–WHO African AIDS Vaccine Programme. It is contributing to the establishment of a network of African laboratories in countries where clinical trials are ongoing in order to test newly developed vaccines against HIV. Nuclear techniques in molecular epidemiology and immunology will be

introduced into these laboratories to support vaccine programmes and to monitor mutation of HIV to predict drug resistance in order to optimize the treatment and care of HIV infected individuals.

Opportunistic infections

HIV infected individuals tend to be more prone to opportunistic infections because of the loss of a normal functioning immune system. Such infections cause significant suffering in HIV infected patients, and so rapid diagnosis and adequate treatment are essential to reduce morbidity and mortality. Unfortunately, many opportunistic infections remain untreated in developing countries or are treated improperly with broad spectrum antibiotics or antifungals, resulting in increased drug resistance. The Agency initiated a CRP to explore the diagnostic advantages in locating and characterizing the extent of opportunistic infections by techniques used in nuclear medicine. These techniques can be used to determine the effectiveness of treatment and the extent of underlying or residual infections. One of the major aims of this project is to empower nuclear medicine facilities in developing countries by making available locally radiolabelled Immunoglobulin G (IgG) for infection imaging. Results to date indicate the feasibility and sustainability of labelled IgG, suitable for use in patients, and it has been produced in countries in Asia and Latin America.

Water Resources

Objective

To improve the integrated management of water resources, geothermal resources and specific water supply infrastructures through the use of isotope technology.

Isotope Methodologies for the Protection and Management of Water Resources

A crucial factor in development is access to safe drinking water — a basic necessity unavailable to more than one sixth of the world's population (Fig. 1). Over 80 technical cooperation projects in water resources development and management were implemented in Africa, the Middle East, Asia and Latin America, substantially expanding their capacity to map underground aquifers, detect and control pollution, and monitor the safety of dams. Twelve training courses, workshops and seminars were organized for developing Member States within the framework of various technical cooperation projects.

Using isotopic methods and tools, hydrogeological maps of the Zarumilla Aquifer, shared by Ecuador and Peru, were developed to assist in the sustainable management of this transboundary resource. In Namibia, isotopic investigations were undertaken to determine the source of recharge of the Oshivelo Aquifer, a water source that is being developed to meet the growing demand for water.

Isotope data for Africa were compiled and synthesized to develop an atlas of isotope hydrology, which will be published in 2006. The atlas is aimed at improving the use of isotopes by Member States and facilitating the integration of isotopic techniques in hydrological investigations and research.

A CRP was completed on the application of isotope techniques to understand the migration of agricultural or other contaminants to groundwater. It provided a methodology to determine the best means of studying the movement of water and pollutants from the surface to groundwater systems. As an additional outcome, the study site — at a research farm in India — was developed with a variety of instrumentation, such as thermal sensors, soil moisture and gas sampling devices, as well as small diameter wells for water sampling.

The use of isotopes for characterizing submarine groundwater discharge was the subject of a CRP that was completed in 2005. Field studies were conducted in Brazil, Italy and Mauritius, which demonstrated the role of isotopes in identifying and quantifying groundwater discharge in coastal areas as well as its impact on coastal zone pollution. The results will form the basis of technical cooperation or interagency projects on coastal zone management.

As part of its Analytical Quality Control and Services, the Agency made available a number of isotope reference materials for use in hydrological, biological, ecological and agricultural studies. Annual requests for reference materials increased from 450 units to 820 units in 2005, and were supplied to 250 laboratories in Member States.

Communication and public outreach were significant areas of focus for the Agency's water resources programme in 2005. Several information brochures were prepared in response to increasing media interest in the Agency's activities in water resources management.

Partnerships for Better Water Management

The Agency places great emphasis on fostering partnerships with national counterparts and international organizations in order to maximize the impact of its activities in water resources management. In 2005, cooperation with the Global Environment Facility (GEF) and related partners

FIG. 1. Groundwater contributes more than half of the drinking water supply around the world and is a particularly important resource for rural development in many Member States.

Use of Isotopes to Reduce the Cost of Providing Arsenic-free Drinking Water in Bangladesh

Groundwater with high arsenic concentrations from naturally occurring sources is the primary source of drinking water for millions of people in Bangladesh. Exposure to elevated arsenic concentrations has resulted in a major public health crisis. Expanding on past cooperation, the Agency has teamed with the World Bank to optimize investment decisions for mitigating the impact of arsenic poisoning in Bangladesh. The main focus is on providing a piped water supply with a centralized water treatment plant to rural communities.

Chapai Nawabganj, in northwestern Bangladesh, is one village where high arsenic concentrations have been detected. The Agency and its counterpart, the Bangladesh Atomic Energy Commission, together with the World Bank conducted an isotope investigation of groundwater in this village in March 2005. The results of this study, which used stable oxygen and hydrogen isotopes and tritium, identified an arsenic-free aquifer in the eastern part of the village with a source of recharge different from the arsenic contaminated aquifer in the western part of the village. These results led to a fresh review of the geological and hydrological data, which then were re-interpreted, resulting in the discovery of two aquifers with little groundwater flow between them. Thus, the eastern aquifer could be used to supply arsenic-free water to Chapai Nawabganj. This will eliminate the need for a separate water treatment plant, thereby saving millions of dollars needed to build and run the plant.

(such as UNDP and the World Bank) expanded with the approval and establishment of new joint initiatives. These included the final approval of UNDP/GEF funding of $1 million for a joint project on the management of the Nubian Aquifer. At a joint meeting involving the Agency, FAO, UNDP–GEF, UNESCO and the World Bank, the World Commission on Groundwater was created. In addition, preparatory work was initiated on a larger scale joint activity to assess groundwater in the Nile Basin. The Agency also began providing technical expertise to the GEF Scientific and Technology Panel, starting with support for the theme of "Managing Aquifer Recharge". This theme, which includes activities related to the artificial recharge of groundwater, is important for Member States in arid and semi-arid climates.

The Agency co-sponsored a workshop on the governance and management of groundwater in arid and semi-arid zones, organized by WMO in Cairo in collaboration with UNESCO, UNEP and the Government of Egypt. Other interagency work included preparation of a chapter in the second edition of the United Nations *World Water Development Report,* co-authored with UNESCO and WMO. A chapter on the application of isotope techniques for delineating protection zones around public groundwater supply wells was contributed for a guidebook on this topic to be published by UNESCO. And special sessions on the use of isotopes in river basin studies and on recent advances in groundwater pollution studies using isotope tools were organized and co-sponsored by the Agency at the European Geosciences Union meeting in Vienna.

In recognition of the increased level of collaboration, the Agency concluded a Memorandum of Understanding (MoU) with the United States Geological Survey. The MoU is expected to provide a structured framework for joint activities, such as a training course on groundwater assessment for African countries, and streamline administrative processes. The US Government also provided extrabudgetary funds to test and adapt a recently developed laser based machine for isotope analysis.

Two programmes for improved training and education in isotope hydrology were established within the framework of the IAEA–UNESCO/Joint International Isotopes in Hydrology Programme

(JIIHP). A graduate degree programme in isotope hydrology was established at the UNESCO–Infrastructural, Hydraulic and Environmental Engineering Institute for Water Education in Delft, Netherlands. And a one-month isotope hydrology training programme for Latin American water professionals was held at the University of Montevideo; the course will be offered on a yearly basis under the technical guidance and sponsorship of the Agency. ■

Protection of the Marine and Terrestrial Environment

Objective

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

The Marine Environment

The measurement and assessment of radionuclides in the marine environment helps to study trends and oceanographic processes. In this connection, IAEA–MEL joined a sampling mission sponsored by Germany to the North East Atlantic Dumping Site, which in the past had received radioactive waste immobilized within specially designed containers. Previous results from sampling in 2002 from the same area had suggested some release of radioactive material into the marine environment. In 2005, samples of sea water, particles and biota were collected to identify potential releases, and analyses are in progress.

In June, based on an agreement with the Helsinki Commission's Project Group for the Monitoring of Radioactive Substances in the Baltic Sea, a set of new data was added to the Agency's MARIS (Marine Information System) web site (*http://maris.iaea.org*). These data provide Member States with information on the distribution and dynamics of radionuclides in the Baltic Sea environment going back to before the time of the Chernobyl accident in 1986.

The bioaccumulation by aquatic organisms of toxins from harmful algal blooms (HABs), or 'red tide', radionuclides and metal contaminants is a matter of concern to many Member States because seafood consumption is a major source of exposure to humans of marine contaminants. An Agency study assessed the accumulation of one specific toxin from sea water in jellyfish. This particular toxin, originating from HABs, has recently been identified as the cause of dolphin and turtle deaths following their consumption of jellyfish.

Over the last ten years, high levels of paralytic and diarrhetic shellfish poisoning have been reported in southern Chile, resulting in the closure of some natural shellfish beds and the initiation of costly monitoring programmes. The Agency has been assisting Chile in the development of national capabilities for receptor binding assay (RBA) in order to provide early information on the presence of saxitoxins — a potent poison produced by HABs — to national authorities and local producers. Through this project, basic capabilities for RBA have been established in certain laboratories, rapid assessment of the presence of saxitoxins has been made possible, allowing for quick and effective remedial actions by authorities and producers, thereby reducing the health risks to the population, and confidence has been created in the shellfish market through the certification of products for the national and international markets.

Radiotracers of toxic metals, for example cadmium and zinc, have revealed unexpectedly high uptake rates in cartilaginous fish, such as shark, as compared with bony fish such as turbot. This has prompted studies to determine the susceptibility of the embryonic stages of fish to contamination and radiation exposure. The Agency's studies, using dogfish embryos as an experimental model, have shown the important role of the egg case in accumulating high levels of radionuclides, which as a consequence enhance radiation exposure of the enclosed embryo. These radiotracer data will permit risk assessments to be made under real environmental conditions of economically important seafood.

Global climate models rely in part on quantifying carbon export, which refers to the loss of organic material from the surface waters of the ocean to deeper waters. The Agency participated in an expedition sponsored by France (BIOSOPE) to measure the export of carbon in waters of different depths and biological activity, from the open ocean 'deserts' to the fertile, nutrient rich waters off Chile. Comparisons were made between a radiochemical technique and classical sediment trap methods, with a view to better understanding carbon loss processes under varying oceanic regimes.

For 30 years the Agency has been collaborating with the UNEP–Mediterranean Action Plan, providing a data quality assurance programme and training pollution chemists from the region. Collaborations with both the Black Sea Ecosystem Recovery Project and the Caspian Environment

Programme were renewed as the Global Environment Facility (GEF)–UNDP projects moved into new implementation phases. The Agency also started a new partnership under a GEF project in the western Indian Ocean region. Contributions included a survey of marine pollution laboratories in seven countries, organizing regional proficiency tests and providing assistance with formulating a regional monitoring programme.

The Agency conducted a regional survey of various organochlorine compounds (agrochemical pesticides, industrial polychlorinated biphenyls (PCBs)) in fish, oysters and coastal sediment of Bahrain, Oman, Qatar and the United Arab Emirates. The results were found to be amongst the lowest reported for surface sediments and contributed to the sparse regional database for organochlorinated compounds in the marine environment. The survey showed that the levels of DDT in the rock oysters from the Gulf of Oman, while relatively low, have remained uniform; there has been an irregular but generally decreasing trend in concentrations of PCBs over the last two decades.

The Terrestrial Environment

Capacity building for Member States in radioecology is facilitated by the provision of training at the Agency's Laboratories, Seibersdorf. Terrestrial radioecology expertise, analytical assessments of contaminated sites, environmental impact assessments and provision of advice, guidelines and training are offered. Fifteen fellows received training in nuclear analytical techniques in 2005. This included training in quality control and quality assurance practices.

Guidelines on methods for the analysis of radionuclides in environmental samples were published for use by Member State laboratories. Also included was an estimation of the uncertainty components associated with gamma ray spectrometry for air filters and a contribution to the recommendations of the International Union of Pure and Applied Chemistry on terminology for soil sampling. Standard methods for analysis of radionuclides in environmental samples, suitable for use by Member State laboratories, are being developed.

The membership of the ALMERA (Analytical Laboratories for the Measurement of Environmental Radioactivity) network increased from 73 to 104. Proficiency tests or intercomparison trials are organized by the Agency to monitor the performance and analytical capabilities of network members (Fig. 1). Through such activities confidence is built that Member States can accurately measure soil pollutants, meet international norms for trade and harmonize emergency responses. The current status of ALMERA network laboratories was evaluated to improve their technical competence through harmonization of sampling, monitoring and measurement protocols, and through staff training. The structure of the ALMERA network and the operation of future proficiency tests and intercomparison trials were also reviewed to maintain and improve the quality of analytical measurements. For example, a soil sampling intercomparison exercise was conducted where the different soil sampling protocols used by the ALMERA laboratories were compared to establish a common ALMERA approach to sampling and sample treatment. Such comparability is important for decision makers, especially in emergency situations.

In a sampling mission to Azerbaijan, samples of sediments and aquatic plants were collected from the Araksz and Kura Rivers and analysed for natural and human-made radionuclides. The project provides Azerbaijan with an independent assessment of radionuclide levels in the rivers, as well as providing training in sampling strategies and techniques.

Agency's Laboratories, Seibersdorf

The Agency's Laboratories are located in the vicinity of the village of Seibersdorf, in Lower Austria, about 35 km southeast of Vienna. The

FIG. 1. An ALMERA field sampling exercise in Italy in November 2005.

Laboratories help to implement the scientific and technical programmes of the Agency through experimental facilities and services. In connection with the Agency's verification activities, the Safeguards Analytical Laboratory (SAL) analysed 706 routine inspection samples and 197 non-routine samples, and the Clean Laboratory of SAL analysed 559 routine environmental safeguards samples, as well as 81 non-routine samples. In addition, 474 sample kits were prepared and provided to safeguards inspectors.

The Laboratories also hosted 78 scientific fellows for training in the Agriculture and Biotechnology Laboratory and Physics, Chemistry and Instrumentation Laboratory, and received 513 visitors, mainly from Permanent Missions in Vienna, Member State officials and media representatives.

A study carried out in 2005 to track the movements of fellows who had been trained at the Agency's Laboratories revealed that of the 149 trained in 2001–2002, 72% went back to work in the field in which they received their training. Most of the trainees (97%) believed that they had acquired knowledge that was useful or very useful for their job. The development of contacts for information exchange after the fellowship programme was an important factor in the career of fellows and in the development of the home institution. It was found that most fellows were involved in other Agency activities later in their careers. ■

Physical and Chemical Applications

Objective

To increase socioeconomic benefits in key sectors of Member States through the application of radioisotopes and radiation technology for producing goods and services which result in improved health care and industrial performance as well as effective quality control processes.

Radioisotopes and Radiopharmaceuticals

Self-reliance in the production and use of radioisotope products is a major interest for many Member States. In this regard, Bangladesh received support in the establishment of a new, larger facility for the production of technetium-99m generators used for diagnostic imaging procedures. In the Latin America region, the protocols for the production, quality control (QC) and validation of some radiopharmaceuticals based on monoclonal antibodies and peptides were developed and adopted by Member States.

A CRP on the development of radioactive sources for the treatment of prostate and eye cancer, and for the development of portable radiation sources for radiographic monitoring, stimulated collaborative research for the production and QC of small sealed sources. The participants in the CRP developed or improved new methods of production, testing, QC methods and encapsulation technology for a variety of sealed sources for applications in medicine and industry.

At an international symposium on trends in radiopharmaceuticals, held in Vienna in November, developments in the design, production, evaluation and application of radiopharmaceuticals were reviewed. The symposium highlighted the continuing relevance of advances in the chemistry and pharmacology of technetium-99m radiopharmaceuticals for diagnostic imaging. Furthermore, it underlined the need for continued support to Member States in strengthening the local production and utilization of emerging therapeutic radiopharmaceuticals, and for medical cyclotron facilities for producing and using fluorine-18 labelled compounds. It also stressed the need for diversified radiopharmaceutical production facilities for greater availability worldwide.

Nuclear and Radioanalytical Techniques

Recognizing the problem posed by declining training opportunities in radiochemistry, the Agency initiated the development of modular distance learning tools for university and research students. A module on radiochemical separations was developed in cooperation with the Institute of Applied Sciences and Technologies in Havana, Cuba. The exercise was evaluated by an expert group, which will help develop other similar modules for further distribution to Member States.

A CRP on new applications of prompt gamma neutron activation analysis (PGNAA) was completed in 2005. The CRP demonstrated the suitability of PGNAA for: the analysis of long lived radioisotopes in nuclear waste; investigating fatigue in batteries; the analysis of mineral deposits from the ocean floor; estimation of major elements in cement; and multi-element analysis of archaeological materials.

The Agency convened a meeting on the use of neutron generators for the detection of explosives and illicit materials to review the successes and limitations of existing technologies and to identify developmental areas in which significant advances could be made. As a result, a CRP was initiated for further research in this area, which will also serve to promote awareness in Member States of nuclear methods and the use of small neutron sources for the detection of bulk explosive materials.

The analysis of heavy metals in bulk and large samples remains a challenge in the field of analytical sciences. An expert group was convened to review current experience and the suitability of small and low flux irradiation facilities for the neutron activation analysis of large samples (i.e. greater than 10 g). This technique could provide additional advantages for the analysis of precious objects in art and archaeology, high purity materials (silicon wafers, high purity metals and alloys), non-homogeneous materials (municipal waste and electronic waste), and for in vivo applications (whole body calcium, kidney cadmium, etc.).

Strengthening and developing gamma radiography techniques as a tool for non-destructive testing (NDT) is important for improving industrial safety and reliability of performance. A CRP on 'Corrosion and Deposit Determination in Large Diameter Pipes with and without Insulation by

Radiography Testing' was completed. Procedures for setting the correct exposure conditions, radiation source and exposure geometry were developed. Periodic testing using this technique enables end-users to predict pipe lifetime, thus saving on maintenance costs as a result of shorter inspection and exchange periods. Written procedures and practical guidelines developed through this CRP will be submitted for review by the International Organization for Standardization (ISO).

Non-destructive testing is important for the quality assurance (QA) of manufactured products and for in-service inspections. Approximately 80 national training courses in five major NDT methods were conducted by Member States in 2005, with a total of over 2000 persons being trained and 1600 being certified. Through earlier technical cooperation projects, many RCA Member States have established the necessary infrastructure for providing NDT services and for conducting training programmes. In this connection, Bangladesh, China, India, Malaysia, Pakistan, the Philippines, Thailand and Vietnam have implemented national qualification and certification schemes for NDT personnel based on ISO 9712.

As a result of the increased application throughout Africa of NDT techniques in industrial QC, the training, qualification and certification of personnel have assumed greater importance. Under a regional AFRA project, the Agency assisted several Member States in strengthening their national capability for providing training in NDT methods and techniques; and in establishing competent authorities for certification/accreditation and for promoting market opportunities for NDT applications.

An example of the expanded use of NDT techniques in Africa is the United Republic of Tanzania, which has increased its use of NDT in the transport of petroleum products. The Agency assisted the Tanzania Industrial Research and Development Organization (TIRDO) in establishing a quality certification scheme. As a result, TIRDO now has the capability to compete with foreign companies in NDT activities related to the inspection of engineering components.

