IAEA ANNUAL REPORT 2010

IAEA
International Atomic Energy Agency

Annual Report 2010

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

This report covers the period 1 January to 31 December 2010.

GC(55)/2

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(as of 31 December 2010)

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

The Agency at a Glance

(as of 31 December 2010)

151 Member States.

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

53 years of international service.

2338 professional and support staff.

€304 million total regular budget for 2010,[1] supplemented by extrabudgetary contributions received in 2010 amounting to **€62.1 million**.

$85 million target in 2010 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **3694** expert and lecturer assignments, **5090** meeting participants, **2493** participants in training courses and **1532** fellows and scientific visitors.

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

2 international laboratories (Seibersdorf and Monaco).

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

4 regional agreements relating to nuclear science and technology.

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

120 active CRPs involving **1586** approved research, technical and doctoral contracts and research agreements. In addition, **80** Research Coordination Meetings were held.

11 national donors and **1** multinational donor (European Union) to the voluntary Nuclear Security Fund.

175 States with safeguards agreements in force, of which **104** States had additional protocols in force, with **2153** safeguards inspections performed in 2010. Safeguards expenditures in 2010 amounted to **€116.1 million** in regular budget and **€18.2 million** in extrabudgetary resources.

20 national safeguards support programmes and **1** multinational support programme (European Commission).

12 million monthly hits to the Agency's *iaea.org* site, representing **2.1** million pages viewed per month.

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

1.2 million documents, technical reports, standards, conference proceedings, journals and books in the IAEA Library and **12 300** visitors to the Library in 2010.

248 publications, brochures, leaflets, newsletters and other promotional material issued in 2010 (in print and electronic formats).

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[1] At the UN average rate of exchange of $1.3248 to €1.00. The total budget was €318 million at the $1.00 to €1.00 rate.

The Board of Governors

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

In the area of nuclear technologies, the Board considered the *Nuclear Technology Review 2010* and established an Agency bank of low enriched uranium for supply by the Agency to its Member States.

In the area of safety and security, the Board discussed the *Nuclear Safety Review for the Year 2009*. It also debated the *Nuclear Security Report 2010.*

As regards verification, the Board considered the *Safeguards Implementation Report for 2009*. It approved a number of safeguards agreements and additional protocols. The Board kept under its consideration the implementation of the NPT safeguards agreement and relevant provisions of United Nations Security Council resolutions in the Islamic Republic of Iran, and the issues of the implementation of the NPT safeguards agreement in the Syrian Arab Republic and the application of safeguards in the Democratic People's Republic of Korea.

The Board discussed the *Technical Cooperation Report for 2009* and approved the Agency's technical cooperation programme for 2011.

The Board took note of the Agency's *Medium Term Strategy 2012–2017.*

The informal and open ended process involving Member States to discuss the future of the Agency completed its work and the Board took note of the report of the Chairpersons of the process.

Composition of the Board of Governors (2010–2011)

Chairperson:

Mr. Ansar PARVEZ
Governor from Pakistan

Vice-Chairpersons:

HE Mr. John Hartmann BERNHARD
Ambassador, Governor from Denmark

Ms. Olena MYKOLAICHUK
Governor from Ukraine

Argentina
Australia
Azerbaijan
Belgium
Brazil
Cameroon
Canada
Chile
China
Czech Republic
Denmark
Ecuador
France
Germany
India
Italy
Japan
Jordan
Kenya
Korea, Republic of
Mongolia
Netherlands
Niger
Pakistan
Peru
Portugal
Russian Federation
Singapore
South Africa
Tunisia
Ukraine
United Arab Emirates
United Kingdom of Great Britain and Northern Ireland
United States of America
Venezuela

The General Conference

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

In 2010, the Conference — upon the recommendation of the Board — approved Swaziland for membership of the Agency. At the end of 2010, the Agency's membership remained at 151.

Notes

- The *Annual Report 2010* aims to summarize only the significant activities of the Agency during the year in question. The main part of the report, starting on page 17, generally follows the programme structure as given in *The Agency's Programme and Budget 2010–2011* (GC(53)/5).

- The introductory chapter, 'Overview', seeks to provide a thematic analysis of the Agency's activities within the context of notable developments during the year. More detailed information can be found in the latest editions of the Agency's *Nuclear Safety Review, Nuclear Technology Review, Technical Cooperation Report* and the *Safeguards Statement* and *Background to the Safeguards Statement and Summary.* For the convenience of readers, these documents are available on the CD-ROM attached to the inside back cover of this report.

- Additional information covering various aspects of the Agency's programme is provided on the attached CD-ROM and is also available on the Agency's web site at *http://www.iaea.org./Publications/Reports/index.html.*

- Except where indicated, all sums of money are expressed in United States dollars.

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

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

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

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
CRP	Coordinated research project
EC	European Commission
Euratom	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
HEU	High enriched uranium
ICTP	Abdus Salam International Centre for Theoretical Physics
IEA	International Energy Agency (OECD)
INFCIRC	Information Circular (IAEA)
INIS	International Nuclear Information System (IAEA)
INPRO	International Project on Innovative Nuclear Reactors and Fuel Cycles (IAEA)
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IPCC	Intergovernmental Panel on Climate Change
LEU	Low enriched uranium
MOX	Mixed oxide
NDA	Non-destructive assay
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OECD	Organisation for Economic Co-operation and Development
OECD/NEA	OECD Nuclear Energy Agency
OPEC	Organization of the Petroleum Exporting Countries
OSCE	Organization for Security and Co-operation in Europe
PAHO	Pan American Health Organization/WHO
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SAL	Safeguards Analytical Laboratory (IAEA)
SQ	Significant quantity
TCF	Technical Cooperation Fund

UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNODC	United Nations Office on Drugs and Crime
UNU	United Nations University
WHO	World Health Organization
WMO	World Meteorological Organization
WWER	Water cooled water moderated power reactor

Overview

For well over fifty years the International Atomic Energy Agency has been dedicated to the achievement of the vision "Atoms for Peace", serving as the focal point for worldwide cooperation in the peaceful uses of nuclear technology, for promoting global nuclear safety and security, and — through its verification activities — for providing assurances that international undertakings to use nuclear facilities and materials for peaceful purposes only are being honoured. What follows is a survey of worldwide nuclear related developments in 2010 and how they affected the work of the Agency.

The accident at the Fukushima Daiichi Nuclear Power Plant, caused by the extraordinary natural disasters of the earthquake and tsunamis that struck Japan on 11 March 2011, continues to be assessed. As this report focuses on developments in 2010, the accident and its implications are not dealt with here, but will be addressed in future reports of the Agency.

Nuclear Technology

Nuclear Power, Nuclear Fuel Cycle and Sustainable Development

Nuclear Power: Status and Trends

The need for sustained economic development to reduce poverty and hunger clearly necessitates increases in the supply of energy and electricity. Nuclear power is a significant contributor to world electricity, and its role as a major source of energy supply and as a mechanism to mitigate climate change has been undergoing a steady re-evaluation. More than 60 countries have expressed an interest in exploring nuclear power, many of which are likely to bring their first reactors on-line by 2030, according to Agency projections.

Construction started on 15 new nuclear power reactors, the largest number of new construction starts since 1985. Five new reactors were connected to the grid, and one reactor was retired, resulting in a net increase of global nuclear generating capacity to 375 gigawatts of electric power (GW(e)). At the end of the year there were 441 reactors in operation and 66 under construction.[1]

[1] For more detailed information on nuclear power reactors in operation and under construction around the world in 2010, see Table A9 in the Annex.

Projected Growth for Nuclear Power

Current expansion and near and long term growth prospects remained centred in Asia. Twelve of the 15 construction starts were in Asia, as were two thirds of the reactors under construction at the end of the year. Four of the five new reactors connected to the grid were in Asia.

Expectations for future growth remained high in 2010. The Agency raised its low projection for global nuclear capacity in 2030 by 7% over the 2009 projection; the high projection declined very slightly. The upward revision in the low projection reflected the progress made by governments, utilities and vendors in implementing their announced plans. The relatively stable high projection means that, globally, aspirations about more ambitious possibilities for nuclear expansion were essentially unchanged in 2010.

"The need for sustained economic development to reduce poverty and hunger clearly necessitates increases in the supply of energy and electricity."

In 2010, the Agency extended its projections to 2050 for the first time. In the low projection, growth slows after 2030. In the high projection, global nuclear capacity in 2050 is four times greater than today.

The Agency also participated in the preparation of the 2010 edition of *Projected Costs of Generating Electricity*, published by the OECD/IEA and OECD/NEA, which showed that at low interest rates, capital intensive, low carbon technologies such as nuclear energy can provide baseload electricity at costs competitive with those of coal fired plants and natural gas fired combined cycle plants. But at high interest rates, fossil fuelled electricity generation costs less than nuclear power in many locations.

Support to Operating Nuclear Power Plants

There is now a more global and competitive energy market than when most existing plants were constructed, as well as more demanding regulatory,

stakeholder and environmental requirements. Of the 441 nuclear power reactors in operation at the end of 2010, 358 had been operating for more than 20 years. Many Member States therefore continued to give high priority to operating their reactors for longer than the 30–40 years originally envisaged.

During the Agency's 2009–2011 technical cooperation cycle, 15 Member States have been participating in technical cooperation projects to strengthen their capabilities to plan and manage for long term operation and improved performance. This is a doubling compared with the participation of seven Member States during the 2007–2008 cycle.

Expansion of Nuclear Power Programmes

Most of the growth in nuclear power capacity will occur in the 29 countries that already have operating nuclear power programmes. After a slowdown in new construction in the 1990s, these countries have recently shown increased interest in building new plants. Currently, 24 countries are planning to expand their existing nuclear programmes and, at the end of 2010, 65 reactors were under construction in countries with operating reactors. At the same time, the Agency received an increasing number of requests for assistance with future expansions of nuclear power programmes. Agency assistance continued to help in developing the necessary nuclear power infrastructure.

"The Agency supports national energy assessments for all interested Member States, not only for those interested in nuclear power."

Energy Assessment Services

The Agency supports national energy assessments for all interested Member States, not only for those interested in nuclear power. Sometimes it conducts assessments directly for Member States. In other cases, by transferring assessment tools to and training experts in Member States, it helps build their capacity to conduct their own assessments. Demand continued to increase in 2010 for Agency assistance in capacity building for energy system analysis and planning, and for conducting national and regional studies on future energy strategies and the role for nuclear power. The Agency's analytical tools developed for this purpose are now being used in more than 120 Member States. During 2010, over 650 energy analysts from 68 countries were trained in the use of these tools. Following successful initial experience with e-training, about 20% of the training was conducted through distance learning courses.

Launching Nuclear Power Programmes

Interest in starting nuclear power programmes remained high. At the end of 2009, Turkey and the United Arab Emirates announced that they had ordered their first nuclear power plants. Additional countries have indicated that they have made a decision to move forward with a nuclear power programme and have been actively preparing the necessary infrastructure. As countries make progress, their plans for nuclear power are becoming more concrete and detailed.

Of the 60 countries that received Agency assistance in this area through national and regional technical cooperation projects in 2010, approximately one third were studying the nuclear power option in preparation for a decision, while roughly half had expressed interest in understanding the issues but had not taken steps toward a decision.

Member States continued to follow the Agency's 'milestones approach' as guidance.[2] Having a clear national policy and government support — the first of the 19 'milestones issues' — is particularly important for successful planning. Member States also requested Agency assistance in the areas of human resource development, stakeholder involvement, financial risk management and waste strategy development.