Applications of Industrial Radiotracers

As a result of Agency sponsored research, a new software package for radiotracer data analysis was developed by the Czech Technical University

FIG. 1. Radiotracer injection at an offshore oil platform in Vietnam.

to obtain more reliable results from experimental data. A computer controlled, single source–single detector system for on-line measurement and image reconstruction software was developed by a group from the Republic of Korea participating in a CRP on industrial process gamma tomography. To improve interpretation capabilities, a new version of a software package for the modelling and analysis of oilfield interwell tracer test data was developed by a group from Argentina participating in a CRP on the validation of tracers and software for interwell investigations. In Vietnam, technology for the application of the multi-tracer technique for interwell communication studies in offshore oil fields was established through a national technical cooperation project and is now in service in the oil fields (Fig. 1).

Radiation Processing Technology and Applications

Radiation treatment has been shown to be effective in converting some pollutants into harmless end products. In this regard, a CRP was launched with the objective of developing reliable analytical methods for the investigation of radiation degradation of volatile organic compounds in their gaseous phase. The research will also focus on

the feasibility of the radiation aided destruction of certain pollutants in exhaust gases from power generation plants, chemical and metallurgical industries, and municipal waste incinerators.

The treatment of municipal and industrial wastewater is an important part of environmental engineering, and electron beam treatment is a comparatively new method for wastewater purification. For example, in the Republic of Korea, wastewater discharge from the Daegu Dye Industry Complex (DDIC) is more than 80 000 m^3. In December 2005, a high power accelerator and wastewater treatment system was installed at DDIC. This system treats up to 10 000 m^3 of textile dyeing wastewater and has shown positive results for the removal of non-degradable organic impurities. The project was supported by the Government of the Republic of Korea, the City of Daegu and the Agency. DDIC is planning to install several more plants to treat its total wastewater output with electron accelerator plants.

Under a regional technical cooperation project, the radiation processing of indigenous natural polymers such as alginates (seaweed extracts) and chitosans was achieved. Hydrogel wound dressings based on these complex carbohydrates have already been put into commercial production in China, India, Japan and Malaysia.

Assisting Quality Assurance in Member State Laboratories

The Agency organizes proficiency tests for laboratories from Member States to assist in evaluating their analytical performance. It also provides analytical QC services and produces and distributes reference materials. Three proficiency tests on the analysis of radionuclides and trace elements were conducted, and 68 Member States were provided with a total of 850 units of matrix reference materials. ■

Safety and Security

Safety of Nuclear Installations

Objective

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

Convention on Nuclear Safety

In April 2005, Contracting Parties to the Convention on Nuclear Safety (CNS) met in Vienna for the Third Review Meeting. Their national reports had been prepared taking into account a Secretariat report presenting generic information on the significant issues, developments and trends in enhancing nuclear safety. For the first time, the national reports could be submitted through a secure web site.

The findings and conclusions of the meeting referred to the need for openness and transparency in the nuclear industry, the necessity for both regulators and operators to show leadership in nuclear safety, the importance of knowledge management as experienced staff retire and facilities move into extended operation, and the requirement to avoid complacency resulting from good safety performance in the recent past. The Contracting Parties made reference to the relevant Agency safety standards as a tool to assist in the review process and recognized the value of the Agency's safety services, such as operational safety and regulatory reviews. The Contracting Parties also recognized the need for a continuous process, with enhanced communication, between review meetings.

Nuclear Safety Standards

The Nuclear Safety Standards Committee (NUSSC)[1] was reconstituted for the 2005–2007 period with modified terms of reference placing more emphasis on the use of standards and sharing of the experience from their use. A review of the new overall safety standards structure identified the need for a number of new Safety Guides. As a result, in 2005 NUSSC endorsed proposals for 11 new Guides.

In the near term, NUSSC will continue to work on the completion of the Safety Guides for research reactors as well as the Safety Requirements and Guides for fuel cycle facilities. Another important task for NUSSC will be the development of Safety Requirements and Guides in the thematic area of assessment and verification, including the methodology and application of probabilistic safety assessments.

Nuclear Power Plant Operational Safety

Nuclear power plant operational safety performance remained high throughout the world in 2005. Using the worldwide unit capability factor[2], Fig. 1 shows that this performance has been on a plateau for a number of years.

The Operational Safety Review Team (OSART) service continued to be in great demand in 2005. Missions were conducted to China, France, the Netherlands, Romania, the Russian Federation and the USA (Fig. 2). In addition, four preparatory and six follow-up missions were conducted. The OSART teams continue to find issues related to fire risk, management objectives, staffing, human performance, surveillance testing, temporary modifications, low level events and near misses, and computer applications. However, OSART follow-up mission results have shown that a significant number of these issues have been resolved in accordance with the Agency's safety standards. The OSART teams also noted several good practices, including the importance of blame-free environments, communication actions, teamwork, self-assessment, corrective action programmes and risk assessment.

Another Agency service — Peer Review of Operational Safety Performance Experience (PROSPER) — provides critical information to nuclear power plant operators. In 2005, the Agency

[1] The preparation and review of safety standards involves the Secretariat and four safety standards committees in the areas of nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), as well as a Commission on Safety Standards (CSS), which oversees the entire safety standards programme.

[2] From the Agency's PRIS database.

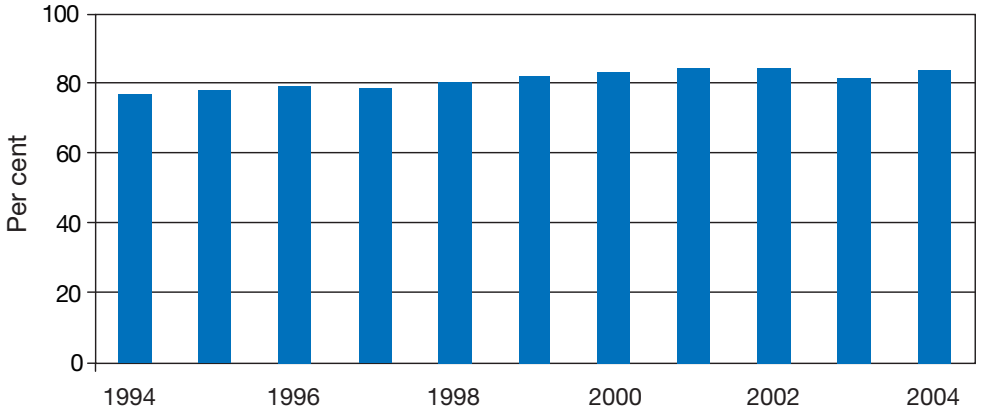


FIG. 1. Worldwide unit capability factor (in per cent) as an indicator of nuclear power plant safety performance.

FIG. 2. OSART members observe new fuel inspection activities at the Penly nuclear power plant in France.

conducted one PROSPER mission to Spain and a follow-up mission to Armenia.

In November, the Agency hosted an international conference on operational safety performance in nuclear installations to share experience and thus strive to improve operational safety performance. Participants made recommendations on how best to achieve and ensure the safety of extended operations and ensure that operating experience is reflected in the design, construction, commissioning and operation of new nuclear power plants. In particular, the participants noted that both operators and regulators must avoid isolation and instead freely share safety information and show leadership in nuclear safety. The results of the conference will be merged with the issues and trends identified from the Agency's safety services for input to the Fourth Review Meeting of the CNS in 2008.

Research Reactor Safety

In December 2005, the Agency held a meeting to discuss how best to ensure effective application of the Code of Conduct on the Safety of Research Reactors. Representatives from 31 Member States agreed that national commitment is best displayed through participation in meetings for exchanging information and experience on the application of the Code of Conduct. Participants also called for periodic review meetings to discuss topics related to the application of the Code of Conduct, and also to exchange experience and lessons learned, identify good practices, discuss future plans, and discuss difficulties encountered and assistance required to reach full compliance. At the request of the meeting

The Agency's Safety Standards

Four Safety Standards were published in the nuclear safety area in 2005:

- *Safety of Research Reactors* (NS-R-4);
- *Design of the Reactor Core for Nuclear Power Plants* (NS-G-1.12);
- *Radiation Protection Aspects of Design for Nuclear Power Plants* (NS-G-1.13);
- *Geotechnical Aspects of Nuclear Power Plant Site Evaluation and Foundations* (NS-G-3.6).

In addition, six draft safety standards were approved by NUSSC for submission to the CSS.

FIG. 3. Members of the INSARR mission to Indonesia at the Siwabessy Research Reactor.

participants, the Agency will establish a web site to facilitate the exchange of information.

The Agency, through its Integrated Safety Assessment of Research Reactors (INSARR) service, conducted pre-INSARR missions to Morocco and the Syrian Arab Republic to define the scope and to prepare for future missions. Full missions were conducted in Indonesia and the Netherlands (Fig. 3) and one follow-up mission was conducted to the Czech Republic to evaluate progress from a previous mission. In addition, ten safety missions were conducted to address specific topics. These missions, as well as other Agency activities related to the safety of research reactors, found that there was a need to: apply the Agency's safety standards in the implementation of modifications; reinforce the role of safety committees; and review training and qualification programmes.

Following up on recommendations made by Agency safety review missions, the Democratic Republic of the Congo implemented a range of improvements at its CREN-K Research Reactor with Agency assistance. The improvements included the: establishment of effective regulatory supervision; setting up of a quality assurance programme; design of a preliminary reactor decommissioning plan; implementation of a safety related erosion monitoring plan; and completion of all safety related documents.

Regulatory Infrastructure

Regional and national technical cooperation projects focused on 11 States in Europe and the Middle East operating or decommissioning nuclear power plants. Agency support was aimed primarily at strengthening national regulatory capabilities, enhancing safety assessment capabilities, enhancing nuclear power plant operational safety and improving design basis documentation and configuration management at nuclear power plants.

In the Russian Federation, a national safety standard project supported by the Agency's technical cooperation programme resulted in the preparation of regulations and guidelines on nuclear power plant lifetime extension. These regulations were applied during the licence renewal process at several nuclear power plants in the country.

At their meeting in April, the Contracting Parties to the CNS highlighted the value of the Agency's services for enhancing regulatory infrastructures and called upon all Member States with nuclear installations to avail themselves of these services. Progress was made in improving the methodology for conducting this service, most notably in developing a self-assessment process by which the recipient organizations would identify areas of strength and weakness and develop self-improvement plans and strategies. Several countries with mature national regulatory programmes have indicated their intention to request a regulatory review in the next two to three years.

Ageing Management and Long Term Operation

The number of Member States giving high priority to continuing the operation of nuclear power plants beyond the timeframe originally anticipated is increasing. Participants at an Agency conference on operational safety performance in nuclear installations observed that 80% of the power reactors operating worldwide could be eligible for long term operation. Figure 4,[3] shows the age of current operating reactors as of the end of 2005. In this regard, the Agency added publications on the ageing management of BWR reactor pressure vessels and their internals to its guidance documents on the safety aspects of ageing. In addition, the Agency produced a draft Safety Guide which will provide key recommendations for effective ageing management.

[3] From the Agency's PRIS database.

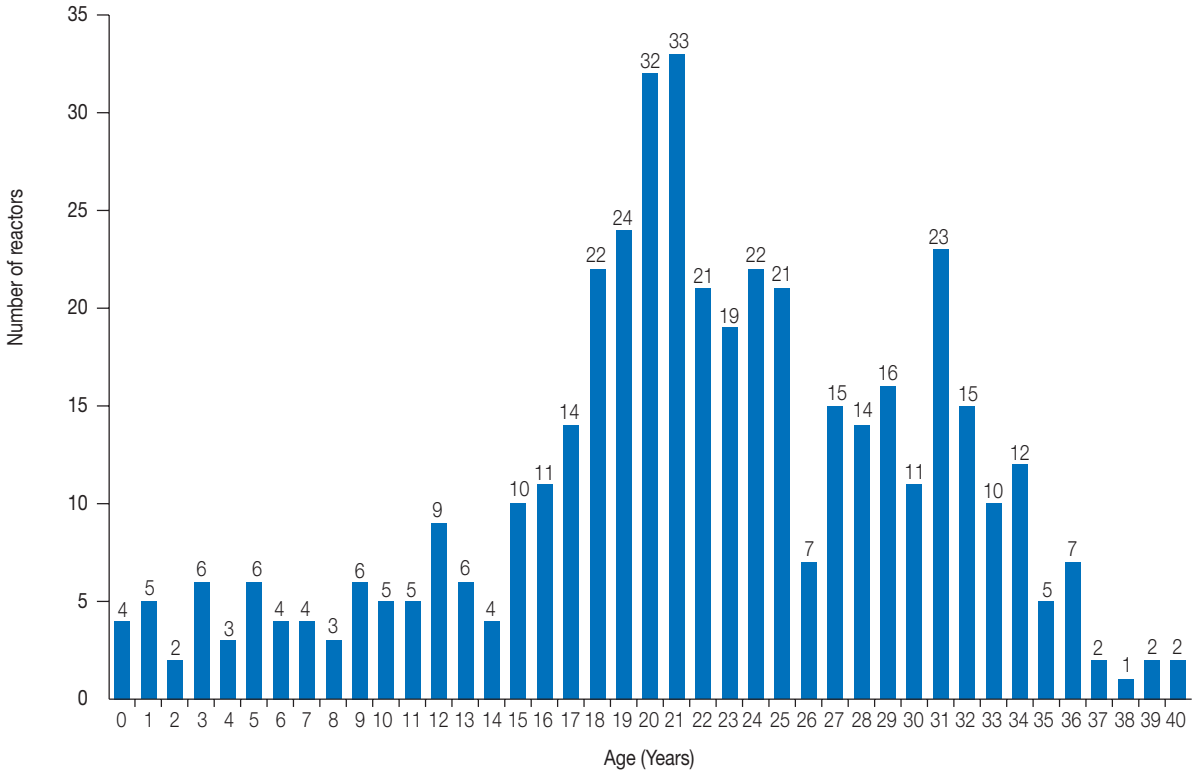


FIG. 4. Number of reactors by age, as of 31 December 2005.

Safety of Fuel Cycle Facilities

Guidelines for the evaluation of the operational safety of fuel cycle facilities were prepared by the Agency. The guidelines describe self-assessment by a Member State of its fuel cycle facilities, as well as the implementation of a new safety peer review service — Safety Evaluation During Operation of Fuel Cycle Facilities.

In a joint effort with the OECD/NEA, the Agency is fostering the exchange of information on fuel cycle facility safety issues. At a technical meeting in 2005, participating Member States endorsed the guidelines for the Fuel Incident Notification and Analysis System, and the Secretariat is currently developing a common web platform which will cover the incident reporting systems dedicated to nuclear power plants, research reactors and fuel cycle facilities.

Incident Reporting System

The Incident Reporting System (IRS), jointly operated by the Agency and the OECD/NEA, is an essential element for providing information regarding nuclear power plant operating experience worldwide. The 2005 joint meeting discussed lessons learned from 40 recent events in countries participating in the IRS. Several events had latent failures (i.e. a failure caused by an undetected degradation in an element of a safety layer, a continuing concern in recent years). Emerging phenomena (i.e. failure mechanisms that had not previously been identified as problems) suggest that problems could be more widespread than previously thought. Quality control on the part of contractors remains a problem and needs greater attention by both operating organizations and regulatory bodies.

Regional Nuclear Safety Networks

With the assistance of the Agency, Asian Nuclear Safety Network (ANSN) hubs and national centres in China, Malaysia, the Philippines, Thailand and Vietnam were made operational. In addition to the documents currently available in the ANSN relating to education and training, other types of documents — for instance on operational safety — are now being added. A bi-weekly *ANSN Newsletter* has also been published since March 2005 by the Agency. Promotional meetings (for example to Indonesia and Vietnam) were also organized to introduce ANSN to a larger audience, including key decision makers.

At the end of 2005, four topical groups had been established and were operating within the

framework of ANSN in the areas of education and training, operational safety, safety analysis and information technology. A substantial expansion of ANSN was agreed by participating countries in December 2005. Work in 2006 will cover new areas such as emergency preparedness and response, research reactor decommissioning and radioactive waste management.

Within the framework of an extrabudgetary programme, the Agency continued to cooperate with the Forum of Ibero-American Nuclear Regulators. The focus is on strengthening knowledge sharing and expertise on nuclear safety standards, regulatory practices, control of radioactive sources, protection of patients and education and training. With the participation of Argentina, Brazil, Cuba, Mexico and Spain, the prototype of an Ibero-American Radiation Safety Network was completed in 2005. The network should enter into operation in 2006.

Radiation and Transport Safety

Objective

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

Radiation Safety Standards

The Radiation Safety Standards Committee (RASSC) was reconstituted for the 2005–2007 period with modified terms of reference that give more emphasis to the use of standards and sharing of the experience from their use.

Safety and Security of Radioactive Sources

One section of the Code of Conduct on the Safety and Security of Radioactive Sources is devoted, inter alia, to the import and export of high activity radioactive sources. During 2005, the Agency provided assistance to Member States in the implementation of guidance on the import and export of radioactive sources. In this connection, the Agency held a meeting in Vienna in December where participants from 54 Member States — and observers from the European Commission, WCO, and the International Source Suppliers and Producers Association — shared experience in implementing the guidance.

An Agency conference on the Safety and Security of Radioactive Sources, held in Bordeaux in June–July 2005, recognized that safety and security are integral to effective and comprehensive regulatory structures for ensuring the continuous control of radioactive sources, and noted that an adequate balance between confidentiality and information exchange was necessary. It also noted that many national and multinational efforts are taking place to regain and maintain control of vulnerable and orphan sources. There was recognition of the need to prevent illicit trafficking in, and inadvertent movements of, radioactive sources. The effective management of radiological emergencies involving radioactive sources also needed to be integrated into national strategies for the safety and security of radioactive sources.

Under the IAEA–Russian Federation–USA ("Tripartite") Initiative to Secure and Manage Radioactive Sources, the Agency has been managing projects for the dismantling of disused sources and facilities (teletherapy machines, irradiators, etc.), and the transport of sources to secure storage. In 2005, projects were completed in Azerbaijan, Belarus, Kazakhstan and the Republic of Moldova.

The *International Catalogue for Sealed Radioactive Sources and Devices* was made available to nominated national focal points. By the end of 2005, the catalogue contained more than 12 000 entries on sealed sources, devices used for the applications of sealed sources, manufacturers and suppliers, as well as information on identifying orphan sources. The data are available to national focal points as well as to Interpol, Europol and the WCO.

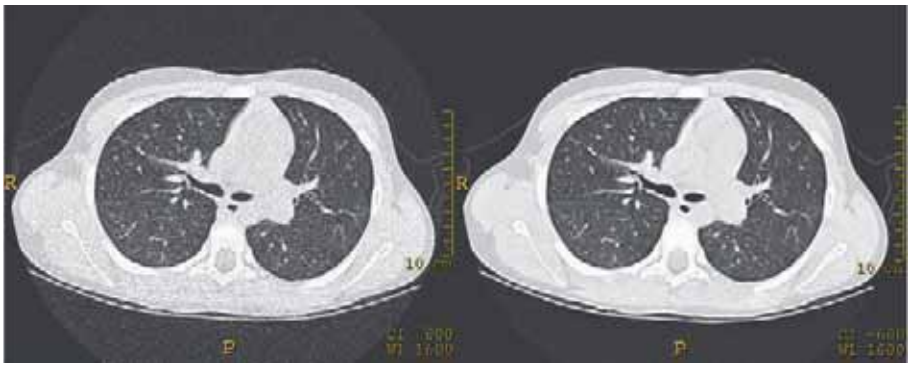
Radiological Protection of Patients

An increasing number of clinicians and doctors are using ionizing radiation in their work, though many have received no formal training in radiation protection. Figure 1 highlights the importance of training, information exchange and guidance in assessing dose and in emphasizing the scope for dose reduction. Since different applications require

The Agency's Safety Standards

During 2005, the Agency published two Safety Guides in the radiation safety area:

- *Environmental and Source Monitoring for Purposes of Radiation Protection* (RS-G-1.8);
- *Categorization of Radioactive Sources* (RS-G-1.9).



Dose X **Dose 13 X**

FIG. 1. Importance of training in widening the scope of dose reduction in the medical uses of radiation. While the two scans are of diagnostic quality, the scan on the right resulted in a dose that was 13 times higher than necessary.

different levels of image quality and radiation dose, it is important for clinicians to be aware of the need to use only the minimum dose for proper diagnosis. To address this issue, the Agency finalized training packages for radiation protection in diagnostic and interventional radiology, nuclear medicine and in radiotherapy. In addition, a third radiation protection training course was held for interventional cardiologists, since they have become major users of radiation techniques.

To facilitate wider dissemination, the Agency gave permission for its training packages to be placed on the web site of the International Organization for Medical Physics (IOMP). With four regional chapters and 74 national member societies, the IOMP reaches thousands of medical physicists worldwide. Some national IOMP member societies have also placed the material on their web sites.

Occupational Radiation Protection

The Agency conducts intercomparisons of monitoring methods for assessing occupational exposure to assist its Member States in complying with dose limitation requirements and to harmonize the use of internationally agreed quantities and assessment methods. For example, the Agency was involved in a research project sponsored by the European Union that featured a worldwide intercomparison exercise, involving 81 laboratories in more than 40 Member States. The object was to assess the harmonization of dose estimation for intakes of radionuclides by workers through ingestion, inhalation or wounds. In addition, the Agency organized an exercise in the African region to measure personal dose equivalent in photon fields.

National Regulatory Infrastructures for the Control of Radiation Sources

Established in 2004, Radiation Safety and Security Infrastructure Appraisal (RaSSIA) missions provide Member States with a means to assess progress in establishing a national regulatory infrastructure for the safety and security of radioactive sources. In 2005, the Agency conducted 23 RaSSIA missions.

As part of its activities to assist Member States in establishing and operating their national regulatory programme, and in particular the national register of radiation sources, the Agency developed RAIS 3.0 (Regulatory Authority Information System), an information management tool for the day to day activities of regulatory bodies. At the request of several States, the migration of RAIS 3.0 to a more widely used data management program is under way.

Standardized packages were published for training staff involved in the regulatory control of radiation sources. These packages cover control of radiation sources in medical practices (radiotherapy, nuclear medicine and radiodiagnostics) and industrial practices (irradiators, industrial radiography, and nuclear gauges and well logging). A similar package was developed on the control of radiation sources in cyclotron facilities. In addition, a course on radiation safety for custom officers was developed with the WCO.

Transport Safety

The Board of Governors approved a new policy for reviewing and revising the Regulations under which the Transport Regulations will be reviewed every two years. However, the decision on issuing a revision or publication will be made after assessment of the safety significance of the changes by the Transport Safety Standards Committee (TRANSSC) and the CSS. In this connection, TRANSSC was reconstituted for the 2005–2007 period with modified terms of reference, giving more emphasis on the use of standards and the sharing of the experience from their use. And the 2005 edition of the Transport Regulations was published by the Agency.[1]

The Agency has undertaken a number of activities to address the issue of denial of shipments of radioactive material intended for use in medical diagnosis and treatment. In July 2005, the Agency took part in the deliberations of the Facilitation Committee of IMO, and assisted in the preparation of a circular to IMO Member States aimed at facilitating the carriage of radioactive cargo prepared and forwarded in conformity with the applicable provisions of the International Maritime Dangerous Goods Code. The Agency also participated in a meeting of the Safety Panel of the International Cargo Handling Co-ordination Association in October 2005 to clarify issues related to the Agency's Transport Regulations.

The work of the International Expert Group on Nuclear Liability (INLEX) continued during 2005, with the Group agreeing on a number of conclusions and recommendations on possible gaps and ambiguities in the scope and coverage of the existing international nuclear liability instruments. Some of these conclusions and recommendations are addressed in a revision of the explanatory texts, which are now available in all official languages. It is expected that INLEX will continue to play an important role not only as a forum of expertise for discussions between shipping and coastal States but also in providing authoritative advice on the nuclear liability instruments adopted under Agency auspices.

In addition, in the context of INLEX's outreach activities, the first Regional Workshop on Liability for Nuclear Damage was held in Sydney, from 28 to 30 November. The workshop was attended by 14 Member States in the Asia region and 12 non-members of the Agency who are members of the Pacific Islands Forum. A second regional workshop, for countries in Latin America, is scheduled to be held in Lima, Peru, in 2006.

A group of eight coastal and shipping States had informal discussions in Vienna, to which the Agency was invited, on communication between governments. The aim was to improve mutual understanding, confidence building and communication in relation to the safe maritime transport of radioactive material.

In 2005, the Agency updated its comprehensive training manual on transport safety to include the latest requirements of the Transport Regulations. A transport safety training course for Latin America was held in Lima in June. In December, the Agency conducted a Transport Safety Advisory Service mission to Japan. The mission report will be published in 2006.

Responding to a Nuclear or Radiological Emergency

The Agency plays a key role in facilitating the sharing of knowledge and information between Member States from past emergencies in a form that allows them to quickly establish an effective capability to respond to a nuclear or radiological emergency. In 2005, guidance on the preparation, conduct and evaluation of exercises to test preparedness for a nuclear or radiological emergency and on medical response during an emergency were published.

Assistance is provided to Member States in their preparations to respond to a nuclear or radiological emergency. The current focus is on preparing 'first responders' (e.g. law enforcement, fire-fighters and public health officials) to respond effectively during the first few hours of a radiological emergency. In this connection, guidance and training material was prepared, jointly with other international organizations, which can be quickly adapted for use by first responders. This material was used to train first responders in Indonesia, after which an exercise to test the response to a radiological dispersal device was conducted (Fig. 2).

Another focus is on completing the set of generic and operational intervention levels on the basis of a new technical framework for criteria to be used

[1] 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).

FIG. 2. A medical team treating a simulated victim during a radiological emergency exercise in Indonesia.

during the response to a radiation emergency. This framework was published and discussed with Member States and other international organizations at a technical committee meeting.

International Incident and Emergency Response System

A well organized emergency response system helps to build confidence that an emergency will be handled effectively. In accordance with General Conference resolutions and considering the new global challenges posed by the potential malevolent use of nuclear and radioactive material, the Agency established an Incident and Emergency Centre (IEC) in February. The IEC's goal is to enhance the capabilities of Member States and intergovernmental organizations to respond to nuclear or radiological incidents and emergencies by offering timely and efficient services. It provides a visible, reliable and accessible focal point for reporting and, if necessary, promptly supporting the response of Member States to such emergencies. It also provides for the exchange of information and sharing of knowledge for the purposes of early warning and prevention.

In 2005, the Agency was informed of 170 events involving or suspected to involve ionizing radiation. Of these, 137 events involved very low activity radiation sources and had no impact on the public or the environment. There were 14 events reported involving radiation sources used in radiography where exposure to workers exceeded regulatory limits, another eight reported cases involving "dangerous" radiation sources and nine other events which occurred at nuclear facilities.

In 15 cases, the Agency was requested to provide assistance pursuant to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention), and in eight other cases the Agency offered its good offices. In four cases, the Agency either sent a fact-finding mission or facilitated multilateral or bilateral assistance and discussions among the parties involved.

The Agency enhanced its Early Notification and Assistance Conventions (ENAC) web site to offer users extended capabilities, including a training function. The system has proved to be effective not only during exercises, but in disseminating information received by the Agency on radiological emergencies and incidents.

Strengthening the International Preparedness and Response System

In implementing the 2004 Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies, a Communication Work Group and an Assistance Work Group were established. In addition, draft documents describing the concept and strategy for achieving an internationally harmonized communications system and for enhancing international assistance for nuclear and radiological incidents and emergencies were prepared.

A major international exercise — ConvEx-3 (2005) — was held in May 2005. Based on a Romanian national exercise involving Unit 1 of the Cernavoda nuclear power plant, the scenario for the exercise was prepared by Cernavoda staff together with the Romanian National Commission for Nuclear Activities Control and the Inter-Agency Committee for Response to Nuclear Accidents. The Agency's participation in this exercise, through the IEC, fulfilled its obligations under the Convention on Early Notification of a Nuclear Accident (Early Notification) and Assistance Conventions (Fig. 3). Sixty-two Member States and eight international organizations participated in the exercise, which was successful in testing key systems that would be required in an actual emergency and in identifying opportunities for improvement. The exercise report was prepared and disseminated to all participants.

FIG. 3. IEC staff involved in ConvEx-3 (2005).

The third meeting of the representatives of competent authorities identified under the Early Notification and Assistance Conventions was held in Vienna in July 2005. The meeting reviewed progress and approved proposals relating to strategies for enhancing international assistance and international communication in the event of a nuclear or radiological incident or emergency, and reviewed the evaluation of ConvEx-3 (2005). Participants agreed on a proposal for enhancing the existing drill and exercise schedule, recommending that it cover all regions over a suitable time period, and that the exercises address both nuclear accidents and radiological emergencies, including those arising from malicious acts. The meeting also encouraged competent authorities to initiate a request to develop a code of conduct for the international emergency management system.

International Nuclear Event Scale

The International Nuclear Event Scale (INES) is used for facilitating rapid communication to the media and the public regarding the safety significance of events at all nuclear installations associated with the civil nuclear industry, including events involving the use of radiation sources and the transport of radioactive materials. More than 60 countries are currently participating in the INES Information Service. In 2005, the INES Advisory Committee assessed the latest developments, including pilot use of guidance for rating events involving radiation sources and their transport. The Committee recommended that the Agency reinforce training in the use of the scale. The Agency assists Member States, upon request, in organizing workshops to promote the INES methodology. In March, the Agency conducted a seminar in Point Lepreau, Canada, on the INES methodology for Canadian nuclear power operators, regulators and public information experts. ■

Management of Radioactive Waste

Objective

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

Waste Safety Standards

The Waste Safety Standards Committee (WASSC) was reconstituted for 2005–2007 with modified terms of reference that emphasize the use of standards and sharing of experience from their use.

In September 2005, the Board of Governors approved the *Plan of Activities on the Radiation Protection of the Environment*, which calls for greater coordination between the various international organizations involved, namely the Agency, European Commission, International Commission on Radiological Protection (ICRP), International Union of Radioecology, the OECD/NEA and UNSCEAR. Enhanced information exchange and the revision and application of relevant Agency safety standards are also features of the plan.

Radioactive Waste Management

In October 2005, the Agency, in cooperation with the OECD/NEA and the Japan Nuclear Energy Safety Organization, organized an international conference in Tokyo on the safety of radioactive waste disposal. The conference focused on national strategies for radioactive waste management and considered all possible disposal options, including near surface, intermediate depth, borehole and geological disposal facilities, as well as multilateral approaches. Participants discussed the situation at sites where large volumes of waste from the mining and milling of radioactive ores or from other industries producing waste containing natural radionuclides have been deposited on the Earth's surface.

Even though it contains a small fraction of the total activity of all radioactive waste produced globally, low and intermediate level waste (LILW) represents more than 90% of the total volume of such waste. Many disposal facilities were developed and began operation long before current regulatory requirements or technical and safety advances took effect. The Agency's project on Improving Long Term Safety Assessment Methodologies for Near Surface Radioactive Waste Disposal Facilities (ISAM) and related projects focus on the practical problems of near surface disposal, such as the development of design concepts, safety reassessments and the upgrading of existing facilities. As part of ISAM activities, the Agency published *Natural Activity Concentrations and Fluxes as Indicators for the Safety Assessment of Radioactive Waste Disposal* (IAEA-TECDOC-1464) and *Upgrading of Near Surface Repositories for Radioactive Waste* (Technical Reports Series No. 433), which consolidate the extensive international experience and information available on actions to upgrade disposal facilities.

During processing, radioactive waste is converted into waste packages and then sent for storage and ultimately for disposal. A records system for waste management should be in place that defines the

The Agency's Safety Standards

During 2005, the Agency published two Safety Guides in the waste safety area:

- *Environmental and Source Monitoring for Purposes of Radiation Protection* (RS-G-1.8);
- *Management of Waste from the Use of Radioactive Materials in Medicine, Industry, Research, Agriculture and Education* (WS-G-2.7).

In addition, the Board of Governors approved a Safety Requirements publication, co-sponsored by the OECD/NEA, on geological disposal (WS-R-4).

data to be collected and stored at each step of waste processing and uses a reliable selection process. In this connection, a report was issued in 2005 — *Methods for Maintaining a Record of Waste Packages during Waste Processing and Storage* (Technical Reports Series No. 434).

Another Agency publication — *Disposal Options for Disused Radioactive Sources* (Technical Reports Series No. 436) — reviews technical factors and issues, as well as approaches and technologies leading to the identification of potential disposal options for disused radioactive sources. It also provides a road map for the disposal of disused radioactive sources, taking into consideration the high degree of variability in the radiological properties of such types of radioactive waste.

Decommissioning of Nuclear Facilities

As the world's existing nuclear power plants continue to age, the Agency has devoted increasing attention to assisting Member States with their decommissioning, including the establishment of an expert group to focus on decommissioning issues important to Member States. As part of these efforts, in 2005 the Agency published *Financial Aspects of Decommissioning* (IAEA-TECDOC-1476) and *Selection of Decommissioning Strategies: Issues and Factors* (IAEA-TECDOC-1478), which identify relevant constraints and conditions for decommissioning strategies. The reports provide information that will enable policy makers to take note of specific decommissioning factors and constraints in order to provide support in the selection of a decommissioning strategy.

The content and format for decommissioning plans and supporting safety related documents were published in 2005 (Safety Reports Series No. 45). The report is applicable to all types of nuclear facilities, including nuclear power plants, reprocessing facilities, university laboratories and manufacturing plants. By using a graded approach in the application of this report, the owner of a facility can provide the information necessary to allow the regulatory body to determine whether the decommissioning activities have been properly evaluated with respect to safety.

A database was developed incorporating information from research reactor decommissioning projects. In addition, extension of PRIS to include nuclear power plants that have been shut down is available on-line for submission of data by Member States.

Remediation of Contaminated Sites

The results of the preliminary radiological assessment of former French nuclear test sites at In Ekker and Reggane, in Algeria, were published. The report provided recommendations for consideration by the Algerian Government.

Dispersed low level contamination poses a particular challenge to those charged with its remediation. Many techniques are not efficient below certain concentration thresholds, or entail more severe impacts on certain environmental compartments than the contamination itself. A report published in 2005 by the Agency on *Remediation of Sites with Dispersed Radioactive Contamination* (Technical Reports Series No. 424) examines a variety of options for dealing with dispersed low level contamination broadly grouped into the three categories of non-intervention, containment and removal.

Chernobyl Forum

The Chernobyl Forum was established to assist in the implementation of the UN project 'Human Consequences of the Chernobyl Accident — A Strategy for Recovery', launched in 2002. The Forum completed its work in 2005 and issued two consensus reports. These are discussed in greater detail in the first chapter, The Year in Review.

Radioactive Waste Services

A peer review mission was requested by the Korean Hydro and Nuclear Power Company (KHNP) to assess the siting process for a LILW repository. The mission to Seoul, conducted in October–November 2005, consisted of four experts from the Czech Republic, France and the United Kingdom. The team visited Gyeongju, the candidate site selected in a public poll to accept the repository. The review team did not find any features disqualifying the proposed candidate sites from further consideration.

Lithuania's national organization for radioactive waste management, RATA, requested the Agency to organize a peer review mission to assess the long term safety aspects of its siting and site characterization programme for development of a disposal facility for short lived LILW. Consistent

with international practice, RATA is developing a near surface disposal concept. A large fraction of the radioactive waste arisings for the new disposal facility will be derived from the operation and decommissioning of the Ignalina nuclear power plant. The peer review meeting took place December 2005 in Vilnius, and included a visit to the three proposed sites near the Ignalina plant. The team concluded that the process of site characterization was being conducted according to good international practice and that the three sites being considered offer good prospects of meeting internationally recognized safety objectives and criteria. However, further work is necessary to improve site selection and confirm safety. The findings will be documented in a forthcoming Agency publication.

In Argentina, there were reports that the groundwater supply in the vicinity of the Ezeiza Atomic Center (EAC) was contaminated with anthropogenic radioactive substances, including enriched and depleted uranium. The Argentine Nuclear Regulatory Authority issued a report that found no contamination. To further reassure the local population, the Argentine Government requested the Agency to organize an independent appraisal. Experts from the Agency, FAO, PAHO, UNSCEAR and WHO, as well as the ICRP and the International Radiation Protection Association, participated in the appraisal. The first stage consisted of a technical field mission to the area in 2005. The final report to the Argentine Government is scheduled for 2006.

Nuclear Security

Objective

To increase Member State awareness and ability to control and protect nuclear and other radioactive materials, nuclear installations and transports, from terrorist and other illegal activities, and to detect and respond to such events and provide engineering safety measures, as necessary.

Completion of the Agency's Nuclear Security Plan for 2002–2005

The Plan of Activities to Protect Against Nuclear Terrorism, approved by the Board of Governors in March 2002, set an ambitious agenda for the Agency. It combined the acceleration of existing Agency activities with the development of an extensive range of new measures to assist Member States, upon request, in the prevention, detection and response to malicious acts involving nuclear and other radioactive materials and their associated facilities and transports. Specific measures included: effective management and control of materials through regulation and accountancy; prevention of theft; physical protection of materials, locations and transports against attacks; detection of illicit trafficking; and radiological emergency response measures.

In implementing the Plan, highest priority was given to activities achieving timely improvements to nuclear security in Member States. These activities resulted in:

Improved preparedness in States to address the risk of malicious acts;
Increased awareness in States of the importance of establishing an infrastructure, including regulatory systems, in support of nuclear security;
Improved physical protection of nuclear facilities;
Enhanced radiation monitoring capabilities established at borders;
Recovery of a substantial number of vulnerable, high activity, radioactive sources
Increased legal commitments;
More States joining the Illicit Trafficking Database (ITDB);
Training and educational activities in all regions, reaching some 1500 participants;
More than 100 evaluation missions, including those for the overall assessment of needs, physical protection evaluation, vulnerability assessment and follow-up to previous activities and missions.

Nuclear Security Plan for 2006–2009

In September 2005, the Board of Governors approved a new Nuclear Security Plan covering the years 2006–2009 to support Member States in their efforts to establish and maintain effective national nuclear security regimes. The cost of implementating the Plan is estimated at $15.5 million annually. It encompasses three main areas of activity:

(1) *Needs assessment, analysis and coordination* to enable a structured approach to nuclear security implementation through effective prioritization of activities, monitoring progress and targeted new activities;
(2) *Prevention* activities that assist States to protect nuclear and other radioactive material from malicious acts, such as theft and sabotage, carried out by terrorists or other criminals;
(3) *Detection and response* activities that provide assistance to help States combat illicit trafficking and emergency response.

The Nuclear Security Plan also covers other activities, for example State systems of accounting for and control of nuclear material, radiation and installation safety, and the management of radioactive waste.