Assurance of Supply

In December 2010, the Board of Governors authorized the Director General to take steps towards the establishment of a low enriched uranium (LEU) bank. The LEU bank will be owned and controlled by the Agency, as a supply of last resort for nuclear power generation while avoiding any disturbance of the existing commercial fuel

[2] *Milestones in the Development of a National Infrastructure for Nuclear Power*, IAEA Nuclear Energy Series No. NG-G-3.1 (2007).

market, and will be funded exclusively through voluntary contributions. Pledges and contributions in excess of $150 000 000 have been provided by the European Union, Kuwait, Norway, the United Arab Emirates, the United States of America and the Nuclear Threat Initiative, and Kazakhstan has offered to provide a location for an Agency LEU bank and bear the relevant storage costs. Should a Member State's LEU supply be disrupted due to exceptional circumstances, and the supply cannot be restored by the commercial market, State to State arrangements or any other such means, the Member State may call upon the Agency's LEU bank to secure LEU for fuel supplies. Work on this fuel bank is continuing.

An agreement approved by the Board in November 2009, which was signed by the Agency with the Russian Federation in March 2010, established an LEU reserve for supply to Member States. In December 2010, the fuel reserve was fully stocked to its planned capacity of 120 tonnes of LEU by the Russian State Atomic Energy Corporation and placed under Agency safeguards at the Angarsk nuclear facility in Siberia.

Uranium Resources

In 2010, the OECD/NEA and the Agency published the latest edition of the 'Red Book', *Uranium 2009: Resources, Production and Demand*, which estimated identified conventional uranium resources recoverable at a cost of less than $130/kg uranium (kg U) at 5.4 million tonnes of uranium (Mt U). An additional 0.9 Mt U were estimated to be recoverable at costs between $130/kg U and $260/kg U. For reference, the spot price for uranium fluctuated between $105/kg U and $115/kg U for the first half of 2010 before rising to a two year high above $160/kg U by year end.

At the 2009 rate of consumption, the projected lifetime of the 5.4 Mt U mentioned above is around 90 years. This compares favourably with reserves of 30–50 years for other commodities (for example, copper, zinc, oil and natural gas). However, to ensure that uranium in the ground is available as 'yellowcake in the can' to fuel the projected expansion of nuclear power, new mines will need to be developed and existing mines will need to be expanded in a timely manner. Expenditures on exploration and mine development are reported in the Red Book only through 2008. They totalled $1.641 billion in 2008, an increase of 133% over the 2006 figures reported in the Red Book's previous edition.

Uranium production increased by 16% in 2009 compared with 2008. In Kazakhstan, production increased by more than 70%, making it by far the world's top uranium producer in 2009, up from fifth place in 2003 and second place in 2008.

Innovation

The 21st century promises the most open, competitive, globalized markets in human history and the most rapid pace of technological change ever. If a technology is to survive and flourish, continual innovation is essential. While the Agency does not develop technology directly, it promotes the exchange of technical information among interested Member States, using Technical Working Groups, coordinated research projects (CRPs), international conferences and the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) to foster international cooperation. In 2010, the Agency released an updated version of its Advanced Reactors Information System (ARIS) containing comprehensive information on all advanced reactor designs and concepts.

"… the Agency … promotes the exchange of technical information among interested Member States, using Technical Working Groups, coordinated research projects …, international conferences and … [INPRO] to foster international cooperation."

The Agency continued its cooperation with other international programmes on advanced technology, in particular the Generation IV International Forum (GIF). In June, the Agency and GIF held a workshop on the operational and safety aspects of sodium cooled fast reactors (SFRs) to exchange information on safety related fast reactor operational experience, national safety approaches for the next generation of SFRs, and ongoing and planned R&D.

To help countries analyse the long term sustainability of nuclear power programmes, INPRO completed a report entitled *Nuclear Energy Development in the 21st Century: Global Scenarios and Regional Trends* in 2010 and continued to help INPRO members build corresponding national long range strategies. The INPRO Dialogue Forum

regularly brings technology holders and technology users together to help ensure that innovations and R&D strategies meet the needs of both.

Research Reactors

Over 20 Member States are considering building new research reactors. To assist these States, the Eastern European Research Reactor Initiative (EERRI), supported by the Agency, organized the second Research Reactor Group Fellowship Training Course. The six week course made use of different research reactors in the EERRI and included theoretical classes, technical visits and hands-on experiments on various aspects of research reactors. The Agency also assisted North Carolina State University (NCSU) in the USA and the Jordan University of Science and Technology (JUST) in implementing the first international 'remote reactor' programme. Signals from the NCSU's PULSTAR research reactor were sent to JUST, where the displays at PULSTAR were replicated in the classroom. Real-time interaction with instructors in the USA was carried out through videoconferencing.

In November–December 2010, the Agency completed the repatriation of spent fuel from the Vinča Institute in Serbia to the Russian Federation as well as the removal of all high enriched uranium (HEU) from Serbia. The repatriation, which followed six years of preparatory work by several hundred experts and cost more than $50 million, was the largest technical cooperation project in the Agency's history. A total of 2.5 tonnes of spent research reactor fuel, including 13.2 kg of HEU, was repatriated. Also in 2010, under the Russian Research Reactor Fuel Return programme, 109.4 kg of fresh HEU fuel was shipped out of Belarus, the Czech Republic and Ukraine. The Agency also assisted in the repatriation of 362.7 kg of spent HEU fuel from Belarus, Poland and Ukraine.

"… the repatriation of spent fuel from the Vinča Institute in Serbia to the Russian Federation … was the largest technical cooperation project in the Agency's history."

Hospitals all over the world use radioisotopes in medicine, mainly for diagnosis. Shortages in the supply of one of the most frequently used radioisotopes, molybdenum-99 (Mo-99), continued to affect patient services for almost eight months into 2010 until the NRU reactor in Canada and the High Flux Reactor in the Netherlands returned to production. A session on 'Multilateral and Regional Approaches to Securing and Supplementing Mo-99 Supplies' at the Agency's General Conference highlighted both current international initiatives to secure adequate Mo-99 supplies and the scope for further international cooperation. During the year, the Agency participated in the review of two reports by the OECD/NEA 'High-level Group on the Security of Supply of Medical Radioisotopes'. One dealt with the economic aspects of Mo-99 production, and the other assessed alternative production technologies.

Applications of Nuclear Technology

Trends and developments in 2010

In 2010, the Agency continued its work in applying nuclear and isotopic techniques in the areas of food and agriculture, human health, water resources, the environment and industry in order to help reach some of the key targets of the Millennium Development Goals (MDGs). The trend in leveraging partnerships with Member States focused on utilizing, wherever possible, their skills, knowledge and facilities. In particular, the Agency continued to expand its Collaborating Centre scheme (involving research institutions in Member States), which grew in 2010 from 14 to 20. Cooperation with universities and research institutions in 2010 resulted in the completion of 19 CRPs. In addition to networking, the trend of expanding its educational and facilitating role yielded tangible results to the Agency in 2010, such as the development of on-line curriculums in the area of human health and training videos in isotope hydrology.

Human Health

As part of its mandate, the Agency seeks to enhance the capabilities of Member States to prevent, diagnose and treat health problems through the application of a range of nuclear techniques. In its efforts to assist in reducing the shortage of medical specialists in the developing world, particularly for cancer treatment, the Agency developed educational materials and syllabuses and launched the on-line 'Human Health Campus'

at *http://humanhealth.iaea.org*. The web site provides insights into the different aspects of modern clinical practice and serves as a resource and platform for hosting and disseminating learning materials.

Ionizing radiation is used in medicine to investigate medical conditions, diagnose illnesses and administer treatment to patients. If improperly used or administered, radiation can harm the patient, the radiation worker and the public. That is why the accurate measurement of radiation dose, known as dosimetry, is vital to health care and the safe use of nuclear technologies in medicine. In November 2010, the Agency hosted an international symposium on 'Standards, Applications and Quality Assurance in Medical Radiation Dosimetry' to foster the exchange of information and highlight recent developments in this field. Twelve international and professional organizations cooperated in the organization of the conference, which featured 372 participants from 66 Member States.

Programme of Action for Cancer Therapy

In 2010, the Agency continued to strengthen its partnerships with health and cancer control organizations through the WHO/IAEA Joint Programme on Cancer Control. As part of its capacity building and awareness initiatives in 2010, the Agency invited 72 policy makers from the African and the Asia–Pacific regions to attend coordination and planning meetings on cancer control. Building upon the Joint Programme, the Agency and WHO also organized the first joint seminar intended for Member States with PACT Model Demonstration Sites (PMDSs). And the Agency's integrated missions of PACT (imPACT) continued to be in high demand by Member States, with 16 imPACT reviews conducted in 2010.

The Agency's support to Member States through PACT relies largely upon external financial resources. In 2010, contributions to PACT from France, the Republic of Korea, Monaco, New Zealand, Spain, the USA, the OPEC Fund for International Development and F. Hoffmann-La Roche Ltd exceeded $5.7 million. Additionally, funding from the USA was received through the Peaceful Uses Initiative (PUI) to cover 25 imPACT reviews and PMDS follow-up missions.

Management of Water Resources

Ten years after adopting the MDG of "reducing in half the number of people without access to safe drinking water", the United Nations discussed progress in the *2010 Millennium Development Goals Report* and in the Dushanbe Declaration, which was an outcome of the 'Water for Life' conference held in Dushanbe, Tajikistan, in June 2010. Both documents noted that significant progress has been made and it is expected that 86% of the population in developing regions will have access to safe water by 2015. However, progress has been uneven, and some large regions currently have less than 60% access. In addition, there is an increasing concern that improvements in water quality have not kept up with enhanced water access.

Consistent with the above mentioned assessments, the Agency initiated a project in 2010 to enable Member States to have a sound scientific basis for the use and sharing of their water resources. The IWAVE (IAEA Water Availability Enhancement) project aims at facilitating the comprehensive gathering and use of scientific information to fully assess the availability and quality of water resources.

"… the Agency's integrated missions of PACT (imPACT) continued to be in high demand by Member States, with 16 imPACT reviews conducted in 2010."

In addition, the Agency strengthened Member State capabilities to use isotope techniques for water resources management by producing training tools and videos, conducting training courses for analytical and data analysis methods, and expanding its global isotope monitoring networks, and by initiating a thematic series of isotope hydrology atlases. In 2010, the first atlas in this series was published for Morocco.

Radioisotopes and Radiation Technology

Radioisotope products are major tools for nuclear applications in diverse fields. The continuing evolution of new applications requires the development and production of new products, mostly radiopharmaceuticals. Agency activities in 2010 focused on promoting innovation in Member States. For example, a CRP completed in 2010 resulted in the development of two novel

technetium-99m tracers. Such substances are used as radioactive tracers in medical diagnoses and treatments. The work included the characterization of the biological properties of the tracers in the pre-clinical phase, as well as the production of kits for their easy preparation. The goal is to accelerate further evaluation and lead to their clinical use in breast cancer patients.