Physical Protection of Nuclear Material

During 2005, the Agency conducted four International Physical Protection Advisory Service (IPPAS) missions, which provided peer review based evaluations of State implementation of physical protection responsibilities and served as the basis of recommendations for improving physical protection systems in States (Fig. 1). The Agency also conducted physical protection courses, workshops and seminars at the national, regional and international levels.

FIG. 1. Inspecting security barriers at a nuclear facility during an Agency expert mission.

Progress was made in the development of guidance documents as part of the emerging IAEA Nuclear Security Series of publications covering such topics as security culture, design basis threat methodology, security of radioactive sources, security of radioactive waste, protection against sabotage, transport security and physical protection regulations.

Security of Radioactive Sources

Radioactive sources are used in numerous applications throughout the world and are difficult to protect due to their large numbers. The Agency is actively involved in building awareness internationally on the need to control and physically protect radioactive sources at their locations, taking a multi-track approach to assist States in their efforts to secure radioactive material. One example was work under the 'Tripartite Initiative', a multilateral effort between the Agency, the Russian Federation and the USA for securing vulnerable radioactive sources in the States of the former Soviet Union. By the end of 2005, work was completed in six States on the dismantling and relocation of high risk radioactive sources, as identified previously by fact-finding missions and agreed with the concerned national authorities.

As in previous years, the Agency continued in 2005 to carry out missions to appraise the effectiveness of national regulatory infrastructures governing both the safety and security of radioactive sources and to promote the adoption of information systems to manage source inventories and control systems. It also maintained and updated the International Catalogue of Radioactive Sources and Devices to aid source identification and recovery efforts in States.

Combating Illicit Nuclear Trafficking

The Agency offers States a wide range of services and support in combating illicit trafficking. In 2005, the Agency provided training to monitor, detect, identify and respond to incidents involving nuclear and other radioactive material. Nuclear security missions to States were opportunities for assessing the technical and organizational means available to States to combat illicit trafficking activity and for consulting with national and local authorities on how outstanding needs should best be met. As needed, the Agency complemented its advisory assistance with technical guidance and activities for building awareness among policy makers and others involved in nuclear security.

In 2005, the Agency continued to receive reports from Member States about incidents of illicit trafficking and other related unauthorized activities involving nuclear and other radioactive material, which were subsequently recorded in the ITDB. Information reported to the ITDB indicates the potential availability of nuclear and other radioactive material for malicious use. It also shows that measures to protect this material from theft and to detect and respond to illicit trafficking in nuclear and other radioactive material require further strengthening. Membership in the ITDB reached 86 in 2005. A total of 161 incidents were reported by Member States, of which 105 occurred during 2005 (Fig. 2).

A new CRP was started in 2005 to assist States in the application of nuclear forensics in combating illicit trafficking. The objective is to strengthen the capability of Member States to characterize seized items while preserving forensic evidence, and to utilize nuclear forensics techniques for nuclear attributions.

Three publications in the new IAEA Nuclear Security Series were circulated to Member States for comments prior to being issued. The first provides a set of technical specifications for use in the design, testing, qualifying and purchase of border radiation monitoring equipment, with an emphasis on facilitating the deployment of equipment in States. The second publication provides guidance to States on the tools and procedures of nuclear forensics

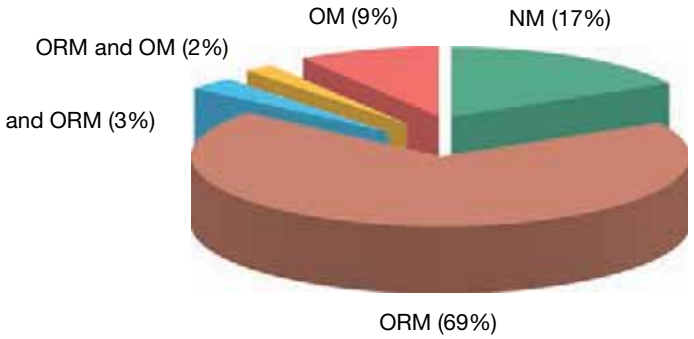


FIG. 2. Confirmed incidents of illicit trafficking and other related unauthorized activities involving nuclear and other radioactive material, as reported to the ITDB in 2005 (NM: nuclear material; OM: other material, which includes mainly radioactively contaminated materials; ORM: other radioactive material, which includes mainly radioactive sources).

investigations in responding to illicit trafficking events involving radioactive material. The third, prepared in cooperation with Interpol and the UPU, provides a description of the techniques and equipment used to detect and control radioactive material in international mail transported by public postal operators.

International Cooperation

Agency activities in the area of nuclear security continue to be underpinned by collaboration and coordination with other regional, transnational and international organizations. In March 2005, the Agency organized an international conference on 'Nuclear Security: Global Directions for the Future', in London. The conference, which was held in cooperation with the European Union, Organization for Security and Co-operation in Europe, International Criminal Police Organization, European Police Office and the World Customs Organization, recognized that the risk of successful acts of nuclear terrorism remains high. Other areas of agreement included: priorities for reducing this risk and continued efforts to implement

Amendment to the Convention on the Physical Protection of Nuclear Material

In response to requests from a majority of States parties to the Convention on the Physical Protection of Nuclear Material (CPPNM), a conference was held in Vienna, from 4 to 8 July 2005, to consider proposed amendments to the convention. The conference adopted by consensus, an amendment to the CPPNM on 8 July 2005. Delegates of 81 States Parties signed the Final Act of the Conference.

The amendment provides for an expanded regime by strengthening the convention in a number of areas. First, the amendment extends the scope of application of the CPPNM by requiring States to establish, implement and maintain a regime applicable to the physical protection of nuclear material in domestic use, storage and transport, and of nuclear facilities. Second, with regard to the prevention and combating of offences relating to nuclear material and nuclear facilities worldwide, the amendment specifies new offences and provides for the revision of the majority of existing offences under the CPPNM. In particular, it requires States to bring under their jurisdiction and make punishable under their national laws certain offences including theft, robbery, smuggling of nuclear material or sabotage of nuclear facilities, as well as acts related to directing and contributing to the commission of such offences. Third, new arrangements for expanded cooperation, assistance and coordination amongst States, for example regarding rapid measures to locate and recover stolen nuclear material, to mitigate any radiological consequences of sabotage, and to prevent and combat relevant offences, are foreseen. The amendment will enter into force on the thirtieth day after the date on which two thirds of the States parties have deposited their relevant instruments with the Director General.

The General Conference, in welcoming the amendment to the CPPNM, encouraged "all States party to the Convention to ratify the amendment as soon as possible and to deposit instruments of ratification, acceptance or approval with the depositary to enable the early entry into force of the amendment." In addition, "all States party to the Convention [were encouraged] to act in accordance with the object and purpose of the amendment until such time as the amendment enters into force."

preventive measures, the emphasis being on the physical protection of and accountability for radioactive material in use, storage and transport. The conference identified the importance of a clear allocation of responsibilities, implementation of a nuclear security culture, and of a graded approach in addressing threats, taking into consideration the risks and potential consequences. The conference also recognized that the Agency had a leading role in the effort to improve the global nuclear security framework and to promote its implementation.

The Joint Action cooperation between the Agency and European Union, initiated on 1 January 2005, entails concerted work to secure nuclear and other radioactive material, including those in non-nuclear use, and to enhance detection and response capabilities in States in south-eastern Europe, Central Asia and the Caucasus. The project's priorities include: strengthening the physical protection of nuclear and of other radioactive material in use, storage and transport, and of nuclear facilities; strengthening the security of radioactive material in non-nuclear applications; and strengthening the capabilities of States in the detection of and response to illicit trafficking. In July 2005, a new agreement was signed, extending the implementation period, the scope of the assistance and the geographical regions covered by the project. ■

Verification

Safeguards

Objective

To provide credible assurance to the international community that nuclear materials and other items placed under safeguards are not diverted or misused, and, for States with comprehensive safeguards agreements in force, to provide credible assurance on the absence of undeclared nuclear material and activities for States as a whole; and to support the efforts of the international community in connection with nuclear disarmament.

Safeguards Conclusion for 2005

At the end of each year, the Agency draws a *safeguards conclusion* for each State, in which it applies safeguards, based upon the evaluation of all information available to it for that year. With regard to a State with a comprehensive safeguards agreement (CSA), the Agency seeks to provide credible assurance on two points: (1) that declared nuclear material remains in peaceful activities; and (2) that no undeclared nuclear material or activities exist. Only when provided with the necessary authority, access and information can the Agency draw the broader *conclusion* for such a State that *all* nuclear material in the State remains in peaceful activities.

For the Agency to draw such a broader conclusion credibly, both a CSA and additional protocol (AP) must be in force or otherwise applied for that State, *and* the Agency must have been able to conduct all necessary verification and evaluation activities under those agreements. For States that have CSAs in force and no APs, the Agency does not have sufficient means to draw a broader conclusion credibly, and therefore can only draw the *conclusion* that *declared* nuclear material remains in peaceful activities.

In 2005, safeguards were applied for 156 States with safeguards agreements in force with the Agency. Seventy States had both CSAs in force and APs in force or being otherwise applied. With regard to 24 of these States, the Agency concluded that for those States all nuclear material remained in peaceful activities. For 46 other such States, the Agency had not yet completed the necessary evaluations and could therefore only conclude that the declared nuclear material remained in peaceful activities. For 77 States with CSAs in force and no APs, the Agency was, similarly, only able to draw that conclusion. Three States had in force safeguards agreements which require the application of safeguards to nuclear material, facilities and other items specified in the relevant safeguards agreement. For these States, the Agency concluded that nuclear material, facilities or other items or material 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, and the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities. The Agency's *Safeguards Statement*, as well as the *Background to the Safeguards Statement and Executive Summary,* are available on the CD-ROM attached to the inside back cover of this report, and also on the Agency's public web site at *http://www.iaea.org/OurWork/SV/Safeguards/index.html.*

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 conclusions about that State's nuclear material or activities.

Islamic Republic of Iran (Iran)

During 2005, the Director General submitted six reports to the Board of Governors on the implementation of the CSA in Iran and the Board adopted two resolutions on the subject.

Iran continued to implement its CSA, and to act as if its AP were in force. Iran also provided the Secretariat with access to interview certain personnel. Corrective actions were undertaken by Iran in relation to the breaches of its obligations under its safeguards agreement.

Verification of the correctness and completeness of Iran's declarations continued in 2005. The Agency was still not in a position to conclude that there were no undeclared nuclear materials or activities in Iran after three years of intensive Agency verification. At the close of 2005, there remained two major issues of direct relevance to these efforts: the origin of low

enriched uranium (LEU) and high enriched uranium (HEU) particle contamination found at various locations in Iran; and the extent and nature of Iran's uranium enrichment programme.

In addition to its implementation of the CSA and AP with Iran, in 2005, the Agency continued to perform verification activities related to Iran's voluntary suspension of enrichment-related and reprocessing activities, which had been requested by the Board of Governors as confidence-building measures. In August 2005, Iran informed the Agency of its decision to resume the uranium conversion activities at the Uranium Conversion Facility at Esfahan.

In a resolution adopted in September 2005, the Board found that Iran's previous failures and breaches of its obligations to comply with its CSA constituted non-compliance in the context of Article XII.C of the Agency's Statute.

Other Safeguards Issues

In June 2005, the Board of Governors decided to establish an Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute. The Advisory Committee is to consider ways and means to strengthen the safeguards system and make relevant recommendations to the Board. The first Committee meeting was held in November 2005. At the request of Member States, the Secretariat proposed a number of areas for the Committee's consideration.

During 2005, consultations were carried out by the Director General and the Secretariat with concerned States of the Middle East region on a forum on the relevance of the experience of existing nuclear-weapon-free-zones (NWFZs), including confidence building and verification measures, for establishing such a zone in the region of the Middle East. Although the concerned States did not reach a final agreement on the agenda for such a forum, the Director General remains ready to continue to consult with the concerned States in order to reach agreement in this regard. The Director General called for an expanded regional dialogue on issues of security to facilitate the establishment of an NWFZ in the region of the Middle East, at the Conference of States Parties and Signatories of Treaties That Establish Nuclear-Weapon-Free Zones held in Mexico City in April 2005. At the 2005 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, held in New York from 2 to 27 May, the Director General continued to encourage the concerned States to initiate a regional security dialogue in parallel with the resolution of long-standing conflicts that could lead to the establishment of an NWFZ in the Middle East.

Conclusion of Safeguards Agreements and APs

The Agency continued to facilitate the conclusion of safeguards agreements and APs. As a result of these activities, the number of States party to the NPT that had yet to conclude CSAs decreased from 40 to 36; APs entered into force for 9 States during 2005. At the end of 2005, APs were in force in 71 States and were otherwise being applied in a further two States (Fig. 1). In 2005, 17 States signed APs and 8 States signed NPT safeguards agreements.

Small Quantities Protocols (SQPs)

In early 2005, the Secretariat brought to the attention of Member States the limitations that the then standard 'Small Quantities Protocol' (SQP) placed on effective safeguards implementation. Introduced in 1971, SQPs were made available to States with little or no nuclear material and with no nuclear material in a facility. The original text of an SQP held in abeyance the implementation of important safeguards measures, including strengthening measures being implemented routinely in other States with CSAs in force.

The Director General submitted a report on the issue to the Board of Governors for its meeting in June 2005. The Board recognized that SQPs, as originally formulated, constituted a weakness of the safeguards system and in September 2005 it decided that, although SQPs should remain part of the Agency's safeguards system, they should be subject to modifications in the standard text and changed criteria for an SQP. The Board also decided that, henceforth, it would approve only SQP texts based on the revised standard text. The changes endorsed by the Board: (a) make an SQP unavailable to a State with an existing or planned facility; (b) require States to provide initial reports on nuclear material and notification as soon as a decision has been taken to construct or to authorize construction of a nuclear facility; and (c) allow for Agency inspections. The Board of Governors authorized the Director General to conclude exchanges of letters with all States with SQPs to give effect to these modifications.

Implementation of Integrated Safeguards

As more States implement APs and the Agency is able to draw the broader safeguards conclusion for more of those States, 'integrated safeguards' are being gradually implemented in these States. The term 'integrated safeguards' refers to an optimum combination of measures of CSAs and APs.

Integrated safeguards were implemented throughout 2005 in Australia, Hungary, Indonesia, Japan, Norway, Peru and Uzbekistan and began during the year in Bulgaria and Slovenia. In addition, integrated safeguards approaches were approved for Canada and Poland. The introduction of integrated safeguards in States with large nuclear programmes has provided a unique opportunity to design and implement tailor-made efficient safeguards methods and approaches in many types of facilities. For instance, a new, less labour intensive safeguards approach for transfers of spent fuel to dry storage installations, field tested in Canada and the Republic of Korea, is expected to reduce substantially the number of days inspectors need to be physically present during spent fuel transfers.

The Agency organized a meeting in September 2005, in Austria, to discuss progress on integrated safeguards. States already having substantial experience with integrated safeguards — Australia, Hungary and Japan — shared views with a larger group of States where integrated safeguards began in 2005 or are being planned for in the near term.

Detecting Undeclared Nuclear Material and Activities: Improved Technological Capabilities and Methodologies

In the development and application of new technologies, the Agency relies heavily on 19 Member State Support Programmes. The Member States, drawing on their technical expertise, assist the Agency in meeting its needs as defined in the *Research and Development Programme for Nuclear Verification, 2006–2007*.

The Agency's new R&D project for the identification and development of effective and appropriate advanced technologies for the detection of undeclared nuclear material and activities focused on the evaluation and prioritization of initial technology proposals from Member States. Over 60 proposals were received and, as a result of review

FIG. 1. Conclusion of additional protocols: 1998–2005.

and prioritization, five specific tasks from three States, covering novel techniques for the detection of undeclared activities were recommended for further development.

Environmental sampling continues to be used extensively to verify the absence of undeclared nuclear activities in facilities subject to routine inspections and complementary access. The handling and analysis of environmental samples in the Safeguards Analytical Laboratory (SAL), in Seibersdorf, was improved by modernizing the systems and methodology used for the screening of samples, sample preparation and measurement of particles by secondary ion mass spectrometry (SIMS).

A new ultra-high sensitive SIMS instrument tested by Agency specialists at laboratories in France and Sweden for application to the analysis of safeguards environmental samples has been recommended for implementation at SAL. In addition, encouraging developments in plutonium and uranium particle age dating and advances in the morphological characterization of process particles might provide promising new tools for future safeguards verification activities.

The need for enhanced Agency analytical services in terms of capacity and detection capabilities was reflected in a number of activities, including elaboration of a proposal on increasing the capacity and independence of safeguards analytical services.

Information Analysis and Remote Monitoring

The cornerstone of the Agency's safeguards system remains the declarations submitted by States, and their subsequent verification by the Agency. However, analysis of open source information, including satellite imagery, continues to play a key role in the evaluation of States' nuclear programmes. The available information assists in the identification of activities and locations of interest, thus helping inspectors to plan field activities, clarify questions and issues of concern, and better understand nuclear programmes. The operation of covert nuclear trade activities and networks poses a new challenge to the Agency's verification work.

In July 2005, the Agency initiated the reengineering of its information systems (ISIS), which are used to collect, store, analyse and evaluate safeguards data. The ISIS Re-engineering Project (IRP) will be carried out over a period of three and a half years. The project will comprise a large number of tasks such as establishing a new physical architecture, hardware, software and standards, defining an integrated information system with appropriate security standards and producing the information environment needed to enhance the efficiency and effectiveness of the Agency's verification activities.

A number of new or enhanced information technology (IT) tools that will support the work of inspectors or improve the efficiency of implementation were introduced during 2005. These include:

- An application that allows inspectors in the field secure access to databases located at Headquarters, and to process information related to on-going inspections;
- Software that facilitates a streamlined process of inspector designations;
- Enhancements to the software for processing AP declarations.

The IT infrastructure has been continuously upgraded, at Agency Headquarters as well as in the Agency's Regional Offices, maintaining the highest level of availability and security.

The number of Agency surveillance and radiation monitoring systems with remote transmission capabilities increased by more than 40% in 2005. Currently, 84 surveillance systems (with 302 cameras) are operating in remote monitoring mode in 15 States.[1] In addition, 39 unattended radiation monitoring systems are transmitting data to Agency Headquarters from facilities in seven States. The application of this technology has resulted in considerable savings of inspection efforts in 2005.

The Agency began cooperation with the European Space Agency in the area of secure satellite communications. As part of this cooperation, the Agency successfully tested secure surveillance data transmission via satellite from a nuclear power plant to Agency Headquarters. It was demonstrated that the same satellite terminal could also be used for secure voice communication, which is considered a useful tool for inspection activities in the field.

The development of the next generation surveillance system was initiated in 2005. The aim

[1] As well as in Taiwan, China.

is to authorize the new system for inspection use by 2008, when the present digital surveillance system will be phased out. In November 2005, the Agency began implementing a new type of electronic optical sealing system, which represents a major technological improvement in electronic sealing applications. The new seal has remote monitoring (RM) capabilities, with strengthened authentication and state of the art encryption technology. At a plutonium storage facility in the USA, an RM system on both the radiofrequency seals and surveillance system was installed in August 2005 for a field trial. In the near future, implementation of this system will also result in considerable savings in the inspection effort at the relevant facilities. Another innovative safeguards system, which has been developed, will allow for unattended monitoring of the loading and shipment of spent fuel at WWER 1000 power reactors.