Radiation induced grafting is a powerful technique for the preparation of advanced materials based on easily available and low cost synthetic and natural polymers. The Agency concluded a CRP in 2010 which resulted in the development of methodologies for the preparation of radiation grafted membranes to remove pollutants (e.g. heavy metal ions, toxic compounds) from wastewater. In expanding the utilization of Member State capabilities, the Institute of Nuclear Chemistry and Technology (INCT) in Poland was designated as a new IAEA Collaborating Centre for Radiation Processing and Industrial Dosimetry. The INCT will help implement industrial dosimetry intercomparison exercises that are vital for the effective and efficient application of radiation processing technology.

Food and Agriculture

In 2010, the world's growing population continued to be faced with inadequate food supplies, partly caused by the changing environment and further exacerbated by the global financial crisis. Science, including nuclear and isotopic techniques, provides solutions for making sustainable agriculture techniques accessible to people everywhere. For example, the early application of rapid and sensitive nuclear and nuclear related diagnostic tests to control transboundary animal diseases was one of the Agency's key priorities in the area of food and agriculture in 2010. It contributed to the control and eradication of rinderpest, a devastating disease of cattle. The Agency has provided $20 million over the years to support the eradication of rinderpest, with the return on investment in Africa alone of $1 billion per year in livestock production. Building on this, FAO and the World Organisation for Animal Health are expected in 2011 to officially declare the global eradication of rinderpest, the first time that this has been achieved for an animal disease.

"The Agency has provided $20 million over the years to support the eradication of rinderpest, with the return on investment in Africa alone of $1 billion per year in livestock production."

Insect pests can seriously affect food security and the commercial value of agricultural products. Sterile insect techniques offer an alternative way of suppressing and/or eradicating insects such as fruit flies, tsetse flies, moths and others. In 2010, an integrated pest management system against cotton and sugarcane major pests, based on the use of biological control agents through the application of radiation technology, was developed for Pakistan. Cotton and sugarcane are the principal crops in Pakistan, and insect pests are a major constraint, resulting in yield losses in spite of huge quantities of insecticides being sprayed every year. As part of a pilot project, biocontrol agents based on the use of radiation are being applied to more than 600 hectares of a cotton field. As a result of this project, the technology was transferred to the sugarcane industry to produce natural enemies of sugarcane borers to manage these pests in an environment friendly way. In 2010, seven sugar mills were producing biological control agents and applying them successfully over 25 000 hectares.

Environment

The Agency provides reference materials to Member States to improve quality, accreditation and measurement procedures for the analysis of environmental samples. An intensive five day IRCA (International Register of Certificated Auditors) certified 'ISO/IEC 17025 Lead Auditor Training' session was held in Monaco at the end of 2010 to prepare for the accreditation of the Agency's Environment Laboratories.

Nuclear Safety and Security

Nuclear Safety: Status and Trends

The international nuclear community maintained a high level of safety performance in 2010. Nuclear power plant safety performance remained high, and indicated an improved trend in the number of emergency shutdowns as well as in the level

of energy available during these shutdowns. In addition, more States explored or expanded their interests in nuclear power programmes, and more faced the challenge of establishing the required regulatory infrastructure, regulatory supervision and safety management over nuclear installations and the use of ionizing radiation.

Building Capacity in Member States

As the global demand for energy intensifies and the need to counteract climate change becomes more urgent, many countries have committed themselves to exploring the possibility of embarking on nuclear power programmes or expanding existing ones. However, not all States have adequate competences, especially with regard to the required legal and regulatory frameworks necessary for nuclear safety and security. In June 2010, the Regulatory Cooperation Forum (RCF) was formed to assist Member States in this effort. The RCF is a regulator to regulator body that optimizes regulatory support from Member States with advanced nuclear power programmes to newcomer Member States.

New and Expanding Nuclear Power Programmes

During 2010, the Agency assisted Member States in developing their governmental and regulatory framework, especially those States interested in developing new, or expanding existing, nuclear power programmes. For instance, the Agency developed a Safety Guide on establishing safety infrastructure. It also carried out a number of missions, inter alia, in the Islamic Republic of Iran, Jordan, Thailand, the United Arab Emirates and Vietnam, particularly for strengthening safety infrastructure. These missions provided guidance on the progressive application of the Agency's safety standards for the different steps in the development of nuclear power programmes. In addition, the Agency conducted several regional and national workshops and training events on regulatory issues for newcomers in the areas of licensing process, regulatory oversight for the construction of nuclear power plants and stakeholder involvement including the public.

Enhancement of Research Reactor Safety

In 2010, the Agency continued its efforts aimed at encouraging Member States to apply the Code of Conduct on the Safety of Research Reactors by organizing meetings and training activities. In 2010, four regional meetings on the application of the Code were organized in Africa, Asia, Europe and Latin America. These meetings focused on safety issues of common interest, including regulatory supervision, ageing management, operational radiation protection, safety of experiments, emergency planning and preparedness, and decommissioning planning.

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The Agency's Incident Reporting System for Research Reactors and Research Reactor Information Network seek to improve the safety of research reactors through the exchange of safety related information on unusual events. In addition to continuing efforts to encourage the sharing of knowledge, operating experience and good safety practices, the Agency facilitated the creation of a Regional Advisory Safety Committee in Africa, and achieved significant progress in creating such committees for other regions.

Incident and Emergency Preparedness

Nuclear emergencies and radiation related events, when they occur, affect workers, the public, property and the environment. Not all Member States are adequately prepared to respond to radiation events, and any expansion in the use of nuclear energy needs to go hand in hand with enhancement of national, regional and international emergency preparedness and response capabilities. Moreover, increased concern over the malicious use of nuclear or radioactive materials stressed the need to broaden those capabilities. In light of these facts, in 2010 Agency activities were geared to enhancing technical guidelines, providing technical assistance, building capacity in Member States, fostering the sharing of information, and improving international and the Agency's arrangements and capabilities. In specific terms,

the Agency organized 38 training events on various aspects of emergency preparedness and response. Six Emergency Preparedness and Review (EPREV) missions were carried out in Azerbaijan, Belarus, Philippines, Qatar, Romania and Thailand, and 13 additional missions were implemented to assist in the development and strengthening of national emergency preparedness and response systems.

Spent Fuel and Radioactive Waste Management

For nuclear power, the disposal of high level waste (HLW) remains the one step in the civilian nuclear fuel cycle where there is still no industrial scale facility in operation. However, Finland, France and Sweden have made substantial progress and expect to bring repositories into full operation around 2020. Industrial scale facilities do exist for the storage of spent fuel and for the disposal of intermediate and low level waste. The Agency's role is to ensure that information on the technology and experience accumulated in the area of waste management and disposal is available to the public at large, to countries considering or introducing nuclear power, and to those involved with waste in all nuclear power programmes.

"… the European Commission … proposal for a Council Directive on the management of spent fuel and radioactive waste. … is based largely on the Agency's Fundamental Safety Principles …"

With respect to HLW disposal, the access tunnel at the Olkiluoto site in Finland was excavated to its final disposal depth of 434 metres by the end of 2010. The tunnel will be used first for rock characterization to ensure the suitability of the site and then for disposal. The construction licence application is scheduled for 2012. In Canada, the Nuclear Waste Management Organization began a process in May 2010 to select a site for a deep geological repository. In the USA, a 'Blue Ribbon Commission on America's Nuclear Future' was established following the US Government's 2009 decision not to proceed with the Yucca Mountain repository. The Commission will make recommendations on long term solutions for spent fuel and high level waste. Its first report is scheduled for June 2011. As part of its assistance to Member States in developing geological disposal programmes, the Agency organized training courses in 2010 in Japan and the USA, including a visit to the Waste Isolation Pilot Plant in Nevada.

For low and intermediate level waste (LILW), disposal facilities are currently operating in 23 countries. In 2010, Slovenia confirmed the site for a new LILW repository near the country's existing nuclear power plant. And the first radioactive waste arrived at the Wolsong repository in the Republic of Korea, where it is currently stored in a storage facility on the repository site. The Agency provided training and information on LILW disposal at courses and workshops in Argentina, Germany, India, Malaysia and Spain.

Long Term Management of Radioactive Waste

In November 2010, the European Commission presented a proposal for a Council Directive on the management of spent fuel and radioactive waste. This proposal is based largely on the Agency's Fundamental Safety Principles and the obligations embodied in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The proposed Directive requires that Member States shall, at least every ten years, carry out self-assessments of their national framework, including assessments of the competent regulatory authority and national programme, and its implementation compared with international peer reviews of their national framework, authority and/or programme.

Decommissioning

Worldwide statistics on the decommissioning of nuclear power plants did not change significantly in 2010. At the end of the year, 124 power reactors were shut down. Of these, 15 reactors were fully dismantled, 52 were in the process of being dismantled or planning for short term dismantling, 48 were being kept in safe enclosure mode, 3 were entombed, and 6 did not yet have specified decommissioning strategies. The Agency's International Decommissioning Network facilitated the exchange of information and experience through workshops and hands-on training in Austria, Belgium, Germany, Hungary, Ukraine and the USA.

In addition to radioactive waste associated with nuclear power, sealed radioactive sources that have

been used in medical, industrial and other non-power applications must be properly packaged, managed and disposed of. The Agency helps Member States improve the management of these sources and repatriate them to their countries of origin. In 2010, the mobile hot cell, a technology developed by the Nuclear Energy Corporation of South Africa under contract to the Agency, was deployed in Uruguay to extract 14 components with high activity sources from the devices in which they were housed, and package them into transport containers for repatriation.

Safety in Medical Uses of Ionizing Radiation

The extent of medical radiation exposure has increased considerably in recent years, and the doses involved are quite large compared with occupational exposures. In some countries, the population dose from medical exposures has rivalled that from natural background radiation, and globally accounted for more than 98% of the contribution from all artificial sources. In general, access to radiation in medicine increased for the global population; however, about 25% of the world's population in developed countries received around 75% of the medical procedures utilizing ionizing radiation.

The safe and appropriate use of new medical radiation technology was examined at the Scientific Forum held in conjunction with the 54th session of the Agency's General Conference in Vienna in September. The Forum drew attention to the challenges in ensuring safety when establishing a radiotherapy programme, especially in settings where there were constraints on capacity and infrastructure. Scientists and regulators discussed evidence based and cost–benefit issues when introducing new technology, as well as governmental commitment when addressing education and training, and safety culture in medicine.

Fostering the Safe Management of Sources

In 2010, the Agency organized two important international meetings where States were able to share their experience and challenges in the 'cradle to grave' management of sources at the international level and to address the issue of sustainable management of disused sealed sources. Both the open-ended meeting on the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and the International Workshop on Sustainable Management of Disused Sealed Radioactive Sources provided recommendations for future international cooperation programmes.

Denials and Delays of Shipments

The safety record for the transport of radioactive material remained excellent in 2010. However, denials and delays of shipment of radioactive materials continued to occur, with the most apparent increase in denials of shipment resulting from national variations in regulations. The International Steering Committee on Denials of Shipment of Radioactive Material continued to coordinate efforts to find solutions related to denials of shipment.

Nuclear Law

Member States have long recognized that coherent and comprehensive national legal frameworks are essential for ensuring the safe, secure and peaceful uses of nuclear energy and related nuclear applications. Since the establishment of the Agency, a number of legally binding and non-binding international legal instruments have been adopted under its auspices in the fields of nuclear safety, nuclear security, safeguards and civil liability for nuclear damage.

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The continued increase in the number and complexity of these instruments presents a significant challenge for Member States. This is particularly the case for States that have expressed an interest in pursuing civil nuclear power programmes and that hence need to bring their respective national legislation in line with these instruments.

With the aim of assisting States required to draft corresponding national implementing legislation,

especially those that have expressed an interest in pursuing civil nuclear power programmes, the Agency established a comprehensive approach to nuclear law that brings different fields of nuclear law together in one piece of national legislation. This approach is being applied widely in the Agency's legislative assistance programme, under which more than 100 Member States have received bilateral legislative assistance, essentially by means of written comments and advice on drafting national nuclear legislation. Also under this programme, training has been provided to over 300 individuals through workshops, courses, short term scientific visits as well as longer term fellowships, allowing individuals to gain further practical experience in nuclear law.

"… the Agency established a comprehensive approach to nuclear law that brings different fields of nuclear law together in one piece of national legislation."

Following up on the publication in 2003 of a reference book providing a theoretical overview of nuclear law — the *Handbook on Nuclear Law* — the Agency published a companion volume in 2010 — *Handbook on Nuclear Law: Implementing Legislation* — setting out concrete model texts of legislative provisions needed for drafting comprehensive national nuclear legislation.

INLEX

The International Expert Group on Nuclear Liability (INLEX), established by the Director General in 2003, continues to serve as the Agency's main forum for dealing with questions related to nuclear liability. INLEX aims at contributing to a better understanding of, and adherence to, international nuclear liability instruments. In 2010, at its tenth meeting, INLEX reported on the status of ratification of the international nuclear liability conventions, and the European Commission legal study on the harmonization of the civil nuclear liability system within the European Union. The Group also exchanged preliminary views on a draft Explanatory Text on the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention. As part of its regular outreach activities, INLEX held a regional workshop on civil liability for countries in Eastern Europe and Central Asia in Moscow from 5 to 7 July 2010. During the workshop, presentations were made on various aspects of the international nuclear liability regime, including the insurance of nuclear risks, and extensive discussions took place on the need for a uniform international nuclear liability regime and on how such a regime might be best reflected in corresponding national laws.

Training in Nuclear Safety and Security

Several Member States have some form of education and training programme in nuclear safety and security; this is fundamental to sustain nuclear safety. To address the challenge of establishing a national strategy for building competence in nuclear safety and security, the Agency issued its updated *Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011–2020.* In this regard, Agency regional training centres for education and training in radiation safety have been established and their activities periodically monitored through Education and Training Appraisal (EduTA) missions. In 2010, there was increasing interest in EduTA missions, with six missions to Algeria, Brazil, Egypt, Ghana, Morocco and South Africa.

Nuclear Security

The Agency's nuclear security activities contributed to efforts by States to mitigate the risk of nuclear or other radioactive material being used in malicious acts through the establishment of appropriate and effective national systems for nuclear security. During 2010, the Agency published guidance, conducted advisory missions, organized training events and provided technical assistance in completing security upgrades to 11 facilities, coordinating the repatriation of HEU and donating to States more than 800 radiation detection instruments.

In April 2010, the Director General attended the Nuclear Security Summit, held in Washington, D.C. At the Summit, he informed participants about the work being carried out by the Agency in the nuclear security area, and "the essential role of the IAEA in the international nuclear security framework" was recognized by the participants in the Summit communiqué.

Technical Cooperation

The Agency's technical cooperation programme is the primary mechanism to support Member States in the peaceful and safe use of nuclear technology for development. Due to the specialized technical nature of its contribution within the wider development context, and in view of ever more complex global challenges that must be tackled in coordination with other relevant actors, the management of the programme emphasizes the importance of partnerships at all levels, from counterparts up to other international organizations. Participation in the United Nations Development Assistance Framework process, as well as linkages with other international and regional development agendas, is highlighted as a means to leverage project impact and achieve synergies with UN system organizations.

Technical cooperation projects are developed and managed jointly by Member States and the Secretariat, based on the principle of shared responsibility. In 2010, technical cooperation projects were under way in 129 countries and territories.[3]

The Agency's Technical Cooperation Programme in 2010

In 2010, nuclear safety accounted for 18.4% of disbursements. It was followed by human health at 17.9%, with food and agriculture, at 14%, in third place. By the end of the year, implementation of the Technical Cooperation Fund (TCF) stood at 73.9%, with implementation of all funds at 76.6%. Considerable efforts were expended throughout the year on pre-planning work for the 2012–2013 technical cooperation cycle. Updated guidance was issued to Member States, and emphasis was placed on the preparation of cohesive country programmes, reflected in Country Programme Notes (CPNs) that align with national Country Programme Frameworks (CPFs).

For many African Member States, meeting basic human needs remained the top priority on the agenda for national development plans and international cooperation programmes in 2010. Activities in the region concentrated on supporting Member States in developing technical, managerial and institutional capacities in nuclear science and technology. A second focus was the sustainable application of nuclear techniques in key areas of national and regional significance to achieve increased food security, improved nutrition and health services, better management of groundwater resources, improved energy development planning including the feasibility of the nuclear power option, quality control in industrial development and a cleaner and safer environment.

In Asia and the Pacific, the focus was on strengthening human and institutional capacity for nuclear safety and for applications of nuclear technology in health, agriculture and industry, and supporting infrastructure building for Member States embarking on nuclear power.

"In all regions, cooperative arrangements, including regional agreements, have become key strategic mechanisms to expand cooperation with other partners at the regional and international levels."

In Europe, projects to support the development of nuclear power and the use of radiation in health care, as well as to maintain appropriate levels of safety and security in all aspects of the peaceful use of nuclear technology were an important area of activity.

In Latin America, in addition to ongoing projects in the areas of radiotherapy, nuclear medicine, plant breeding, pest control and water management, strategic alliances and partnerships continued to be important means to address the development needs of Member States. Emphasis was placed on disseminating the achievements of the projects carried out in connection with the ARCAL Regional Agreement over the last 25 years.

In all regions, cooperative arrangements, including regional agreements, have become key strategic mechanisms to expand cooperation with other partners at the regional and international levels. During the General Conference, consultations were held among the regions to identify synergies and initiatives for enhancing communication and cooperation between them, especially through regional agreements.

[3] More detailed information on the Agency's technical cooperation programme can be found in the *Technical Cooperation Report for 2010: Report by the Director General* (GC(55)/INF/2).

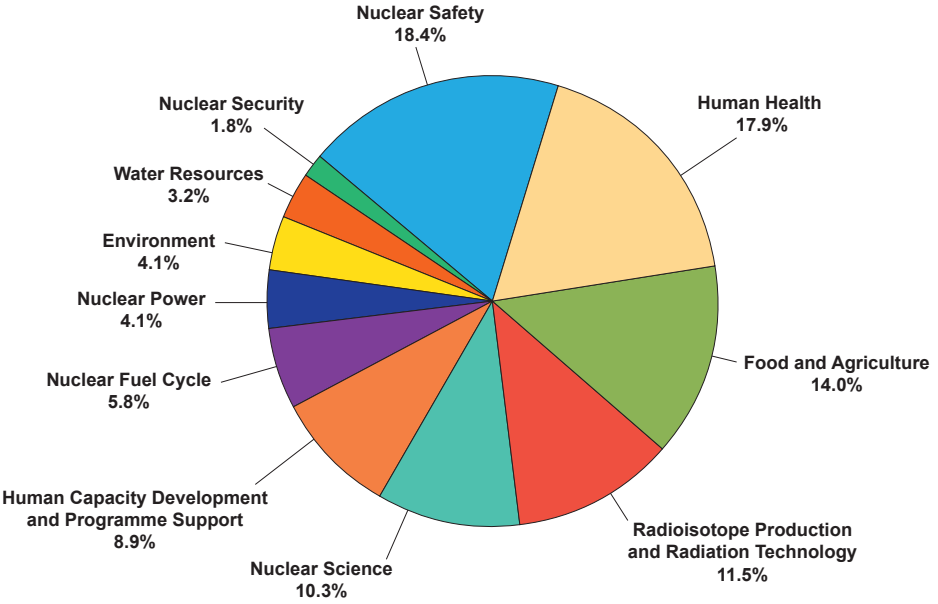

FIG. 1. Distribution of technical cooperation disbursements in 2010 by Agency programme (percentages in the chart may not add up to 100 due to rounding).

Financial Resources

The technical cooperation programme is funded by contributions to the TCF, as well as through extrabudgetary contributions, government cost sharing and contributions in kind. Overall, new resources reached a total of $127.6 million in 2010, with $79.7 million for the TCF (including previous year payments to the TCF, assessed programme costs, national participation costs[4] (NPCs) and miscellaneous income), $45.6 million in extrabudgetary resources, and $2.2 million representing in-kind contributions. These resources were applied directly to technical cooperation projects.

"Resources were sufficient to carry out the core technical cooperation programme as planned for 2010."

In 2010, the technical cooperation programme benefited from generous funding through the PUI. Eleven 'footnote-a/' projects[5] in the area of nuclear power infrastructure were being implemented with over $1.9 million in funds. Over 80 Member States were participating in various PUI funded activities under these projects, and a number of other footnote-a/ projects in non-power applications will also be funded by up to $478 000 through the PUI. The European Commission also made available up to €1.1 million for the period 2010–2012, with €507 000 received in 2010. Projects funded under this contribution concentrate on nuclear safety.

The rate of attainment[6] for the TCF stood at 92.3% on pledges and at 87.9% on payments at the end of the year, while payment of NPCs totalled $0.8 million. Resources were sufficient to carry out the core technical cooperation programme as planned for 2010.

Disbursements

In 2010, the sum of $114.3 million was disbursed to 129 countries or territories, of which 29 were

[4] *National participation costs*: Member States receiving technical assistance are assessed a charge of 5% of their national programme, including national projects and fellows and scientific visitors funded under regional or interregional activities. At least half of the assessed amount for the programme must be paid before contractual arrangements for the projects may be made.

[5] *Footnote-a/*: Projects that are awaiting funding or are partially funded by the TCF.

[6] The rate of attainment is the percentage that results from dividing the total voluntary contributions pledged and paid to the TCF for a particular year by the TCF target for the same year. As payments can be made after the year in question, the rate of attainment can increase over time.

least developed countries, reflecting the Agency's ongoing effort to address the development needs of the world's poorest States (Fig. 1).

Safeguards and Verification

The Agency's verification programme remains at the core of multilateral efforts to curb the proliferation of nuclear weapons. Through the application of safeguards, the Agency aims to assure the international community that nuclear material and facilities are used only for peaceful purposes. As such, the Agency has an essential verification role under the Treaty on the Non-Proliferation of Nuclear Weapons, as well as other treaties such as those establishing nuclear-weapon-free zones.

Safeguards Conclusions for 2010

At the end of each year, based upon an evaluation of all information available to it for that year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force. In 2010, safeguards were applied for 175 States[7] with safeguards agreements in force with the Agency.[8]

For a 'broader conclusion' to be drawn that 'all nuclear material remained in peaceful activities', both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) must be in force, and the Agency must have been able to conduct all necessary verification and evaluation activities. Of the 99 States that had both a CSA and an AP in force, the Agency concluded that all nuclear material remained in peaceful activities in 57 States[9]. For the remaining 42 States, the Agency was only able to conclude that declared nuclear material remained in peaceful nuclear activities, as it had not yet completed all the necessary evaluations under these States' respective APs.

For States that have a CSA in force but no AP, the Agency does not have sufficient tools to draw soundly based safeguards conclusions regarding the absence of undeclared nuclear material and activities. For the 68 such States, the Agency drew the safeguards conclusion that declared nuclear material remained in peaceful activities.