Assistance to SSACs

State systems of accounting for and control of nuclear material (SSACs) are fundamental to effective and efficient safeguards implementation. A software application aimed at improving the quality of State reporting of nuclear material accounts has been developed and acceptance tests carried out with the cooperation of selected States. The software is available to all States with safeguards agreements on request.

Following testing during a pilot mission of the IAEA SSAC Advisory Service (ISSAS) in 2004, guidelines for the conduct of these missions were published. During 2005, emphasis was placed on the implementation of ISSAS. Upon the request of the Republic of Korea, the first ISSAS mission was conducted. Eight national, regional and international training courses were conducted for personnel in Member States to assist them in fulfilling their obligations under safeguards agreements and APs.

Covert Nuclear Trade Networks

During 2005, proliferation risks created by covert nuclear trade networks related to the supply and procurement of sensitive nuclear technology remained a concern to the Agency. The General Conference welcomed the Secretariat's activities to strengthen safeguards by verifying and analysing information provided by Member States on nuclear supply and procurement and invited all States to cooperate with the Agency in this regard. The Agency worked with Member State Governments to facilitate the acquisition of information on the trade in sensitive technologies through a network of contacts. Analysis of such information continued and increased the Agency's understanding of the scope and operation of covert nuclear trade networks, which, in return, contributed to the implementation of safeguards.

Verification in Iraq Pursuant to UNSC Resolutions

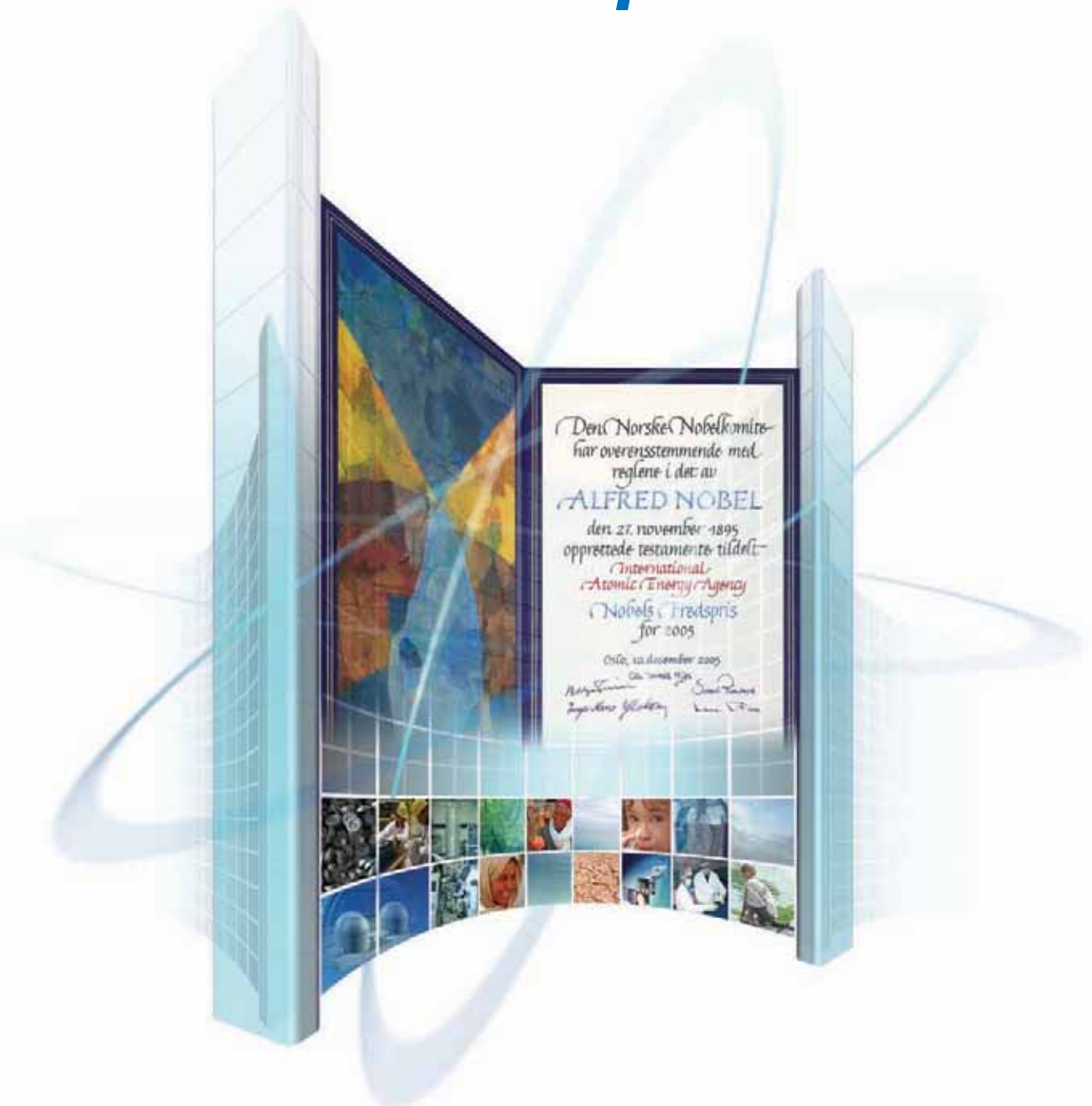
Objective

To provide credible assurance to the United Nations Security Council (UNSC) that Iraq is complying with the provisions of UNSC Resolution 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 the year 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 further strengthen the technical cooperation programme by contributing to sustainable and significant social and economic benefits in Member States and increased self-reliance in the application of nuclear techniques.

Streamlining Technical Cooperation Activities

As the quality of the technical cooperation programme begins with the quality of its preparation, careful upstream work constitutes the foundation upon which the programme is built. Therefore, the Secretariat devoted considerable effort in 2005 to supporting countries in comprehensively drafting or updating their Country Programme Frameworks (CPFs) as well as choosing and preparing their concepts for technical cooperation projects, with emphasis on project quality and potential for impact.

Achieving a coherent, results-based programme of technical cooperation requires good project design, as well as close coordination with partner governments and institutions in order to maximize impact for the long term. On the basis of such coordination and consultation, the Agency — through the technical cooperation programme — disbursed $73.6 million in 2005 in the form of projects and activities. The breakdown of disbursements by region was: Africa, $19.5 million; Asia and the Pacific, $18.1 million; Europe, $23.3 million; and Latin America, $11.9 million. Least developed countries received 16% of the disbursements.

Streamlining efforts carried out by the Secretariat included the finalization and implementation of the new organizational structure for the Department of Technical Cooperation. The overall objective is to improve working arrangements to enhance the quality of the programme and facilitate the Agency's ability to carry out strategic functions. The organizational structure focuses on regions and on responding to regional and national priorities. The main elements of this structure are:

- Four regional divisions: Africa, Asia and the Pacific, Europe and Latin America.
- Two sections within each regional division: Member States have been grouped into these sections to establish an appropriate balance between funding and workload and taking into account factors such as sub-regional priorities, cooperative arrangements, thematic and CPF focus areas, and opportunities for technical cooperation among developing countries.
- A Division of Programme Support and Coordination that provides advice, information and support services to senior management and the regional divisions, and coordinates aspects of the Technical Cooperation Strategy and programme development.

The quality and consistency of the technical cooperation programme across all regions are further benefiting from a renewed focus on process improvement. Initial steps of a systematic approach to quality management included the adoption of a team approach in the regional divisions for project planning and implementation, and a review of processes to make them simpler and more consistent with best practices.

Responding to the evolution of the technical cooperation programme in terms of size, complexity and number of participating Member States, the Agency established a working group which, in consultation with Member States, developed and implemented the Programme Cycle Management Framework (PCMF). The aims of the PCMF are to:

- Help Member States take responsibility for the design and execution of the programme;
- Capitalize on the teamwork and participation of all stakeholders from the outset;
- Promote greater transparency and consistent application of good business practices;
- Make use of a flexible methodology;
- Provide greater focus on needs assessment and problem analysis through fieldwork early in the programming cycle.

The PCMF is being developed and implemented in a phased manner to support the formulation of the technical cooperation programme for the

2007–2008 cycle. Phase I was completed, facilitating project identification through concept submission by Member States and review by the Secretariat, on the basis of CPFs and technical criteria. Phase II covers the development of the pre-qualified project concepts into full-fledged projects comprising background information on the project, a logical framework matrix and work plans. Further phases will address project implementation and monitoring, as well as project review and impact assessment. The entire framework is planned to be fully functional by the end of 2006. A web-based platform to support the PCMF process is being developed in parallel, to reduce the workload for counterparts and the Secretariat.

In addition, during 2005 a draft of comprehensive guidelines for CPFs was developed in response to recommendations from external auditors and the Standing Advisory Group for Technical Assistance and Cooperation. The task was undertaken by an interdepartmental working group whose membership drew on the knowledge and experience of all the stakeholders in the CPF process, including National Liaison Officers and Member State representatives.

Legislative Assistance to Member States

As in previous years, the Agency provided assistance to Member States to enable them to further develop their national nuclear legislation. In 2005, assistance in drafting such legislation was provided to 11 Member States. Training on issues related to nuclear legislation was provided to 17 fellows.

The increasing number and complexity of international instruments in the areas of nuclear safety, security and verification led to the development of a new approach with regard to the Agency's legislative assistance activities that recognizes the interface between these different areas. The new approach also includes the creation of an international nuclear law web site for use by Member States and guidance material on drafting national legislation in the various fields of nuclear law. ■

Annex

Table A1. Allocation and utilization of regular budget resources in 2005

Table A2. Extrabudgetary funds in support of the regular budget, 2005 (including the Nuclear Security Fund)

Table A3. Technical cooperation disbursements by Agency programme and region in 2005

Table A4. Status with regard to the conclusion of safeguard agreements, additional protocols and small quantities protocols (as of 31 December 2005)

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Table A12. Safety Review Service and expert missions in 2005

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Table A14. International Physical Protection Advisory Service (IPPAS) missions in 2005

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Table A19. Number of States having significant nuclear activities at the end of 2002, 2003, 2004 and 2005

Table A20. Approximate quantities of material subject to Agency safeguards at the end of 2005

Table A21. Number of facilities under Agency safeguards or containing safeguarded material on 31 December 2005

Table A22. Coordinated Research Projects initiated in 2005

Table A23. Coordinated Research Projects completed in 2005

Table A24. Training courses, seminars and workshops in 2005

Table A25. Publications issued in 2005

Note: Tables A6–A25 are available on the attached CD-ROM.

Table A1. Allocation and Utilization of Regular Budget Resources in 2005

Major Programme/Programme	2005 original budget (at €0.9229) (in $) (1)	2005 revised adjusted budget[a] (at €0.8017) (in $) (2)		Total expenditure Amount (3)	Total expenditure % of adjusted budget (3)/(2) (4)	Phase II security enhancement (5)	Unused (overexpended) budget (2) – (3) – (5) (6)
1. Nuclear Power, Fuel Cycle and Nuclear Science							
1. Overall Management, Coordination and Common Activities	725 200	808 900		809 849	100.12%		(949)
A. Nuclear Power	5 283 000	5 871 600		5 867 166	99.92%		4 434
B. Nuclear Fuel Cycle and Materials Technologies	2 588 400	2 867 400		2 861 146	99.78%		6 254
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	7 759 500	8 641 600		8 643 836	100.03%		(2 236)
D. Nuclear Science	8 717 900	9 428 500		9 436 003	100.08%		(7 503)
Sub-total – Major Programme 1	**25 074 000**	**27 618 000**		**27 618 000**	**100.00%**		**–**
2. Nuclear Techniques for Development and Environmental Protection							
2. Overall Management, Coordination and Common Activities	791 700	884 600		879 440	99.42%		5 160
E. Food and Agriculture	12 269 800	13 486 400		13 591 564	100.78%		(105 164)
F. Human Health	8 186 000	8 919 100		8 848 279	99.21%		70 821
G. Water Resources	3 324 600	3 682 900		3 571 541	96.98%		111 359
H. Protection of the Marine and Terrestrial Environment	3 984 200	4 458 400		4 488 377	100.67%		(29 977)
I. Physical and Chemical Applications	2 751 700	3 033 600		3 085 581	101.71%		(51 981)
Sub-total – Major Programme 2	**31 308 000**	**34 465 000**		**34 464 782**	**100.00%**		**218**
3. Nuclear Safety and Security							
3. Overall Management, Coordination and Common Activities	985 400	1 090 000		1 095 488	100.50%		(5 488)
J. Safety of Nuclear Installations	8 704 200	9 701 800		9 478 033	97.69%		223 767
K. Radiation and Transport Safety	5 539 500	6 194 227	[b]	6 425 345	103.73%		(231 118)
L. Management of Radioactive Waste	6 717 700	7 451 200		7 431 479	99.74%		19 721
M. Nuclear Security	1 394 200	1 556 700		1 563 582	100.44%		(6 882)
Sub-total – Major Programme 3	**23 341 000**	**25 993 927**	[b]	**25 993 927**	**100.00%**		**–**
4. Nuclear Verification							
4. Overall Management, Coordination and Common Activities	1 055 300	1 182 100		1 239 596	104.86%		(57 496)
N. Safeguards	107 728 700	119 932 900		119 854 787	99.93%		78 113
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)							
Sub-total – Major Programme 4	**108 784 000**	**121 115 000**		**121 094 383**	**99.98%**		**20 617**
5. Information Support Services							
P. Public Information and Communication	3 390 100	3 803 900		3 606 621	94.81%		197 279
Q. Information and Communications Technology (ICT)	7 736 900	8 775 500		8 586 725	97.85%		188 775
R. Library and Information Support	2 661 800	2 996 100		3 000 906	100.16%		(4 806)
S. Conference, Translation and Publishing Services	5 594 200	6 303 500		6 684 748	106.05%		(381 248)
Sub-total – Major Programme 5	**19 383 000**	**21 879 000**		**21 879 000**	**100.00%**		**–**
6. Management of Technical Cooperation for Development							
6. Overall Management, Coordination and Common Activities	573 300	643 000		838 917	130.47%		(195 917)
T. Management of Technical Cooperation for Development	15 755 700	17 685 073		16 707 763	94.47%		977 310
Sub-total – Major Programme 6	**16 329 000**	**18 328 073**		**17 546 680**	**95.74%**		**781 393**
7. Policy and General Management							
U. Executive Management, Policy-Making and Coordination	14 174 100	15 756 500		15 031 121	95.40%		725 379
V. Administration and General Services (excluding V.5 – Security Enhancement Phase II)	38 271 800	43 472 300		44 510 965	102.39%		(1 038 665)
W. Oversight Services and Performance Assessment	1 858 100	2 072 200		1 758 904	84.88%		313 296
Sub-total – Major Programme 7	**54 304 000**	**61 301 000**		**61 300 990**	**100.00%**		**10**
Subtotal – Agency Programmes	**278 523 000**	**310 700 000**	[b]	**309 897 762**	**99.74%**		**802 238**
[a] V.5. GC(49)/RES/4	0	7 718 000		346 859	4.49%	7 371 141	–
TOTAL – Agency Programmes	**278 523 000**	**318 418 000**		**310 244 621**	**97.43%**	**7 371 141**	**802 238**
8. Reimbursable work for others	2 907 000	3 261 000		2 596 621	79.63%		664 379
TOTAL	**281 430 000**	**321 679 000**	[b]	**312 841 242**	**97.25%**	**7 371 141**	**1 466 617**

[a] Based on General Conference resolution GC(49)/RES/4, funding of the Agency's share of security enhancements was partly met by the use of salary provisions of all Major Programmes, partly by the use of the cash surplus for 2003, and partly by additional contributions from Member States.

[b] Based on the decision of the Board of Governors in document GOV/1999/15, an amount of $29 927 was transferred to Major Programme 3 'Nuclear Safety and Security" to cover the cost of emergency assistance provided to Chile. To recover this advance, year-end unencumbered balances in the Regular Budget Appropriation 6 "Management of Technical Cooperation for Development" were used.

Table A2. Extrabudgetary Funds in Support of the Regular Budget, 2005 (including the Nuclear Security Fund)

Major Programme / Programme	Extrabudgetary budget figures GC(47) /3	Resources			Total resources as at 31 Dec. 2005 (2)+(3)+(4)	Total expenditures as at 31 Dec. 2005	Unused balance as at 31 Dec. 2005 (5) – (6)
		Unused balance as at 1 Jan. 2005	Receipts[a] as at 31 Dec. 2005	Adjustments as at 31 Dec. 2005			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Nuclear Power, Fuel Cycle and Nuclear Science							
1. Overall Management, Coordination and Common Activities	0	2 367	(2 367)	0	0	0	0
A. Nuclear Power	1 460 000	680 473	1 634 019	47 375	2 361 867	1 169 075	1 192 792
B. Nuclear Fuel Cycle and Materials Technologies	350 000	573 230	551 425	2 100	1 126 755	558 377	568 378
C. Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	45 000	177 219	330 300	3 488	511 007	316 266	194 741
D. Nuclear Science	12 000	331 174	250 000	0	581 174	263 867	317 307
Sub-total — Major Programme 1	**1 867 000**	**1 764 463**	**2 763 377**	**52 963**	**4 580 803**	**2 307 585**	**2 273 218**
2. Nuclear Techniques for Development and Environmental Protection							
2. Overall Management, Coordination and Common Activities	0	112 061	104 741	0	216 802	199 157	17 645
E. Food and Agriculture (excl. FAO)	835 000	39 899	18 536	0	58 435	34 485	23 950
FAO	2 834 000	95 553	2 041 490	2 910	2 139 953	2 031 339	108 614
Total Programme E	3 669 000	135 452	2 060 026	2 910	2 198 388	2 065 824	132 564
F. Human Health	540 000	308 316	237 000	4 026	549 342	276 094	273 248
G. Water Resources	0	0	0	0	0	0	0
H. Protection of the Marine and Terrestrial Environment	922 000	518 181	816 299	1 028	1 335 508	754 766	580 742
I. Physical and Chemical Applications	0	5 500	39 985	0	45 485	39 985	5 500
Sub-total — Major Programme 2	**5 131 000**	**1 079 510**	**3 258 051**	**7 964**	**4 345 525**	**3 335 826**	**1 009 699**
3. Nuclear Safety and Security							
3. Overall Management, Coordination and Common Activities	0	482 753	264 741	790	748 284	233 299	514 985
J. Safety of Nuclear Installations	3 142 000	4 596 580	2 695 076	(21 477)	7 270 179	3 107 502	4 162 677
K. Radiation and Transport Safety	2 670 000	4 162 873	4 107 568	25 609	8 296 050	3 851 552	4 444 498
L. Management of Radioactive Waste	460 000	1 219 301	969 706	2 472	2 191 479	1 123 364	1 068 115
M. Nuclear Security	8 179 000	17 373 615	6 258 065	115 349	23 747 029	6 127 582	17 619 447
Sub-total — Major Programme 3	**14 451 000**	**27 835 122**	**14 295 156**	**122 743**	**42 253 021**	**14 443 299**	**27 809 722**
4. Nuclear Verification							
4. Overall Management, Coordination and Common Activities	0	452 485	231 873	0	684 358	0	684 358
N. Safeguards	14 614 000	25 782 141	15 896 983	475 888	42 155 012	12 927 699	29 227 313
O. Verification in Iraq Pursuant to UNSC Resolutions (Extrabudgetary Funding only)	11 715 000	1 597 910	112 000	157 768	1 867 678	1 600 018	267 660
Sub-total — Major Programme 4	**26 329 000**	**27 832 536**	**16 240 856**	**633 656**	**44 707 048**	**14 527 717**	**30 179 331**
5. Information Support Services							
P. Public Information and Communication	620 000	272 698	894 680	43 057	1 210 435	701 236	509 199
Q. Information and Communications Technology (ICT)	0	3 995	0	0	3 995	0	3 995
R. Library and Information Support	0	0	0	0	0	0	0
S. Conference, Translation and Publishing Services	0	0	0	0	0	0	0
Sub-total — Major Programme 5	**620 000**	**276 693**	**894 680**	**43 057**	**1 214 430**	**701 236**	**513 194**
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	128 000	296 884	534 670	0	831 554	480 537	351 017
Sub-total — Major Programme 6	**128 000**	**296 884**	**534 670**	**0**	**831 554**	**480 537**	**351 017**
7. Policy and General Management							
U. Executive Management, Policy-Making and Coordination	344 000	659 502	177 242	11 442	848 186	480 945	367 241
V. Administration and General Services	0	545 179	638 194	0	1 183 373	537 971	645 402
W. Oversight Services and Performance Assessment	0	185 732	239 000	0	424 732	216 770	207 962
Sub-total — Major Programme 7	**344 000**	**1 390 413**	**1 054 436**	**11 442**	**2 456 291**	**1 235 686**	**1 220 605**
Total Extrabudgetary Programme Fund	**48 870 000**	**60 475 621**	**39 041 226**	**871 825**	**100 388 672**	**37 031 886**	**63 356 786**

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

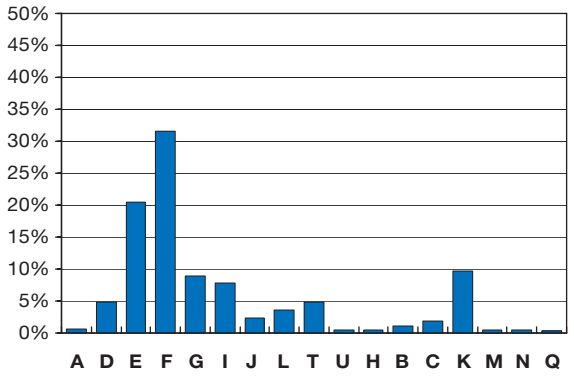
Table A3. Technical Cooperation Disbursements by Agency Programme and Region in 2005

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

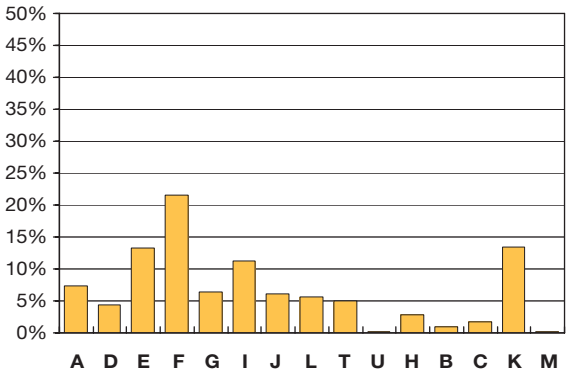
	Programme	Africa	Asia and the Pacific	Europe	Latin America	Global/ Inter-regional	Total
A	Nuclear Power	110.6	1 252.3	1 111.0	370.0	124.7	2 968.6
B	Nuclear Fuel Cycle and Materials Technologies	225.0	148.1	14.3	151.2	0.0	538.7
C	Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	354.5	283.1	458.6	174.8	101.7	1 372.9
D	Nuclear Science	938.5	761.7	5 739.6	756.8	15.0	8 211.6
E	Food and Agriculture	3 928.1	2 262.5	300.2	1 429.1	265.0	8 184.9
F	Human Health	6 076.0	3 679.4	4 710.9	3 301.3	107.1	17 874.6
G	Water Resources	1 726.6	1 091.1	382.1	977.5	16.2	4 193.5
H	Protection of the Marine and Terrestrial Environment	93.0	485.4	352.0	500.3	9.3	1 440.1
I	Physical and Chemical Applications	1 516.5	1 929.1	1 070.2	1 233.1	73.9	5 822.7
J	Safety of Nuclear Installations	453.4	1 048.3	2 688.0	99.5	35.5	4 324.6
K	Radiation and Transport Safety	1 850.0	2 302.5	2 122.0	1 474.3	688.8	8 437.7
L	Management of Radioactive Waste	683.3	963.2	2 537.5	195.7	480.8	4 860.6
M	Nuclear Security	88.6	20.8	676.9	11.8	114.1	912.1
N	Safeguards	94.0	0.2	2.4	6.2	0.0	102.7
P	Public Information and Communication	6.3	0.0	0.0	6.2	0.0	12.5
Q	Information and Communication Technology (ICT)	57.9	2.2	0.0	0.0	0.0	60.1
T	Management of Technical Cooperation for Development	919.3	867.9	626.9	699.8	952.3	4 066.2
U	Executive Management, Policy-Making and Coordination	103.5	27.2	29.4	12.7	0.0	172.9
Total		**19 225.1**	**17 125.1**	**22 822.0**	**11 400.4**	**2 984.4**	**73 557.0**

II. Distribution by Region (in thousands of dollars)

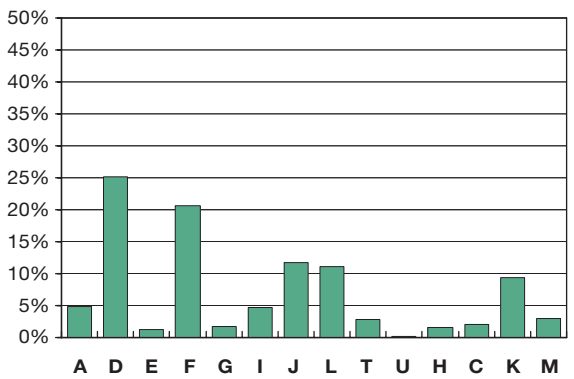
Africa: $19 225.1



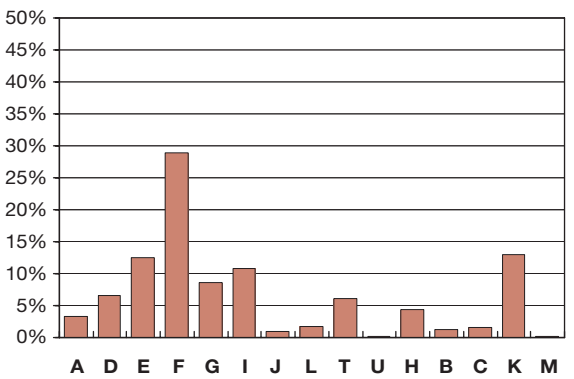
Asia and the Pacific: $17 125.1



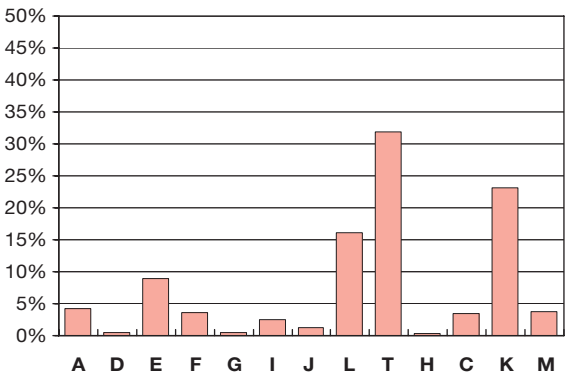
Europe: $22 822.0



Latin America: $11 400.4



Interregional: $2 984.4



Note: Letters denote Agency programmes (see part I of Table A3).

Table A4. Status with Regard to the Conclusion of Safeguards Agreements, Additional Protocols [a, b] and Small Quantities Protocols [c] (as of 31 December 2005)

State	SQP [c]	Status of safeguards agreement(s)	INFCIRC	Status of additional protocol
Afghanistan	X	In force: 20 February 1978	257	In force: 19 July 2005
Albania[d]		In force: 28 November 2002	359/Mod.1	Signed: 2 December 2004
Algeria		In force: 7 January 1997	531	Approved: 14 September 2004
Andorra	*X*	*Signed: 9 January 2001*		*Signed: 9 January 2001*
Angola				
Antigua and Barbuda[e]	X	In force: 9 September 1996	528	
Argentina[f]		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[g]		Accession: 31 July 1996	193	In force: 30 April 2004
Azerbaijan	X	In force: 29 April 1999	580	In force: 29 November 2000
Bahamas[e]	X	In force: 12 September 1997	544	
Bahrain				
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados[e]	X	In force: 14 August 1996	527	
Belarus		In force: 2 August 1995	495	Signed: 15 November 2005
Belgium		In force: 21 February 1977	193	In force: 30 April 2004
Belize[e]	X	In force: 21 January 1997	532	
Benin	X	*Signed: 7 June 2005*		*Signed: 7 June 2005*
Bhutan	X	In force: 24 October 1989	371	
Bolivia[e]	X	In force: 6 February 1995	465	
Bosnia and Herzegovina[h]		In force: 28 December 1973	204	
Botswana		*Approved: 20 September 2005*		*Approved: 20 September 2005*
Brazil[i]		In force: 4 March 1994	435	
Brunei Darussalam	X	In force: 4 November 1987	365	
Bulgaria		In force: 29 February 1972	178	In force: 10 October 2000
Burkina Faso	X	In force: 17 April 2003	618	In force: 17 April 2003
Burundi				
Cambodia	X	In force: 17 December 1999	586	
Cameroon	X	In force: 17 December 2004		Signed: 16 December 2004
Canada		In force: 21 February 1972	164	In force: 8 September 2000
Cape Verde		*Signed: 28 June 2005*		*Signed: 28 June 2005*
Central African Republic				
Chad				
Chile[j]		In force: 5 April 1995	476	In force: 3 November 2003
China		In force: 18 September 1989	369*	In force: 28 March 2002
Colombia[j]		In force: 22 December 1982	306	Signed: 11 May 2005
Comoros	X	*Signed: 13 December 2005*		*Signed: 13 December 2005*
Congo, Republic of the				
Costa Rica[e]	X	In force: 22 November 1979	278	Signed: 12 December 2001
Côte d'Ivoire		In force: 8 September 1983	309	
Croatia	X	In force: 19 January 1995	463	In force: 6 July 2000
Cuba		In force 3 June 2004	Pending	In force: 3 June 2004
Cyprus	X	In force: 26 January 1973	189	In force: 19 February 2003
Czech Republic[k]		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[l]		In force: 21 February 1977	193	In force 30 April 2004
Djibouti				
Dominica[m]	X	In force: 3 May 1996	513	

State	SQP [c]	Status of safeguards agreement(s)	INFCIRC	Status of additional protocol
Dominican Republic[e]	X	In force: 11 October 1973	201	
Ecuador[e]	X	In force: 10 March 1975	231	In force: 24 October 2001
Egypt		In force: 30 June 1982	302	
El Salvador[e]	X	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	*X*	*Approved: 13 June 1986*		
Eritrea				
Estonia[n]		Accession: 1 December 2005	547	Accession: 1 December 2005
Ethiopia	X	In force: 2 December 1977	261	
Fiji	X	In force: 22 March 1973	192	Approved: 16 June 2005
Finland[o]		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[p]		
Gabon	*X*	*Signed: 3 December 1979*		*Signed: 8 June 2005*
Gambia	X	In force: 8 August 1978	277	
Georgia		In force: 3 June 2003	617	In force: 3 June 2003
Germany[q]		In force: 21 February 1977	193	In force: 30 April 2004
Ghana		In force: 17 February 1975	226	In force: 11 June 2004
Greece[r]		Accession: 17 December 1981	193	In force: 30 April 2004
Grenada[e]	X	In force: 23 July 1996	525	
Guatemala[e]	X	In force: 1 February 1982	299	Signed: 14 December 2001
Guinea				
Guinea-Bissau				
Guyana[e]	X	In force: 23 May 1997	543	
Haiti[e]	*X*	*Signed: 6 January 1975*		*Signed: 10 July 2002*
Holy See	X	In force: 1 August 1972	187	In force: 24 September 1998
Honduras[e]	X	In force: 18 April 1975	235	Signed: 7 July 2005
Hungary		In force: 30 March 1972	174	In force: 4 April 2000
Iceland	X	In force: 16 October 1974	215	In force: 12 September 2003
India		In force: 30 September 1971	211	
		In force: 17 November 1977	260	
		In force: 27 September 1988	360	
		In force: 11 October 1989	374	
		In force: 1 March 1994	433	
Indonesia		In force: 14 July 1980	283	In force: 29 September 1999
Iran, Islamic Republic of		In force: 15 May 1974	214	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[e]		In force: 6 November 1978	265	In force: 19 March 2003
Japan		In force: 2 December 1977	255	In force: 16 December 1999
Jordan	X	In force: 21 February 1978	258	In force: 28 July 1998
Kazakhstan		In force: 11 August 1995	504	Signed: 6 February 2004
Kenya				
Kiribati	X	In force: 19 December 1990	390	Signed: 9 November 2004
Korea, Republic of		In force: 14 November 1975	236	In force: 19 February 2004
Kuwait	X	In force: 7 March 2002	607	In force: 2 June 2003
Kyrgyzstan	X	In force: 3 February 2004		
Lao Peoples Democratic Republic	X	In force: 5 April 2001	599	
Latvia		In force: 21 December 1993	434	In force: 12 July 2001
Lebanon	X	In force: 5 March 1973	191	
Lesotho	X	In force: 12 June 1973	199	
Liberia				
Libyan Arab Jamahiriya		In force: 8 July 1980	282	Signed: 10 March 2004

State	SQP [c]	Status of safeguards agreement(s)	INFCIRC	Status of additional protocol
Liechtenstein		In force: 4 October 1979	275	Approved: 16 June 2005
Lithuania		In force: 15 October 1992	413	In force: 5 July 2000
Luxembourg		In force: 21 February 1977	193	In force: 30 April 2004
Madagascar	X	In force: 14 June 1973	200	In force: 18 September 2003
Malawi	X	In force: 3 August 1992	409	
Malaysia		In force: 29 February 1972	182	Signed: 22 November 2005
Maldives	X	In force: 2 October 1977	253	
Mali	X	In force: 12 September 2002	615	In force: 12 September 2002
Malta	X	In force: 13 November 1990	387	In force: 12 July 2005
Marshall Islands		In force: 3 May 2005		In force: 3 May 2005
Mauritania	*X*	*Signed: 2 June 2003*		*Signed: 2 June 2003*
Mauritius	X	In force: 31 January 1973	190	Signed: 9 December 2004
Mexico[s]		In force: 14 September 1973	197	Signed: 29 March 2004
Micronesia, Federated States of				
Monaco	X	In force: 13 June 1996	524	In force: 30 September 1999
Mongolia	X	In force: 5 September 1972	188	In force: 12 May 2003
Morocco	X	In force: 18 February 1975	228	Signed: 22 September 2004
Mozambique				
Myanmar	X	In force: 20 April 1995	477	
Namibia	X	In force: 15 April 1998	551	Signed: 22 March 2000
Nauru	X	In force: 13 April 1984	317	
Nepal	X	In force: 22 June 1972	186	
Netherlands		In force: 5 June 1975	229	
		In force: 21 February 1977	193	In force: 30 April 2004
New Zealand	X	In force: 29 February 1972	185	In force: 24 September 1998
Nicaragua[e]	X	In force: 29 December 1976	246	In force: 18 February 2005
Niger		In force: 16 February 2005		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	*X*	*Signed:28 June 2001*		
Pakistan		In force: 5 March 1962	34	
		In force: 17 June 1968	116	
		In force: 17 October 1969	135	
		In force: 18 March 1976	239	
		In force: 2 March 1977	248	
		In force: 10 September 1991	393	
		In force: 24 February 1993	418	
Palau		In force: 13 May 2005		In force: 13 May 2005
Panama[j]	X	In force: 23 March 1984	316	In force: 11 December 2001
Papua New Guinea	X	In force: 13 October 1983	312	
Paraguay[e]	X	In force: 20 March 1979	279	In force: 17 September 2004
Peru[e]		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[t]		Accession: 1 July 1986	193	In force: 30 April 2004
Qatar				
Republic of Moldova	*X*	*Signed: 14 June 1996*		
Romania		In force: 27 October 1972	180	In force: 7 July 2000
Russian Federation		In force: 10 June 1985	327*	Signed: 22 March 2000
Rwanda				
St. Kitts and Nevis[m]	X	In force: 7 May 1996	514	
Saint Lucia[m]	X	In force: 2 February 1990	379	
St. Vincent and the Grenadines[m]	X	In force: 8 January 1992	400	
Samoa	X	In force: 22 January 1979	268	

State	SQP [c]	Status of safeguards agreement(s)	INFCIRC	Status of additional protocol
San Marino	X	In force: 21 September 1998	575	
São Tome and Principe				
Saudi Arabia		*Signed: 16 June 2005*		
Senegal	X	In force: 14 January 1980	276	Approved: 1 March 2005
Serbia and Montenegro[u]		In force: 28 December 1973	204	Approved: 14 September 2004
Seychelles	X	In force: 19 July 2004	635	In force: 13 October 2004
Sierra Leone	*X*	*Signed: 10 November 1977*		
Singapore	X	In force: 18 October 1977	259	Signed: 22 September 2005
Slovakia[v]		Accession: 1 December 2005	173	Accession: 1 December 2005
Slovenia		In force: 1 August 1997	538	In force: 22 August 2000
Solomon Islands	X	In force: 17 June 1993	420	
Somalia				
South Africa		In force: 16 September 1991	394	In force: 13 September 2002
Spain		Accession: 5 April 1989	193	In force: 30 April 2004
Sri Lanka		In force: 6 August 1984	320	
Sudan	X	In force: 7 January 1977	245	
Suriname[e]	X	In force: 2 February 1979	269	
Swaziland	X	In force: 28 July 1975	227	
Sweden[w]		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	X	In force: 14 December 2004	Pending	In force: 14 December 2004
Thailand		In force: 16 May 1974	241	Signed: 22 September 2005
The Former Yugoslav Rep. of Macedonia	X	In force: 16 April 2002	610	Signed: 12 July 2005
Timor-Leste				
Togo	*X*	*Signed: 29 November 1990*		*Signed: 26 September 2003*
Tonga	X	In force: 18 November 1993	426	
Trinidad and Tobago[e]	X	In force: 4 November 1992	414	
Tunisia		In force: 13 March 1990	381	Signed: 24 May 2005
Turkey		In force: 1 September 1981	295	In force: 17 July 2001
Turkmenistan		*Signed: 17 May 2005*		*Signed: 17 May 2005*
Tuvalu	X	In force: 15 March 1991	391	
Uganda	*X*	*Signed: 14 June 2005*		*Signed: 14 June 2005*
Ukraine		In force: 22 January 1998	550	Signed: 15 August 2000
United Arab Emirates	X	In force: 6 October 2003	622	
United Kingdom		In force: 14 December 1972	175[x]	
		In force: 14 August 1978	263*	In force: 30 April 2004
		Approved: 16 September 1992[p]		
United Republic of Tanzania	*X*	*In force: 7 February 2005*		*In force: 7 February 2005*
United States of America		In force: 9 December 1980	288*	Signed: 12 June 1998
		In force: 6 April 1989[p]	366	
Uruguay[e]		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[e]		In force: 11 March 1982	300	
Viet Nam		In force: 23 February 1990	376	
Yemen, Republic of	X	In force: 14 August 2002	614	
Zambia	X	In force: 22 September 1994	456	
Zimbabwe	X	In force: 26 June 1995	483	

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 comprehensive safeguards agreement (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 with a legal obligation to conclude a CSA, with nuclear material in quantities not exceeding the limits of paragraph 37 of INFCIRC/153 and no nuclear material in a facility, have the option to conclude a small quantities protocol (SQP), thus holding in abeyance the implementation of most of the detailed provisions set out in Part II of a CSA as long as these conditions continue to apply. This column contains countries whose SQPs have been approved by the Board of Governors and for whom, as far as the Secretariat is aware, these conditions continue to apply. "X" signifies that the modified SQP text, pursuant to the decision of the Board of Governors on 20 September 2005, has been accepted.