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

The Secretariat could not draw any safeguards conclusions for the 17 NPT non-nuclear-weapon States without safeguards agreements in force.

For the three States that had safeguards agreements in force based on INFCIRC/66/Rev.2, the Secretariat concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities.

During 2010, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement and relevant United Nations Security Council resolutions in the Islamic Republic of Iran (Iran). In 2010, while the Agency continued to verify the non-diversion of declared nuclear material at the nuclear facilities and locations outside facilities declared by Iran, the Agency was not able to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran was in peaceful activities. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran did not: implement the provisions of its AP; implement the modified Code 3.1 of the subsidiary arrangements general part to its CSA; suspend its enrichment related activities; suspend its heavy water related activities; and clarify the remaining outstanding issues which give rise to concerns about possible military dimensions to its nuclear programme. In 2010, Iran announced that it had selected the sites for new enrichment

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[7] The 175 States do not include the Democratic People's Republic of Korea (DPRK), where the Agency did not implement safeguards and, therefore, could not draw any conclusions.

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

[9] And Taiwan, China.

facilities and that construction of one of these facilities would start in 2011.

In 2010, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement in the Syrian Arab Republic (Syria). The Agency continued its verification activities in relation to the allegations that an installation destroyed by Israel at Dair Alzour in Syria in September 2007 had been a nuclear reactor under construction. Syria has yet to provide a credible explanation for the origin and presence of anthropogenic natural uranium particles found at the Dair Alzour site.[10] Syria has not cooperated with the Agency since 2008 in connection with the unresolved issues related to the Dair Alzour site and the three other locations to which it is allegedly functionally related. In 2009, the Agency found anthropogenic natural uranium particles at the Miniature Neutron Source Reactor (MNSR) near Damascus. A plan of action was agreed between Syria and the Agency, the aim of which is to resolve the inconsistencies between Syria's declarations and the Agency's findings.

Other Verification Activities

Since December 2002, the Agency has not implemented safeguards in the Democratic People's Republic of Korea (DPRK) and, therefore, cannot draw any safeguards conclusion regarding the DPRK. Since 15 April 2009, the Agency has not implemented any measures under the ad hoc monitoring and verification arrangement agreed between the Agency and the DPRK and foreseen in the Initial Actions agreed at the Six-Party Talks. Although not implementing any verification in the field, the Agency continued to monitor the DPRK's nuclear activities by using open source information, satellite imagery and trade information. In this regard, the Agency learned with great regret of the report on the uranium enrichment facility at Yongbyong. The Agency also continued to further consolidate its knowledge of the DPRK's nuclear programme with the objective of maintaining operational readiness to resume safeguards implementation in the State, to implement ad hoc monitoring and verification arrangements and to resolve any issues that may have arisen due to the long absence of Agency safeguards. In 2010, the Agency continued to regard the DPRK nuclear issue and that country's nuclear tests as a serious threat to the international nuclear non-proliferation regime and regional and international peace and stability.

"… in 2010, the Agency also continued its work on the conceptual framework for safeguards, aimed at further improving the State evaluation process and ensuring that States have a high level of confidence in the Agency's assurances."

Conclusion of Safeguards Agreements and Additional Protocols

The Secretariat continued to implement its Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols, which was updated in September 2010. Outreach events in 2010 included: a briefing on Agency safeguards held in New York in May at the 2010 Review Conference of the Parties to the NPT; and an interregional seminar on the Agency's safeguards system for Portuguese speaking States with limited nuclear material and activities, conducted in Lisbon, in June.

In 2010, CSAs entered into force for five States and APs for ten States. One State acceded to the safeguards agreement between the non-nuclear-weapon States of Euratom, Euratom and the Agency, as well as the AP thereto. Small quantities protocols were amended to reflect the revised text with three States.

Strengthening Safeguards

In August, the Agency completed *The Long-Term Strategic Plan (2012–2023)*, which addresses the conceptual framework for safeguards, legal authority, technical capabilities and human and financial resources for Agency verification.

The drawing of soundly based safeguards conclusions is of utmost importance to the Agency. Therefore, in 2010, the Agency also continued its work on the conceptual framework for safeguards, aimed at further improving the State evaluation process and ensuring that States have a high level

[10] 'Anthropogenic' refers to nuclear material that has been produced as a result of chemical processing.

of confidence in the Agency's assurances. The Agency continued to further develop the State level concept for the planning, implementation and evaluation of safeguards activities for all States with CSAs in force. Key to this approach is the strengthening of collaborative analysis, involving multi-disciplinary teams throughout the entire safeguards process.

The Secretariat continued to work with State authorities responsible for implementing systems of accounting for and control of nuclear material on safeguards implementation issues, such as the quality of operator systems for the measurement of nuclear material, the timeliness and accuracy of State reports and declarations, and support for the Agency's verification activities, including through training and advisory missions.

Further enhancements were made to the capabilities of the safeguards analytical services through a project entitled 'Enhancing Capabilities of the Safeguards Analytical Services (ECAS)': the architectural design for a Nuclear Material Laboratory to analyse nuclear material samples was completed; and construction of an extension to the Clean Laboratory at Seibersdorf began in April.

In November, the Agency held its 11th Symposium on International Safeguards in Vienna. Some 670 participants from 64 States and 17 international organizations attended the event, the theme of which was 'Preparing for Future Verification Challenges'.

Conclusion

The role that the Agency has played in helping to achieve global development objectives continues to conform to the objective stated in Article II of its Statute, namely to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". In this context, several principles central to the Agency's mission were reinforced during 2010, the most important of which were the following:

- Important benefits for achieving sustainable development and for improving the quality of life can derive from the peaceful application of nuclear energy and nuclear techniques. The Agency thus has an important role in assisting developing countries to improve their scientific and technological capabilities in the nuclear area.
- Both national measures and international cooperation are essential for nuclear, radiation, waste and transport safety, and the Agency has a key role in the promotion of a global safety culture.
- Agency safeguards are a basic component of the non-proliferation regime and create an environment conducive to nuclear disarmament and nuclear cooperation.

Responding to the challenges of the future requires collaborative efforts by Member States, international organizations and civil society. It also requires flexibility — the ability to adapt to changing circumstances to achieve common goals. For the Agency, this cooperation is the key to harnessing nuclear energy in the service of peace and development for humanity.


Nuclear Technology

Nuclear Power

Objective

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

Launching and Expanding Nuclear Power Programmes

Some 60 Member States have expressed interest in the introduction of a nuclear power programme. To strengthen coordination of Agency activities to respond to this interest, an Integrated Nuclear Infrastructure Group (INIG) was established in 2010. Its responsibilities include: the integration of information from various databases for more effective planning and delivery of support activities under technical cooperation projects; training in the use of energy planning tools; legislative assistance; guidance on ensuring beneficial, responsible and sustainable nuclear development; building capabilities, including self-assessment capabilities, among governmental and operating organizations; and the preparation and implementation of education and training materials.

In 2010, the Agency also established the Technical Working Group on Nuclear Power Infrastructure (TWG-NPI), a group of international experts to provide advice to the Agency to support Member States considering or introducing a nuclear programme and to share experience and information on national programmes.

Thailand was the site of the fourth Integrated Nuclear Infrastructure Review (INIR) mission, which benefited from the feedback, experience and lessons learned from the 2009 INIR missions to Indonesia, Jordan and Vietnam.

The Agency organized a workshop on 'Topical Issues on Infrastructure Development: Managing the Development of a National Infrastructure for Nuclear Power', which was attended by 100 representatives from 45 Member States, the European Commission and the World Association of Nuclear Operators. The main outcome was improved understanding of techniques for developing a national strategy for nuclear power and sharing of experience in starting a nuclear power programme. It was also recognized that a strong national strategy forms the basis for many aspects of the infrastructure including workforce planning. Additional workshops were organized in 2010 on common challenges in site selection for nuclear power plants and on industrial involvement and technology transfer for nuclear power plant projects.

"To strengthen coordination of Agency activities … an Integrated Nuclear Infrastructure Group (INIG) was established in 2010."

An interregional training course on leadership and management of nuclear power infrastructure in emerging nuclear power States, organized through the technical cooperation programme, was held in October at the Argonne National Laboratory (ANL) in the USA. The course, organized for a second year jointly by the Agency and the ANL, was attended by 28 participants at the decision making level from 20 Member States from Africa, Asia, Europe and Latin America.

Also through the technical cooperation programme, the Korea Hydro & Nuclear Power Company (KHNP) hosted a two week event to mentor potential future leaders of nuclear power programmes in developing countries. Experienced KHNP managers served as full time mentors to participants, and the KHNP organized site visits to a utility, an engineering company, a training centre, research organizations, an operating nuclear power plant, a construction site, a heavy component manufacturing company, government ministries and the nuclear safety regulatory body.

FIG. 1. Pouring the first concrete at the Sanmen nuclear power project site in China.

At the end of 2010, 24 countries were planning to expand their existing nuclear programmes, and of the 66 reactors under construction, all but one were in countries that are expanding or are planning to expand their existing programmes (Fig. 1). Any increase in the use of nuclear power is expected to occur largely through the expansion of existing nuclear power programmes. In 2010, the Agency therefore initiated new activities on expanding nuclear power programmes to help interested Member States develop the necessary nuclear power infrastructure for expansion and to build the needed expertise in operating organizations.

"At the end of 2010, 24 countries were planning to expand their existing nuclear programmes …"

Engineering Support for Operation, Maintenance and Plant Life Management

A number of Member States have given high priority to the long term operation of nuclear power plants beyond the 30 or 40 years originally anticipated. In 2010, there were 15 technical cooperation projects on strengthening Member State capabilities to improve nuclear power plant performance and service life, a doubling relative to the previous (2007–2008) cycle.

The Agency began two new CRPs in 2010, one on 'Continued Operations beyond 60 Years in Nuclear Power Plants' and the second on the 'Review and Benchmark of Calculation Methods on Piping Wall Thinning Due to Erosion–Corrosion in Nuclear Power Plants'. The objective of the first is to establish a quantitative evaluation method for possible continued operations beyond 50–60 years. The objective of the second is to improve methods for predicting piping wall thinning.

A unified procedure for lifetime assessment of components and piping in WWER nuclear power plants (VERLIFE) for the structural integrity of such plants was completed in 2010. This procedure had been partially developed by the European Union's Joint Research Centre in 2008 and was then completed under the leadership of the Agency. It has been approved for analysing reactor pressure vessels and piping categorized in a particular safety class by licensing authorities in Bulgaria, the Czech Republic, Hungary and Slovakia.

In the area of instrumentation and control (I&C), the Agency introduced a new review service, Independent Engineering Review of I&C Systems (IERICS). Two IERICS missions were conducted in 2010. The first visited the Doosan Heavy Industries & Construction Company Limited in the Republic of Korea to review the prototype of the advanced digital I&C systems designed for APR-1400 nuclear power plants. The second evaluated the digital I&C

systems, based on field programmable gate arrays, used for reactor protection, control and monitoring in Ukrainian nuclear power plants.

Human Resource Management

The Agency conducted 11 workshops on workforce planning in 2010. It also organized an international conference on 'Human Resource Development for Introducing and Expanding Nuclear Power Programmes,' in Abu Dhabi, United Arab Emirates, in March. At the conference, an initiative was announced by the Agency and eight other organizations to conduct a number of surveys of human resource needs throughout the nuclear power field, and to develop workforce planning tools for countries considering or launching new nuclear power programmes. The Agency will have a lead role in those aspects of the surveys related to operating organizations, regulatory bodies and staffing for new nuclear power programmes.