[d] 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.

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

[f] 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.

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

[h] 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.

[i] 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.

[j] 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.

[k] 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.

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

[m] An exchange of letters has taken place between this State and the Agency confirming that the NPT safeguards agreement satisfies the obligations of the State under Article 13 of the Treaty of Tlatelolco.

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

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

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

[q] 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.

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

[s] 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.

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

[u] 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 and Montenegro (formerly the Federal Republic of Yugoslavia) to the extent relevant to the territory of Serbia and Montenegro.

[v] The application of safeguards in Slovakia under the 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 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, to which Slovakia had acceded, entered into force for Slovakia.

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

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

Table A5. Facilities under Agency Safeguards or Containing Safeguarded Material on 31 December 2005

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Power reactors				
Argentina	Atucha NPP[c]	1	Lima	—
	Embalse NPP[c]	1	Embalse	—
Armenia	Armenia NPP[c]	2	Medzamor	x
Belgium	DOEL-1	2	Doel	x
	DOEL-3	1	Doel	x
	DOEL-4	1	Doel	x
	Tihange-1	1	Tihange	x
	Tihange-2	1	Tihange	x
	Tihange-3	1	Tihange	x
Brazil	Admiral Alvaro Alberto (Angra-1)	1	Angra dos Reis	x
	Admiral Alvaro Alberto (Angra-2)	1	Angra dos Reis	x
Bulgaria	Kozloduy-I	2	Kozloduy	x
	Kozloduy-II	2	Kozloduy	x
	Kozloduy-III	2	Kozloduy	x
Canada	Bruce A	4	Tiverton	x
	Bruce B	4	Tiverton	x
	Darlington N.G.S.	4	Bowmanville	x
	Gentilly-2	1	Gentilly	x
	Pickering G.S.	8	Pickering	x
	Point Lepreau G.S.	1	Point Lepreau	x
China	QSNPP	1	Hai Yan	x
Czech Republic	EDU-1	2	Dukovany	x
	EDU-2	2	Dukovany	x
	Temelin	2	Temelin	x
Democratic People's Republic of Korea	Nyongbyon-1	1	Nyongbyon	—
Finland	Loviisa	2	Loviisa	—
	TVO I	1	Olkiluoto	—
	TVO II	1	Olkiluoto	—
Germany	AVR	1	Jülich	—
	KWG Grohnde	1	Grohnde	x
	GKN-2	1	Neckarwestheim	x
	GKN Neckarwestheim	1	Neckarwestheim	x
	RWE Biblis-A	1	Biblis	x
	RWE Biblis-B	1	Biblis	x
	KBR Brokdorf	1	Brokdorf	x
	KKB Brunsbüttel	1	Brunsbüttel	x
	KKE Emsland	1	Lingen	x
	KKG Grafenrheinfeld	1	Grafenrheinfeld	x
	KKI Isar-Ohu	1	Ohu bei Landshut	x
	KKI Isar-2	1	Essenbach	x
	KKK Krümmel	1	Geesthacht	x
	KWO Obrigheim	1	Obrigheim	x
	KKP Philippsburg-1	1	Philippsburg	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	KKP Philippsburg-2	1	Philippsburg	x
	KRB II Gundremmingen B	1	Gundremmingen	x
	KRB II Gundremmingen C	1	Gundremmingen	x
	KKU Unterweser	1	Unterweser	x
	HKG-THTR 300	1	Hamm	x
	KKW Greifswald 1	1	Lubmin	—
	KKW Greifswald 2	1	Lubmin	—
Hungary	PAKS-I	2	Paks	x
	PAKS-II	2	Paks	x
India	RAPS	2	Rajasthan	x
	TAPS	2	Tarapur	x
	KKNP	2	Kudankulam	—
Italy	ENEL-Latina	1	Borgo-Sabotino	x
	ENEL-Caorso	1	Caorso	x
	ENEL-Trino	1	Trino-Vercellese	x
Japan	Fugen	1	Tsuruga-shi, Fukui-ken	x
	Fukushima Dai-Ichi-1	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-2	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-3	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-4	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-5	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ichi-6	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-1	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-2	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-3	1	Futaba-gun, Fukushima-ken	x
	Fukushima Dai-Ni-4	1	Futaba-gun, Fukushima-ken	x
	Genkai-1	1	Higashimatsura-gun, Saga-ken	x
	Genkai-2	1	Higashimatsura-gun, Saga-ken	x
	Genkai-3	1	Higashimatsura-gun, Saga-ken	x
	Genkai-4	1	Higashimatsura-gun, Saga-ken	x
	Hamaoka-1	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-2	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-3	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-4	1	Ogasa-gun, Shizuoka-ken	x
	Hamaoka-5	1	Ogasa-gun, Shizuoka-ken	—
	Ikata-1	1	Nishiuwa-gun, Ehime-ken	x
	Ikata-2	1	Nishiuwa-gun, Ehime-ken	x
	Ikata-3	1	Nishiuwa-gun, Ehime-ken	x
	Joyo	1	Higashi-gun, Ibaraki-ken	x
	Kashiwazaki-1	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-2	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-3	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-4	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-5	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-6	1	Kashiwazaki-shi, Niigata-ken	x
	Kashiwazaki-7	1	Kashiwazaki-shi, Niigata-ken	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	Mihama-1	1	Mikata-gun, Fukui-ken	x
	Mihama-2	1	Mikata-gun, Fukui-ken	x
	Mihama-3	1	Mikata-gun, Fukui-ken	x
	Monju	1	Tsuruga-shi, Fukui-ken	x
	Ohi-1 and 2	2	Ohi-gun, Fukui-ken	x
	Ohi-3	2	Ohi-gun, Fukui-ken	x
	Ohi-4	2	Ohi-gun, Fukui-ken	x
	Onagawa-1	1	Oshika-gun, Miyaki-ken	x
	Onagawa-2	1	Oshika-gun, Miyaki-ken	x
	Onagawa-3	1	Oshika-gun, Miyaki-ken	x
	Sendai-1	1	Sendai-shi, Kagoshima-ken	x
	Sendai-2	1	Sendai-shi, Kagoshima-ken	x
	Shika	1	Hakui-gun, Ishikawa-ken	x
	Shimane-1	1	Yatsuka-gun, Shimane-ken	x
	Shimane-2	1	Yatsuka-gun, Shimane-ken	x
	Takahama-1	1	Ohi-gun, Fukui-ken	x
	Takahama-2	1	Ohi-gun, Fukui-ken	x
	Takahama-3	1	Ohi-gun, Fukui-ken	x
	Takahama-4	1	Ohi-gun, Fukui-ken	x
	Tokai-2	1	Tokai-Mura, Ibaraki-ken	x
	Tomari-1	1	Furuu-gun, Hokkaidox	x
	Tomari-2	1	Furuu-gun, Hokkaidox	x
	Tsuruga-1	1	Tsuruga-shi, Fukui-ken	x
	Tsuruga-2	1	Tsuruga-shi, Fukui-ken	x
Kazakhstan	BN-350	1	Aktau	—
Korea, Republic of	Kori-1	1	Pusan	x
	Kori-2	1	Pusan	x
	Kori-3	1	Pusan	x
	Kori-4	1	Pusan	x
	Ulchin-1	1	Ulchin	x
	Ulchin-2	1	Ulchin	x
	Ulchin-3	1	Ulchin	x
	Ulchin-4	1	Ulchin	x
	Ulchin-5	1	Ulchin	x
	Ulchin-6	1	Ulchin	—
	Wolsong-1	1	Kyongju	x
	Wolsong-2	1	Kyongju	x
	Wolsong-3	1	Kyongju	x
	Wolsong-4	1	Kyongju	x
	Younggwang-1	1	Younggwang	x
	Younggwang-2	1	Younggwang	x
	Younggwang-3	1	Younggwang	x
	Younggwang-4	1	Younggwang	x
	Younggwang-5	1	Younggwang	x
	Younggwang-6	1	Younggwang	x
Lithuania	Ignalina NPP	2	Visaginas	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Mexico	Laguna Verde 1	1	Alto Lucero	x
	Laguna Verde 2	1	Alto Lucero	x
Netherlands	Borssele	1	Borssele	x
	Dodewaard NPP	1	Dodewaard	x
Pakistan	KANUPP	1	Karachi	x
	Chasnupp-1	1	Kundian	—
Romania	Cernavoda-1	1	Cernavoda	x
Slovakia	EMO-1	2	Mochovce	—
	V-1	2	Bohunice	x
	V-2	2	Bohunice	x
Slovenia	Krško	1	Krško	x
South Africa	Koeberg-1	1	Cape Town	x
	Koeberg-2	1	Cape Town	x
Spain	Almaraz-1	1	Almaraz	x
	Almaraz-2	1	Almaraz	x
	Asco-1	1	Asco	x
	Asco-2	1	Asco	x
	Cofrentes	1	Cofrentes	x
	José Cabrera	1	Almonazid de Zorita	x
	Santa María de Garona	1	Santa María de Garona	x
	Trillo-1	1	Trillo	x
	Vandellos 1	1	Vandellos	—
	Vandellos 2	1	Vandellos	x
Sweden	Barsebäck 1	1	Malmö	—
	Barsebäck 2	1	Malmö	—
	Forsmark 1	1	Uppsala	—
	Forsmark 2	1	Uppsala	—
	Forsmark 3	1	Uppsala	—
	Oskarshamn 1	1	Oskarshamn	—
	Oskarshamn 2	1	Oskarshamn	—
	Oskarshamn 3	1	Oskarshamn	—
	Ringhals 1	1	Göteborg	—
	Ringhals 2	1	Göteborg	—
	Ringhals 3	1	Göteborg	—
	Ringhals 4	1	Göteborg	—
Switzerland	KKB Beznau I	1	Beznau	x
	KKB Beznau II	1	Beznau	x
	KKG Gösgen	1	Gösgen-Däniken	x
	KKL Leibstadt	1	Leibstadt	x
	KKM Mühleberg	1	Mühleberg	x
Ukraine	Chernobyl NPP	3	Chernobyl	—
	Khmelnitski 1	1	Neteshin	—
	Khmelnitski 2	1	Neteshin	—
	Rovno 1 and 2	2	Kuznetsovsk	—
	Rovno 3	1	Kuznetsovsk	—
	Rovno 4	1	Kuznetsovsk	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	South Ukraine 1	1	Yuzhnoukrainsk	—
	South Ukraine 2	1	Yuzhnoukrainsk	—
	South Ukraine 3	1	Yuzhnoukrainsk	—
	Zaporozhe 1	1	Energodar	—
	Zaporozhe 2	1	Energodar	—
	Zaporozhe 3	1	Energodar	—
	Zaporozhe 4	1	Energodar	—
	Zaporozhe 5	1	Energodar	—
	Zaporozhe 6	1	Energodar	—
Research reactors and critical assemblies				
Algeria	NUR Reactor	1	Algiers	—
	Es Salam research reactor	1	Ain Oussera	—
Argentina	Argentine reactor-1	1	Constituyentes	x
	Argentine reactor-3	1	Ezeiza	x
	Argentine reactor-4	1	Rosario	x
	Argentine reactor-6	1	Bariloche	x
	Argentine reactor-0	1	Córdoba	x
	Argentine reactor-8	1	Pilcaniyeu	x
Australia	HIFAR	1	Lucas Heights	x
	MOATA	1	Lucas Heights	x
	OPAL	1	Lucas Heights	x
Austria	ASTRA	1	Seibersdorf	x
	Siemens Argonaut Reactor	1	Graz	—
	Triga II	1	Vienna	—
Bangladesh	At. Energy Res. Est.	1	Dhaka	x
Belarus	Sosny	1	Minsk	—
Belgium	BR1-CEN	1	Mol	x
	BR2-CEN-BRO2	2	Mol	x
	CEN-Venus	1	Mol	x
	Thetis	1	Gent	x
Brazil	IEA-R1	1	São Paulo	—
	RIEN-1 Argonaut RR	1	Rio de Janeiro	x
	IPR-RI-CDTN	1	Belo Horizonte	x
	IPEN Critical assembly	1	São Paulo	x
Bulgaria	IRT-2000	1	Sofia	x
Canada	Biology, Chemistry, Physics	2	Chalk River	x
	McMaster	1	Hamilton	x
	NRU	1	Chalk River	x
	NRX	1	Chalk River	x
	Slowpoke-Dalhousie Univ.	1	Halifax	x
	Slowpoke-Ecole Polytechnique	1	Montreal	x
	Slowpoke-Kingston	1	Kingston	x
	Slowpoke-Saskatchewan	1	Saskatoon	x
	Slowpoke-Univ. of Alberta	1	Edmonton	x
	DIF	1	Chalk River	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Chile	La Reina	1	Santiago	x
	Lo Aguirre	1	Santiago	x
China	HTGR	1	Nankou	—
Colombia	IAN-R1	1	Bogotá	x
Czech Republic	LR-O	1	Řež	x
	Univ. Training Reactor VR-1P	1	Prague	x
	VVR-S	1	Řež	x
Democratic People's Republic of Korea	Critical Assembly		Bungang-Ri, Nyongbyon	
	IRT	1	Bungang-Ri, Nyongbyon	x
Democratic Republic of the Congo	Triga II	1	Kinshasa	x
Egypt	RR-I	1	Inshas	x
	MPR	1	Inshas	—
Estonia	Paldiski reactor	1	Paldiski	—
Finland	FIR 1	1	Espoo	—
Germany	BER-2	1	Berlin	x
	FH-Furtwangen	1	Furtwangen	x
	FRM	1	Garching	x
	FRM-II	1	Garching	—
	GKSS-FRG1&FRG2	2	Geesthacht	x
	KFA-FRJ2	1	Jülich	x
	SUR 100	1	Hannover	x
	SUR 100 (FHK)	1	Kiel	x
	SUR 100 (FHU)	1	Ulm	x
	SUR 100 (UNIV)	1	Stuttgart	x
	SUR 100 (TUB)	1	Berlin	x
	SUR 100 (RWTH)	1	Aachen	x
	Tech. Univ. AKR	1	Dresden	x
	Tech. Hochschule ZLR	1	Zittau	x
	Triga	1	Mainz	x
Ghana	GHARR-1	1	Legon-Accra	x
Greece	GRR-1	1	Attiki	x
Hungary	Training reactor	1	Budapest	x
	WWR-S M 10	1	Budapest	x
Indonesia	PPNY	1	Yogyakarta	x
	RSG-GAS	1	Serpong	x
	P3TN	1	Bandung	x
Iran, Islamic Republic of	TRR	1	Tehran	x
	HWZPR	1	Esfahan	x
	MNSR	1	Esfahan	x
	LWSCR	1	Esfahan	x
Israel	IRR-1	1	Soreq	x
Italy	AGN-201	1	Palermo	x
	RTS-1	1	San Piero a Grado	x
	TAPIRO	1	Santa Maria di Galeria	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	Triga-RC1	1	Santa Maria di Galeria	x
	Triga-2	1	Pavia	x
Jamaica	Centre for Nucl. Sciences	1	Kingston	x
Japan	DCA	1	Oarai-machi, Ibaraki-ken	x
	FCA	1	Tokai-Mura, Ibaraki-ken	x
	HTR	1	Kawasaki-shi, Kanagawa-ken	x
	HTTR	1	Higashi-gun, Ibaraki-ken	x
	JMTR	1	Higashi-gun, Ibaraki-kenx	x
	JMTRCA	1	Higashi-gun, Ibaraki-ken	x
	JRR-2	1	Tokai-Mura, Ibaraki-ken	x
	JRR-3	1	Tokai-Mura, Ibaraki-ken	x
	JRR-4	1	Tokai-Mura, Ibaraki-ken	x
	Kinki University reactor	1	Higashiosaka-shi, Osaka-fu	x
	KUCA	3	Osaka	x
	KUR	1	Sennan-gun, Osaka	x
	Musashi reactor	1	Kawasaki-shi, Kanagawa-ken	x
	NCA	1	Kawasaki-shi	x
	NSRR	1	Tokai-Mura, Ibaraki-ken	x
	Rikkyo University R.R.	1	Nagasaka, Kanagawa-ken	x
	TCA	1	Tokai-Mura, Ibaraki-ken	x
	TODAI	1	Tokai-Mura, Ibaraki-ken	x
	TTR	1	Kawasaki-shi, Kanagawa-ken	x
	VHTRC	1	Tokai-Mura, Ibaraki-ken	x
Kazakhstan	Kurchatov test reactor	3	Semipalatinsk	—
	WWR-K	1	Almaty	—
Korea, Republic of	Kyunghee Univ.	1	Suwoon	x
	Hanaro	1	Taejon	x
	Triga III	1	Seoul	x
Latvia	IRT	1	Riga	x
Libyan Arab Jamahiriya	IRT reactor	1	Tajura	x
Malaysia	Puspati	1	Bangi, Selangor	x
Mexico	Triga Mark III	1	Ocoyoacac	x
Netherlands	HOR	1	Delft	x
	HFR	1	Petten	x
	LFR	1	Petten	x
Nigeria	NIRR-1	1	Zaria	—
Norway	HBWR-Halden	1	Halden	x
	JEEP-II	1	Kjeller	x
Pakistan	PARR-1	1	Rawalpindi	x
	PARR-2	1	Rawalpindi	x
Peru	RP-0	1	Lima	x
	RP-10	1	Lima	x
Philippines	PRR-1	1	Quezon City, Diliman	x
Poland	Agata and Anna	2	Swierk	x
	Ewa	1	Swierk	x
	Maria	1	Swierk	x
Portugal	RPI	1	Sacavem	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Romania	Triga II	1	Piteşti Colibaşi	x
	VVR-S	2	Magurele	x
Serbia and Montenegro	RA-RB	2	Vinča	x
Slovenia	Triga II	1	Ljubljana	x
South Africa	SAFARI-1	1	Pelindaba	x
Sweden	Studsvik RR	2	Studsvik	—
Switzerland	AGN 211P	1	Basel	x
	Crocus	1	Lausanne	x
	Proteus	1	Würenlingen	x
Syrian Arab Republic	MNSR	1	Damascus	x
Thailand	TRR-1	1	Bangkok	x
Turkey	Çekmece Nuclear Research and Training Centre	1	Istanbul	x
	ITU-TRR Triga Mark II	1	Istanbul	x
Ukraine	Kiev RR	1	Kiev	—
	IR-100 RR	1	Sevastopol	—
Uzbekistan	Photon	1	Tashkent	—
	WWR-SM	1	Tashkent	—
Venezuela	RV-I	1	Altos de Pipe	x
Vietnam	Da Lat Research Reactor	1	Da Lat, Lam Dong	x
Conversion plants, including pilot plants				
Argentina	UF_6 production facility		Pilcaniyeu	—
	UO_2 conversion plant		Córdoba	—
Canada	CAMECO		Port Hope	x
	Blind River	1	Blind River, Ontario	x
	Port Hope	1	Port Hope	x
Chile	Lab. exper. de conversión		Santiago	x
Iran, Islamic Republic of	Uranium Chemistry Laboratory	1	Esfahan	—
	UCF	1	Esfahan	—
Japan	JCO		Tokai-Mura, Ibaraki-ken	x
	Ningyo R&D		Tomata-gun, Okayama-kenx	x
	PCDF		Tokai-Mura, Ibaraki-ken	x
Mexico	Fuel fabrication pilot plant		Salazar	x
Romania	UO_2 powder fabrication plant		Feldioara	—
South Africa	Conversion plant		Pelindaba	x
	HEU-UF_6 production plant		Pelindaba	x
Sweden	Ranstad Mineral		Ranstad	—
Fuel fabrication plants, including pilot plants				
Algeria	UDEC		Draria Nuclear Site	—
Argentina	Experimental plant		Constituyentes	—
	Fuel fabrication plant		Ezeiza	x
	RR Fuel element fabrication plant		Constituyentes	x
	RR Fuel Fabrication plant		Ezeiza	x
Belgium	BN-MOX		Dessel	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	FBFC		Dessel	x
	FBFC MOX		Dessel	—
Brazil	Fuel fabrication plant		Resende	x
Canada	CRNL fuel fabrication		Chalk River	x
	Fuel fabrication facility		Chalk River	x
	GEC, Inc.		Toronto	x
	GEC, Inc.		Peterborough	x
	Zircatec		Port Hope	x
Chile	UMF		Santiago	x
Democratic People's Republic of Korea	Nuclear fuel fabrication plant		Nyongbyon	—
Egypt	FMPP		Inshas	—
Germany	Adv. Nuclear Fuels		Lingen	x
India	Ceramic fuel fab. assembly area		Hyderabad	x
	EFFP-NFC		Hyderabad	x
Indonesia	Experimental fuel element installation (IEBE)		Serpong	x
	Research reactor fuel element production installation (IPEBRR)		Serpong	x
Iran, Islamic Rep. of	Fuel fabrication lab.		Esfahan	—
Italy	Fabnuc		Bosco Marengo	x
Japan	JNF		Yokosuka-shi, Kanagawa-ken	x
	MNF		Tokai-Mura, Ibaraki-ken	x
	NFI (Kumatori-1)		Sennan-gun, Osaka	x
	NFI (Kumatori-2)		Sennan-gun, Osaka	x
	NFI Tokai		Tokai-Mura, Ibaraki-ken	x
	PFPF		Tokai-Mura, Ibaraki-ken	x
	PPFF		Tokai-Mura, Ibaraki-ken	x
Kazakhstan	Ulbinski Metallurgical Works		Kamenogorsk	—
Korea, Republic of	KNFFP	2	Taejon	x
Romania	Romfuel		Piteşti Colibaşi	x
South Africa	LEU + MTR fuel fabrication	2	Pelindaba	x
	MTR fuel fabrication plant		Pelindaba	x
Spain	ENUSA fuel fabrication plant		Juzbado	—
Sweden	ABB		Västeras	x
Turkey	Nuclear fuel pilot plant		Istanbul	x
Chemical reprocessing plants, including pilot plants				
Democratic People's Republic of Korea	Radiochemical Laboratory		Bungang-Ri, Nyongbyon	—
Germany	WAK		Eggenstein-Leopoldshafen	x
India	PREFRE		Tarapur	x
Italy	EURE		Saluggia	x
	ITREC-Trisaia		Rotondella	x
Japan	Tokai reprocessing plant		Tokai-Mura, Ibaraki-ken	x
	Rokkasho Reprocessing Plant		Kamikita-gun, Aomori-ken	x
In addition, the following R&D facilities and locations are associated with reprocessing technology				
Argentina	*Lapep*		*Buenos Aires*	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	Fission products div.		*Ezeira*	—
Brazil	*Reprocessing project*		*São Paulo*	—
Indonesia	*RMI*		*Serpong*	—
Japan	*SCF*		*Tokai-Mura, Ibaraki-ken*	x
	JAERI Tokai R&D		*Tokai-Mura, Ibaraki-ken*	x
	JNC Tokai R&D		*Tokai-Mura, Ibaraki-ken*	x
	Sumitomi Met. Mining		*Tokai-Mura, Ibaraki-ken*	x
Enrichment plants, including pilot plants				
Argentina	Pilcaniyeu enrichment plant		Pilcaniyeu	—
Brazil	Enrichment laboratory		Ipero	—
	Uranium enrichment pilot plant		São Paulo	—
	Laser spectroscopy lab.		San jose dos Campos	—
China	Shaanxi		Han Zhong	—
Germany	UTA-1		Gronau	x
Japan	Uranium Enrichment Plant		Tomata-gun, Okayama-ken	x
	Rokkasho Enrichment Plant		Kamikita-gun, Aomori-ken	x
	CTF	1	Kitakami-gun, Aomori-ken	x
Iran, Islamic Republic of	PFEP		Natanz	—
Netherlands	URENCO		Almelo	x
United Kingdom	URENCO E22, E23 & A3 plant	3	Capenhurst	x
In addition, the following R&D facilities and locations are associated with enrichment technology:				
Australia	*Silex*		*Lucas Heights*	—
Brazil	*UF_6 laboratory*		*Belo Horizonte*	—
Germany	*Urenco*		*Jülich*	—
Japan	*Asahi Chemical Industry*		*Hyuga-shi, Miyazaki-ken*	x
	Hitachi laboratory		*Hitachi-shi, Ibaraki-ken*	x
	JAERI Tokai R&D		*Tokai-Mura, Ibaraki-ken*	x
	NDC U-Lab.		*Tokai-Mura, Ibaraki-ken*	x
	JNC Tokai R&D		*Tokai-Mura, Ibaraki-ken*	x
	Toshiba R&D Centre		*Kawasaki-shi, Kanagawa-ken*	x
	CTF		*Kitakami-gun, Amori-ken*	x
Netherlands	*Urenco*		*Almelo*	x
Separate storage facilities				
Argentina	Central store		Ezeiza	x
	Central store		Constituyentes	x
	DUE		Ezeiza	—
	Nuclear material store		Constituyentes	—
	Storage Bunker		Ezeiza	—
Armenia	Dry Spent Fuel Storage		Metsamor	—
Australia	Vault storage		Lucas Heights	x
Belgium	Belgoprocess		Dessel	x
	Elbel		Beveren	—
	Wet Store		Tihange	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Brazil	Aramar stores	2	Ipero	—
	UF_6 production facility		São Paulo	—
Bulgaria	Long term storage		Kozloduy	x
Canada	Nuclear material		Chalk River	x
	Spent fuel canister store		Chalk River	x
	Douglas Point dry storage		Tiverton	x
	Gentilly-1		Gentilly	x
	Spent fuel storage		Chalk River	x
	Spent Fuel Storage		Chalk River	—
	ACEL Research		Pinawa	x
	PUFDSF		Pickering	x
	WUFDSP		Tiverton	—
Czech Republic	Storage Škoda		Bolevec	x
	HLW store		Řež	—
	ISFS Dukovany		Dukovany	x
Democratic People's Republic of Korea	Nuclear fuel storage		Bungang-Ri, Nyongbyon	—
Denmark	Risø Store		Roskilde	x
	Risø Waste		Roskilde	—
Finland	TVO-KPA store		Olkiluoto	—
France	Cogéma UP2 and UP3	2	La Hague	x
Georgia	Decom. IRT-M		Tbilisi	x
Germany	Bundeslager		Wolfgang	—
	Standort Zwischenlager		Lingen	—
	ANF UF_6 Lager		Lingen	x
	KFA AVR BL		Jülich	—
	KFA AVR		Jülich	x
	BZA-Ahaus		Ahaus	—
	NCS-Lagerhalle		Hanau	—
	PTB Spaltstofflager		Hanau	—
	Energiewerke Nord GmbH		Lubmin	x
	Energiewerke Nord-ZLN		Lubmin	—
	Transportbehälterlager		Gorleben	—
	TR Halle 87		Rossendorf	—
	Kernmateriallager		Rossendorf	—
Hungary	Central radionuclide store		Budapest	x
	MVDS		Paks	x
India	AFR		Tarapur	x
Indonesia	TC and ISFSF		Serpong	—
Iran, Islamic Republic of	Karaj Waste Storage		Karaj	—
Iraq	Tuwaitha, Location C		Tuwaitha	—
Italy	Compes. deposito		Saluggia	x
	Essor nuclear plant		Ispra	—
	Essor storage		Ispra	x
	Research centre		Ispra	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
Japan	KUFFS		Kyoto	x
	Fukushima Dai-Ichi SFS		Futaba-gun, Fukushima-ken	x
Kazakhstan	Ulbinski Thorium Storage		Kamenogorsk	—
	Kurchatov Thorium Storage		Semipalatinsk	—
Korea, Republic of	DUF 4 Conv.		Taejon	—
	NMSF		Taejon	—
Lithuania	Spent Fuel Dry Storage		Visaginas	—
Netherlands	Covra Store		Vlissingen	—
	Habog		Vlissingen	—
Pakistan	Hawks Bay depot		Karachi	x
Portugal	Inst. de Armazenagem		Sacavem	x
Romania	ISFS Cernavoda NPP		Cernavoda	x
Slovakia	AFRS		Bohunice	x
South Africa	Waste storage		Pelindaba	—
	Bulk storage facility		Pelindaba	x
	HEU storage vault		Pelindaba	x
	Thabana pipe store		Pelindaba	x
	Z - Plant		Pelindaba	x
	E - building		Valindaba	—
	Koeberg Castor Storage Facility		Cape Town	x
Spain	Trillo		Trillo	x
Sweden	Central long term storage		Oskarshamn	—
Switzerland	Saphir		Würenlingen	x
	Zwilag		Würenlingen	—
Ukraine	Chernobyl storage		Chernobyl	—
	Zaporoshe SFS		Energodar	—
	Khmelnitski FF Storage		Neteshin	x
	Rovno FF Storage		Kuznetsovsk	x
	South Ukraine FF Storage		Yushnoukrainsk	x
	Zaporoshe FF Storage		Energodar	—
United Kingdom	Special nuclear material store 9		Sellafield	x
	Thorp Plutonium Store		Sellafield	—
United States of America	Pu storage vault		Hanford	—
	Y-12 plant		Oak Ridge	x
	KAMS storage		Savannah River	
Other facilities				
Algeria	AURES 1		Ain Oussara	—
	Es Salam reactor		Ain Oussara	—
Argentina	Alpha facility		Constituyentes	—
	Experimental UO_2 plant		Cordoba	—
	Enriched uranium lab		Ezeiza	—
	Fission products div.		Ezeiza	x
	LFR		Buenos Aires	—
	Uranium powder fab. plant		Constituyentes	—
	Triple Altura Lab.		Ezeiza	—