Nuclear Reactor Technology Development

Member States, both those considering their first nuclear power plant and those with an existing nuclear power programme, are interested in access to up to date information about all available nuclear reactor designs as well as important development trends. In 2010, the Agency introduced the Advanced Reactors Information System (ARIS). ARIS is a web accessible database that provides Member States with comprehensive and balanced information about all advanced reactor designs and concepts (Fig. 2) (*http://aris.iaea.org*).

In the area of water cooled reactors, the Agency produced two publications. *Good Practices in Heavy Water Reactor Operation* (IAEA-TECDOC-1650) identifies regulatory advances, occupational dose reductions, performance improvements, and operational and maintenance cost reductions achieved in heavy water reactor operation. *Advanced Fuel Pellet Materials and Fuel Rod Design for Water Cooled Reactors* (IAEA-TECDOC-1654) reviews the current status of and potential improvements in fuel rod designs for light and heavy water cooled power reactors.

"The Agency conducted 11 workshops on workforce planning in 2010. It also organized an international conference on 'Human Resource Development for Introducing and Expanding Nuclear Power Programmes,' …"

As part of a CRP, the Agency organized a training course on 'Natural Circulation Phenomena and Passive Safety Systems in Advanced Water Cooled Reactors'. The course provided lectures on actual examples of such systems, their theoretical and experimental background, and analytical methods

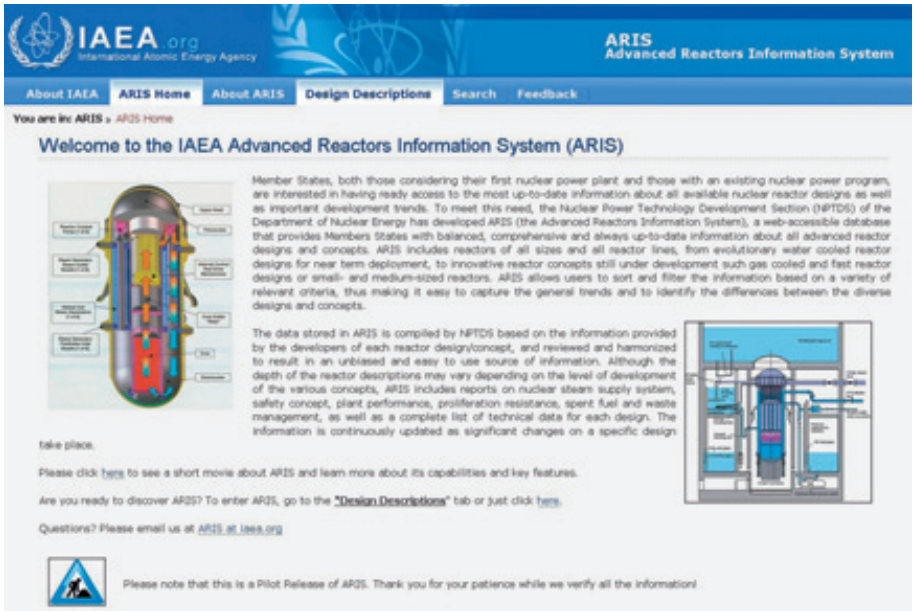

FIG. 2. The home page of the ARIS database.

for natural circulation phenomena in water cooled reactors.

With regard to fast reactors, the Agency organized a workshop — together with experts from Generation IV International Forum (GIF) member countries with fast reactor development programmes, the EC Joint Research Centre and the OECD/NEA — to exchange information on safety related fast reactor operational experience, various national safety approaches for the next generation of sodium cooled fast reactors (SFRs), and ongoing and planned R&D in this field. The workshop developed an improved understanding of safety issues of SFRs based on the comprehensive information contained in over 30 presentations from seven countries.

The Agency continues to facilitate technology development and improvements in the area of high temperature gas cooled reactors (HTGRs) to achieve the successful demonstration of HTGRs by Member States. Two CRPs related to advances in HTGR technology development were completed in 2010, one on 'Evaluation of High Temperature Gas Cooled Reactor Performance: Benchmark Analysis Related to the HTR-10, HTTR, PBMR 400, GT-MHR and the ASTRA Critical Facility' and another on 'Advances in HTGR Fuel Technology'. The first demonstrated the capabilities of the current generation of computational tools used for HTGR analysis and recommended areas for further development. These computer codes are capable of accurately predicting the transient experimental results from the Chinese HTR-10 reactor. The second CRP examined the use of current knowledge in coated fuel particle manufacturing processes by using different characterization techniques to investigate fuel quality at different manufacturing stages. The irradiation of the fuel and subsequent post-irradiation examination resulted in very low fission product releases, thereby demonstrating the high quality of coated particle fuel manufacturing technologies in existence today.

"The report identified the advantages of these reactors, such as the absence of refuelling equipment, stored fresh fuel or stored spent fuel at the sites of such reactors."

In the area of small and medium sized reactors, a CRP on 'Small Reactors without On-site Refuelling' was completed and its final report published as *Small Reactors without On-site Refuelling: Neutronic Characteristics, Emergency Planning and Development Scenarios* (IAEA-TECDOC-1652). The report identified the advantages of these reactors, such as the absence of refuelling equipment, stored fresh fuel or stored spent fuel at the sites of such reactors. It also developed a method to calculate emergency planning zones for such reactors, with risks comparable with those for large reactors. The report further identified experiments to reduce discrepancies in the results of neutron depletion codes used for fuel design.

The Agency offers the Hydrogen Economic Evaluation Program (HEEP), which can be used to compare nuclear and fossil energy sources as options for hydrogen production, as well as nuclear energy for hydrogen production alone versus nuclear energy for co-generation of hydrogen and electricity. In 2010, the Agency released an improved version of HEEP featuring easier installation, increased flexibility to override default values, an improved help manual and the elimination of software bugs. And *Environmental Impact Assessment of Nuclear Desalination* (IAEA-TECDOC-1642) was published, which assembles operating experience from existing nuclear desalination demonstration projects to estimate the environmental impacts of commercial scale nuclear powered desalination and compares them with those of desalination powered by fossil fuels.

INPRO

The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) was established to ensure that sustainable nuclear energy is available to meet the energy needs of the 21st century. INPRO brings together technology holders and users so that they can consider what national and international actions are necessary to achieve innovations in nuclear reactors and fuel cycles. In 2010, the Agency marked the 10th anniversary of INPRO's founding in a technical session during the IAEA's 54th General Conference in September (Fig. 3). The session was attended by more than 50 Member States and highlighted achievements in understanding nuclear energy sustainability, long range nuclear energy planning, and promoting technical and institutional innovations.

FIG. 3. Director General Yukiya Amano addressing the technical session at the 54th General Conference to mark the tenth anniversary of INPRO's establishment.

Poland joined INPRO in 2010, bringing total membership to 32[1].

The Agency established the INPRO Dialogue Forum on Nuclear Energy Innovations in 2010. Two meetings were held. The first addressed socioeconomic and macroeconomic factors of nuclear energy deployment, proven technologies in innovative nuclear power systems and safety approaches for these systems. The second dealt with institutional challenges associated with multilateral approaches to sustainable nuclear power deployment.

The Agency completed an *Assessment of Nuclear Energy Systems Based on a Closed Nuclear Fuel Cycle with Fast Reactors* (IAEA-TECDOC-1639). The report identified: the benefits of multilateral approaches for countries with high growth and limited accumulations of spent fuel, and thus correspondingly limited amounts of plutonium; the likely reduction of environmental and waste impacts; the likely proliferation resistance benefits assuming advanced reprocessing not involving plutonium separation; and the design modifications needed to bring costs down to those of thermal reactors and fossil fuelled power plants. It proposed four follow-on collaborative projects for INPRO members, all of which are currently under way. Finally, Kazakhstan initiated a new national nuclear energy system assessment. This involves training provided by international and Agency experts on how to use the INPRO Methodology for nuclear energy system planning.

"The Agency established the INPRO Dialogue Forum on Nuclear Energy Innovations in 2010."

[1] Other members of INPRO are Algeria, Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, the Czech Republic, France, Germany, India, Indonesia, Italy, Japan, Kazakhstan, the Republic of Korea, Morocco, Netherlands, Pakistan, the Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, the United States of America and the European Commission.

Nuclear Fuel Cycle and Materials Technologies

Objective

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

Uranium Production Cycle and the Environment

Uranium mine production is expected to increase in a number of countries, including Australia, Canada, Kazakhstan, Namibia, Niger and the Russian Federation, to meet the needs of an anticipated increase in demand. Exploration activities continued in 2010 in many countries, and additional resources were identified in Australia, Canada and Namibia. However, several challenges remain despite strong market conditions. These include high production costs, a weak supply chain, ageing facilities and workforce, shortages of new and experienced staff for expansion, and geopolitical issues.

"The 23rd edition of the joint OECD/NEA–IAEA … 'Red Book', was published in 2010."

The 23rd edition of the joint OECD/NEA–IAEA report *Uranium 2009: Resources, Production and Demand*, commonly known as the 'Red Book', was published in 2010. Identified conventional uranium resources recoverable at a cost of less than $130 per kilogram of uranium (kg U) are currently estimated at 5.7 million tonnes of uranium (Mt U). This is an increase of over 0.2 Mt U relative to 2007, due mainly to increases reported by Australia, Canada and Namibia. There are an additional 0.7 Mt of identified conventional uranium resources recoverable at costs between $130 and $260/kg U. For reference, the spot price for uranium in 2009 fluctuated between $110 and $135/kg U with a very gradual downward trend. The report indicates that at the estimated 2009 rate of consumption, the projected lifetime of the 5.7 Mt of identified conventional uranium resources recoverable at less than $130/kg U is almost 90 years.

The Agency was requested by Brazil to send a Uranium Production Site Appraisal Team (UPSAT) to undertake a peer review of operations at the uranium mine at Caetité (Fig. 1). UPSAT peer reviews may be requested by any Member State for any part of their uranium production cycle operations. The UPSAT mission to Caetité took place in February. The team comprised five experts — from Australia, Canada, the Czech Republic, France and the Agency — who

FIG. 1. UPSAT members interviewing staff at the Caetité uranium mine in Brazil.

reviewed all aspects of the uranium mining and processing operations, including future expansion plans and proposed changes in both mining and processing methods. The team concluded that the operations at Caetité are run in a clean and efficient manner with no evidence of adverse environmental impacts outside the mining licence area, and provided recommendations on the management of groundwater at the mine site. It also noted that the work force at the facility was motivated and conscientious and identified opportunities for the personnel to benefit from international good practices. The final report was completed in 2010 and will be published in 2011.

Nuclear Power Reactor Fuel Engineering

Several years of effort collecting and compiling information on fuel failures culminated in the publication of a *Review of Fuel Failures in Water Cooled Reactors* (IAEA Nuclear Energy Series No. NF-T-2.1). The review, covering 96% of the world's water cooled reactor fleet, analysed the mechanisms and root causes of fuel failures, reviewed methods to detect and examine failures, and recommended prevention and remediation measures.