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	LAPEP		Buenos Aires	
Australia	Research Lab.		Lucas Heights	x
Belgium	IRMM-Geel		Geel	x
	CEN-Labo		Mol	x
	CEN-Waste		Dessel	—
	I.R.E.		Fleurus	x
	CEN-lab. Pu		Mol	x
Brazil	Fuel tech. coord. unit		São Paulo	x
	Isotope laboratory		São Paulo	—
	Metal. uran. project		São Paulo	—
	Nuclear material lab.		Ipero	—
	Nuclear fuel & instr. dev. lab.		São Paulo	—
	Reconversion project		São Paulo	—
	Reprocessing project		São Paulo	x
	Safeguards store		São Paulo	x
Cuba	In Stec	1	Havana	x
Czech Republic	Nuclear Fuel Inst. (UJP)		Zbraslav	x
	Research Laboratories		Řež	x
Democratic People's Republic of Korea	Subcritical assembly		Pyongyang	x
Estonia	Balti ES		Narva	—
Georgia	Subcritical Assembly		Tbilisi	—
	Sukhumi Institute		Sukhumi	—
Germany	KFA-heisse Zellen		Jülich	x
	KFA Lab.		Jülich	x
	Transuran		Eggenstein-Leopoldshafen	x
Hungary	Institute of Isotopes		Budapest	x
Indonesia	RMI		Serpong	x
Iran, Islamic Republic of	JHL		Tehran	—
Italy	CNEN-LAB. PU.		Santa Maria di Galeria	x
Japan	JAERI-Oarai R&D		Higashi-gun, Ibaraki-ken	x
	JAERI-Tokai R&D		Tokai-Mura, Ibaraki-ken	x
	Kumatori R&D		Sennan-gun, Osaka	x
	NDC Fuel Hot Lab.		Tokai-Mura, Ibaraki-ken	x
	NERL, University of Tokyo		Tokai-Mura, Ibaraki-ken	x
	NFD		Higashi-gun, Ibaraki-ken	x
	NFI Tokai-2		Tokai-Mura, Ibaraki-ken	x
	NRF Neutron Radiation Facility		Tsukuba-shi, Ibaraki-ken	x
	JNC FMF		Higashi-gun, Ibaraki-ken	x
	JNC IRAF		Higashi-gun, Ibaraki-ken	x
	JNC-Oarai R&D		Higashi-gun, Ibaraki-ken	x
	JNC-Tokai R&D		Tokai-Mura, Ibaraki-ken	x
	SCF		Tokai-Mura, Ibaraki-ken	x
	Uranium Material Laboratory		Higashi-gun, Ibaraki-ken	
Korea, Republic of	PIEF		Taejon	x

State[a]	Abbreviated name of facility	No. of units	Location	SA[b] in force
	Acrylonitrile plant		Ulsan	x
	DFDF		Taejon	x
	HFFL		Taejon	x
	IMEF		Taejon	x
	KAERI R&D		Taejon	—
Libyan Arab Jamahiriya	Tajura Uranium R&D Facility		Tajura	—
Netherlands	ECN and JRC		Petten	x
Norway	Research laboratories		Kjeller	x
Poland	Institute for Nuclear Chemistry and Engineering		Warsaw	—
	Institute of Nuclear Research		Swierk	x
South Africa	Decommissioned pilot enrichment plant		Pelindaba	x
	Decontamination and waste recovery		Pelindaba	x
	Hot Cell Complex		Pelindaba	x
	NU and DU metals plant		Pelindaba	x
Spain	ENRESA		El Cabril	—
Switzerland	EIR		Würenlingen	x
	CERN		Geneva	x
Turkey	Nuclear fuel pilot plant		Istanbul	x
Ukraine	Chernobyl unit 4 shelter		Chernobyl	—
	KHFTI		Kharkov	—
	Sevastopol subcritical assembly		Sevastopol	—
	IR-100 RR		Sevastopol	—
United States of America	BWXT Facility 179		Lynchburg, VA	—

[a] An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

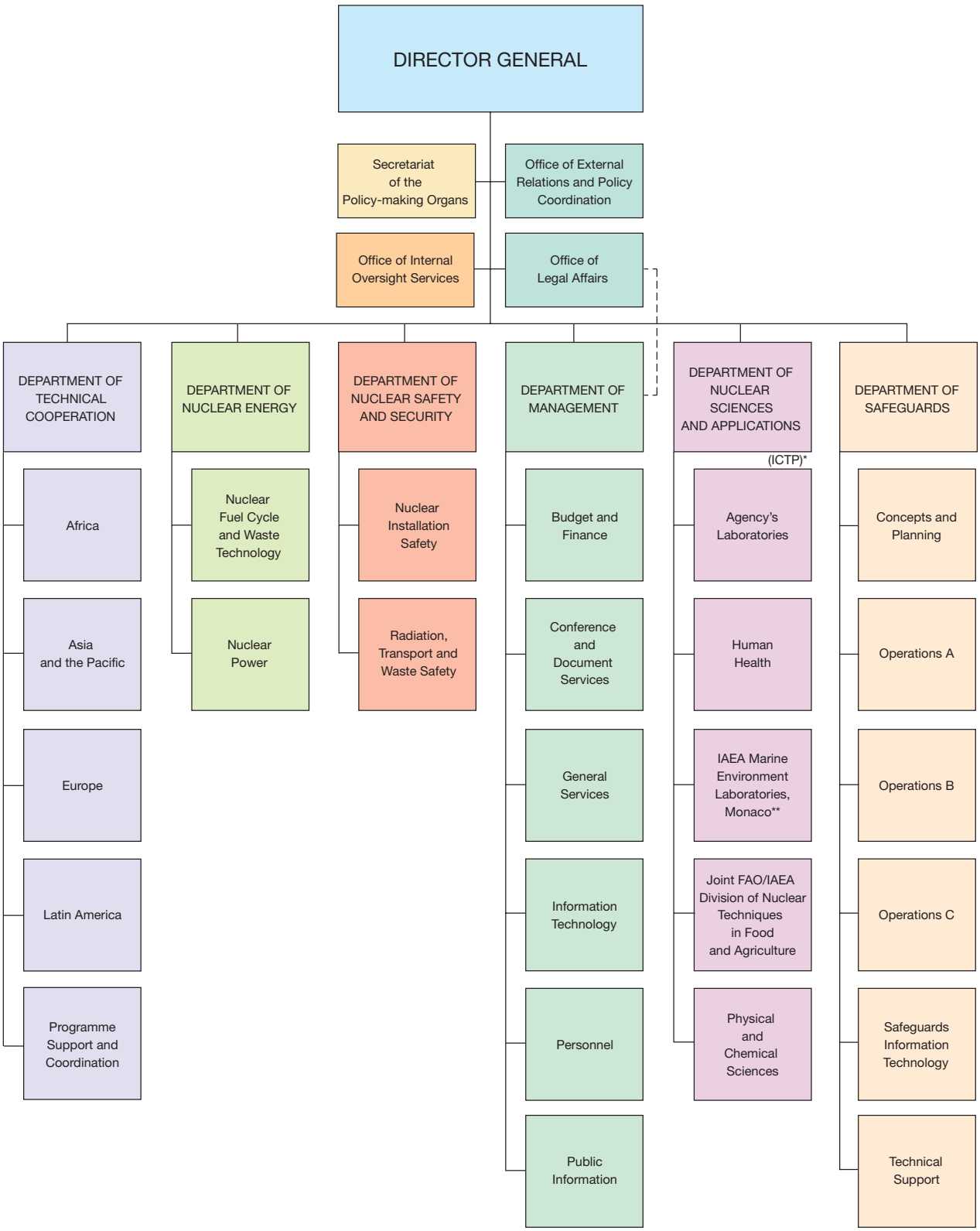
[b] SA: Subsidiary Arrangement.

[c] NPP: nuclear power plant.

Note: The Agency was also applying safeguards in Taiwan, China, at eight power reactors, four research reactors/critical assemblies, one uranium pilot conversion plant, one fuel fabrication plant, one storage facility and one R&D facility.

Organizational Chart

(as of 31 December 2005)



* The Abdus Salam International Centre for Theoretical Physics (Abdus Salam ICTP), legally referred to as "International Centre for Theoretical Physics", is operated as a joint programme by UNESCO and the Agency. Administration is carried out by UNESCO on behalf of both organizations. The Agency's involvement in the Centre is managed by the Department of Nuclear Sciences and Applications.

** With the participation of UNEP and IOC.

"The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."

Article II of the IAEA Statute

IAEA

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