The Agency also published the results of a CRP on *Delayed Hydride Cracking of Zirconium Alloy Fuel Cladding* (IAEA-TECDOC-1649), which transferred the technology for testing of fuel cladding to nine Member States and investigated the cracking behaviour of six commercial cladding alloys. Also published were the proceedings of a technical meeting on *Advanced Fuel Pellet Materials and Fuel Rod Design for Water Cooled Reactors* (IAEA-TECDOC-1654).

The Post-Irradiation Examination Facilities Database (*http:www-nfcis.iaea.org/PIE/PIEMain.asp*), which is administered by the Agency in cooperation with the HOTLAB Association, was substantially revised with the addition of new members and updated information. The joint OECD/NEA–IAEA International Fuel Performance Experiments Database was also updated, with new experimental data on high burnup fuel performance under normal and transient conditions. These data were derived from an ongoing CRP on 'Fuel Behaviour Modelling: FUMEX-3'.

Spent Fuel Management

Currently, less than 25% of discharged fuel is reprocessed, and the implementation of disposal facilities for spent fuel or high level waste has been delayed in most Member States. Consequently, there are growing inventories of spent nuclear fuel (SNF), and spent fuel will have to be stored for longer periods than initially intended, with storage times possibly extending beyond 100 years (Fig. 2).

"Together with the OECD/NEA, the Agency organized an international conference on 'Management of Spent Fuel from Nuclear Power Reactors', …"

Together with the OECD/NEA, the Agency organized an international conference on 'Management of Spent Fuel from Nuclear Power Reactors', which was attended by more than 200 participants from over 40 countries as well as 4 international organizations. The conference concluded that repositories for either SNF or high

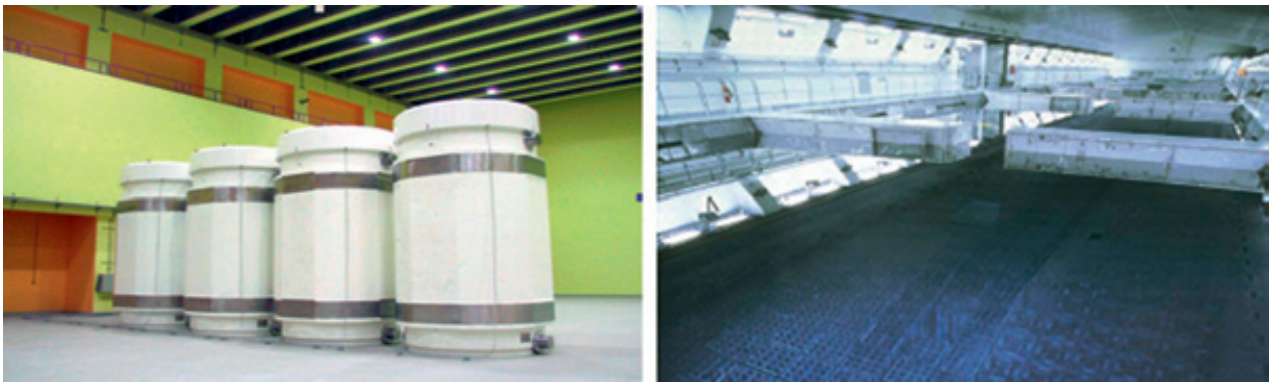

FIG. 2. Spent fuel dry (left) and wet (right) storage facilities.

level waste from recycling facilities remain at least a decade away. This will necessitate an increase in both the amount of SNF in interim storage and the length of time SNF will be stored. The participants felt that more work was needed to strengthen confidence in the integrity of SNF for these long periods of storage. The conference also identified the need for additional work to be done on burnup credit for spent fuel from power reactors, fuel behaviour in dry storage, and the behaviour and safety of high burnup fuels and MOX fuels in long term storage. It stressed the importance of greater international cooperation on R&D and progress towards harmonized safety regulations.

"The future growth of nuclear energy and its sustainability will depend on the continued adoption of advanced and innovative technologies in the nuclear fuel cycle."

The Agency started the third phase of the CRP on 'Spent Fuel Performance Assessment and Research' (SPAR-III). SPAR-III will investigate potential deterioration mechanisms of spent fuel elements stored for long periods.

A CRP on 'Spent Fuel Performance Demonstration' was initiated which will coordinate the collection and analysis of experimental results on the integrity of stored spent fuel.

A new activity on very long term storage of used nuclear fuel was begun to assess the technical, institutional and societal aspects of managing spent fuel for periods of 100 years or longer.

Topical Advanced Fuel Cycle Issues

Member States have pursued activities focused on developing advanced and innovative technologies for safe, proliferation resistant and economically efficient nuclear fuel cycles with the aim of minimizing waste and adverse environmental impacts. One such strategy is the partitioning and transmutation of minor actinides. Rather than merely separating uranium and plutonium from fuel that is being recycled, this process involves the additional chemical separation of elements such as americium, curium and neptunium. The inclusion of these 'minor actinides' in fuel or targets for fast neutron systems results in their fission (transmutation) into less problematic elements, removing their burden from eventual waste disposal scenarios. In 2010, the Agency published an *Assessment of Partitioning Processes for Transmutation of Actinides* (IAEA-TECDOC-CD-1648), which discusses various aspects of partitioning processes in detail with the aim of exchanging information among those involved in studying and developing viable separation methods.

The future growth of nuclear energy and its sustainability will depend on the continued adoption of advanced and innovative technologies in the nuclear fuel cycle. The Agency organized a topical meeting on 'Manufacturing Methods for Advanced Nuclear Fuels' to clarify the present status of and future prospects for the use of advanced technologies in fuel fabrication and to identify challenges facing the development of more innovative applications. The meeting concluded that although there are established methods for manufacturing uranium/plutonium based fuels, more developmental work was needed, particularly for manufacturing highly radioactive minor actinide advanced fuels.

Significant efforts are under way in several Member States such as China, India, Japan, the Republic of Korea and the USA to develop high temperature gas cooled reactors (HTGRs) for process heat, hydrogen production and electricity generation. Research programmes are being pursued in these Member States to predict the behaviour of HTGR fuel under normal and off-normal operating conditions. The Agency organized a technical meeting on high temperature gas cooled reactor fuel and fuel cycles to exchange recent information on technological progress made in various aspects of fuel and fuel cycles for HTGRs, and to identify the major challenges facing the development of fuel and fuel cycles for these reactors. It was concluded that more technological development was needed for the manufacture of multilayer coated particle fuel, advanced techniques for the characterization of coated particles by both destructive and non-destructive methods and irradiation testing. In addition, the Agency published the proceedings of an international topical meeting on *Nuclear Research Applications and Utilization of Accelerators* (Proceedings Series No. 173 (CD-ROM)).

Integrated Nuclear Fuel Cycle Information System

Comprehensive information on worldwide nuclear fuel cycle activities is available through the

FIG. 3. NFCIS coordinators and nuclear fuel cycle experts discussing fuel cycle synergies and sustainability at the spent fuel reprocessing plant in La Hague, France.

Agency's Integrated Nuclear Fuel Cycle Information System (iNFCIS) (*http://www-nfcis.iaea.org/*). In 2010, iNFCIS received more than 600 000 visits from about 12 000 registered users. The on-line information system includes the Nuclear Fuel Cycle Information System (NFCIS), World Distribution of Uranium Deposits (UDEPO), Post-Irradiation Examination Facilities Database (PIE) and Minor Actinide Property Database (MADB). In 2010, a new activity was initiated to collect information on the World Distribution of Thorium Deposits and Resources (ThDEPO).

With iNFCIS it is possible to analyse the different stages, facilities, capacities, interlinkages and synergies related to various fuel cycle options and approaches (Fig. 3). The Agency organized a technical meeting on 'Nuclear Fuel Cycle Information and Synergies for Leveraging Sustainability' in Vienna in December to analyse the potential strengths in the fuel cycle supply chain and to examine early warnings of potential bottlenecks in meeting the increased demands expected in the future.

Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development

Objective

To enhance the capacity of Member States to perform their own analyses of electricity and energy systems development, energy investment planning and energy–environment policy formulation and their economic implications. To sustain and effectively manage nuclear knowledge and information resources for the peaceful uses of nuclear science and technology and to support Member States interested in including nuclear energy in their national energy mixes by providing nuclear information.

"Each year, the Agency prepares low and high projections of future nuclear capacity development in the world."

Energy Modelling, Databanks and Capacity Building

Each year, the Agency prepares low and high projections of future nuclear capacity development in the world. In 2010, for the first time, the time frame for these estimates was extended to 2050. In the 2010 high projection, the global nuclear power capacity increased from 375 GW(e) in 2010 to 803 GW(e) in 2030 and 1415 GW(e) by 2050, an almost fourfold increase over 40 years. In the low projection, the capacity increased to 546 GW(e) in 2030 and 590 GW(e) in 2050. The low and high projections are not intended to identify extremes, but to cover a plausible range. They were developed by international experts assembled by the Agency and are based on a country by country 'bottom-up' approach reflecting both announced plans by governments and electric utilities and the judgment of the assembled experts. Figure 1 shows the regional breakdown of the

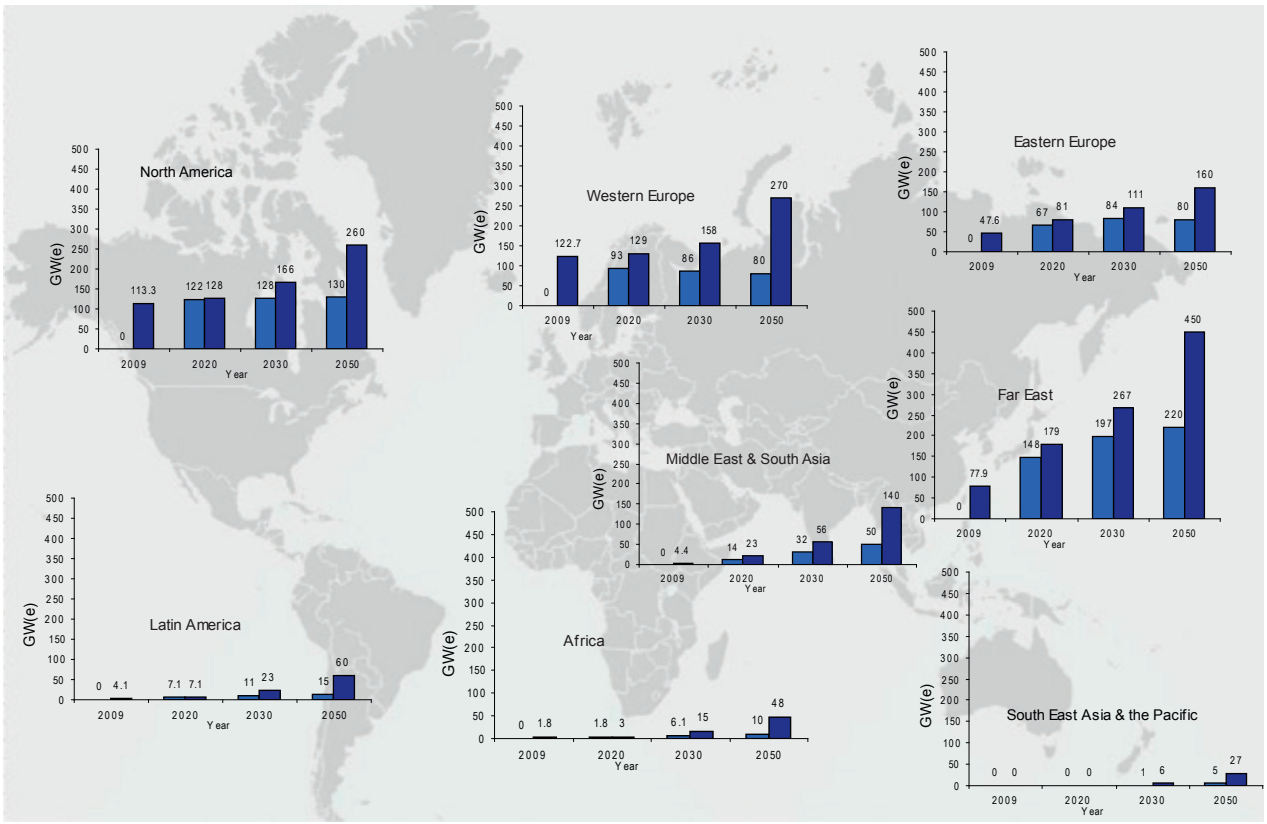

FIG. 1. The Agency's updated high and low projections from 2010, by region.

projections. The highest growth is expected in the Far East and is dominated by expansion plans in China.

Demand continued to increase for Agency assistance in capacity building for energy system analysis and planning, and for conducting national and regional studies of future energy strategies and the role for nuclear power. The Agency's analytical tools developed for this purpose are now being used in more than 120 Member States, and during 2010, over 650 energy analysts and planners from 68 countries were trained in their use. About 20% of this training was conducted through distance learning courses. A report was completed on *Assessment of the Techno-Economic Viability of Nuclear Energy in Kuwait — A Pre-Feasibility Study*, which showed that nuclear energy can be a viable electricity generating and desalination technology even in a country well endowed with hydrocarbon resources.

To ensure that Member States and the Agency have authoritative data when conducting such analyses, the Agency completed the 2010 annual update, in cooperation with the United Nations, the OECD International Energy Agency, the United States Department of Energy and other partners, of its information on energy supply and demand, energy resources, and electricity generation and consumption.

Energy–Economy–Environment (3E) Analysis

At the 16th Session of the Conference of the Parties (COP-16) to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancún, Mexico, the Agency maintained an information centre, as it had at COP-14 and COP-15, which provided an opportunity to present the Agency's work on the linkages between climate change mitigation and nuclear power, to disseminate pertinent publications and to discuss the nuclear power option and its climate change mitigation benefits with government and non-government delegates.

In addition to Agency assistance for near term comparisons of nuclear power and its alternatives, as described above, a number of Member States are interested in long term comparisons between large scale carbon capture and storage and final repositories for radioactive waste. In connection with a CRP, the Agency completed a report in 2010 featuring a technical–economic comparison of the geological disposal of carbon dioxide and nuclear waste. It is intended to serve the broader scientific and policy communities involved in carbon dioxide and radioactive waste disposal.

Nuclear Knowledge Management

In 2010, the nuclear power industry continued to face the challenge of growing demand for qualified personnel both in countries with established nuclear power programmes and in countries exploring or launching nuclear power, such as Brazil, Egypt, Italy, Jordan, Malaysia and the United Arab Emirates. In March 2010, the Agency convened an international conference in Abu Dhabi on 'Human Resource Development for Introducing and Expanding Nuclear Power Programmes'. The conference was jointly hosted by the Government of the United Arab Emirates, the Emirates Nuclear Energy Corporation (ENEC), the Federal Authority for Nuclear Regulation (FANR) and the Khalifa University of Science, Technology and Research (KUSTAR). The conference provided a forum for discussion and networking to advance nuclear science, engineering education and research programmes, and confirmed the importance of a balanced approach to human resource development that emphasizes building expertise in all areas of the nuclear field (Fig. 2). The need to attract a younger workforce early in their careers was underlined, ideally encouraging them to receive early experience in different areas of nuclear power and maintaining a strong safety culture.

"In 2010, the nuclear power industry continued to face the challenge of growing demand for qualified personnel both in countries with established nuclear power programmes and in countries exploring or launching nuclear power, …"

The Agency continued to support Member States in preserving nuclear knowledge by conducting knowledge management assistance visits to Armenia, Belarus, Bulgaria, Kazakhstan, the Russian Federation, Ukraine and Vietnam. Such visits provide assistance, education and advice on best practices and strategies in knowledge management. They also reinforce existing strengths and offer recommendations on possible improvements.

FIG. 2. One focus of the Abu Dhabi conference was on demonstrations of human resource related tools and methods.

Specific enhancements were implemented in 2010 at the Kozloduy nuclear power plant in Bulgaria and at all nuclear power plants in Ukraine, including a methodology for knowledge loss risk assessment. Another knowledge management assistance team suggested that the Russian National Nuclear Research University enhance cooperation with nuclear power plants and research institutes employing graduates by inviting industry experts to give lectures, seminars and courses. In Vietnam, the mission recommended that three universities offering nuclear curriculums coordinate their programmes to avoid duplication in infrastructure, equipment and courses. And, with the assistance of Agency experts, the Kazakhstan Atomic Energy Committee launched a pilot version of a nuclear knowledge management portal.

"In 2010, the International Nuclear Information System (INIS) marked its 40th anniversary."

Training courses on nuclear knowledge management were conducted by the Agency to reach broader audiences and support networks that disseminate information in this area. In cooperation with the Kuwait National Foundation of Science, the Agency held the 2010 School of Nuclear Knowledge Management at the Abdus Salam ICTP, in Trieste. For the first time, the Agency also conducted the Nuclear Energy Management School at the Abdus Salam ICTP. This course provided an opportunity for young managers from developing countries to be involved in nuclear programme management and to learn from world experts and the Agency's specialists about global nuclear energy development.

The Agency also conducted knowledge management seminars: at the Karlsruhe Research Centre, Germany, in cooperation with the European Commission; in Sevastopol, Ukraine; and in Gelendjik, the Russian Federation.

During 2010, the Fast Reactor Knowledge Base was further developed by introducing 'topic trees' and 'knowledge mining' software and creating new possibilities for performing specialized analysis. In 2010, the knowledge base was made available to Member States as a web application through the Internet (*http://www.iaea.org/inisnkm/nkm/aws/frdb/index.html*).

International Nuclear Information System and the IAEA Library

In 2010, the International Nuclear Information System (INIS) marked its 40th anniversary. From the initial 25 members, INIS has grown into a global information system with a current membership of 148 countries and 24 international organizations. Removing barriers to access by making nuclear

information available on the web in 2009 positioned INIS as a key provider of knowledge on the peaceful uses of nuclear science and technology.

In 2010, the IAEA Library received over 1000 visitors per month. Efficiency gains were realized by merging the Reference and Loan Desks into a single contact point. A total of 15 000 research requests were answered and 10 000 books were checked out to users. While usage statistics confirmed the continuing demand for a strong print collection, the Library intends to provide access to e-books in the future.

Nuclear Science

Objective

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

Atomic and Nuclear Data

The Agency maintains a wide range of databases of nuclear, atomic and molecular data that are available to Member States, primarily through on-line services. During 2010, there were approximately 150 000 retrievals, an increase of about 15% over the previous year. In addition, more than 7000 reports, manuals and technical documents were downloaded.

"The Agency maintains a wide range of databases of nuclear, atomic and molecular data that are available to Member States, primarily through on-line services."

An important related activity is to provide on-line tools to aid searches and enhance the visual display and ease of use of databases. The Experimental Nuclear Reaction Data (EXFOR) collection of experimental reaction measurements, for example, covers measurements from 1935 to the present day and contains data from almost 19 000 experiments (approximately 11 500 000 data points). An on-line tool which enables a user to upload and compare data against other data in EXFOR and to include uncertainties/variables in calculations was developed for use by partners and mirror sites.

The Evaluated Nuclear Structure Data File (ENSDF) graphical interface and retrieval tool, released in 2009, was significantly extended to show diagrams of energy levels and a wider range of properties, such as magnetic dipole moments and nuclear radii (Fig. 1). This tool can be accessed at *http://www-nds.iaea.org/livechart/*.

The creation of the Agency's Reference Input Parameter Library (RIPL) has made the collection

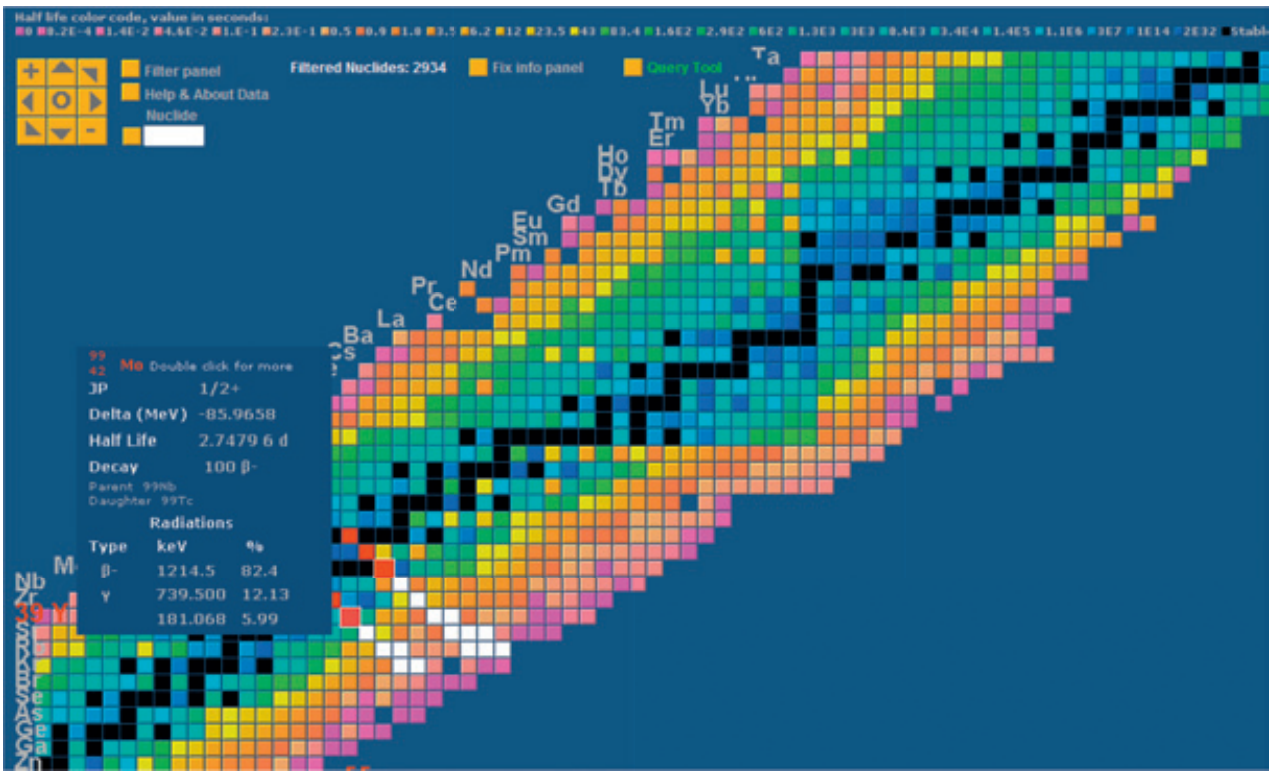

FIG. 1. The ENSDF LiveChart of Nuclides, an on-line interactive tool which enables users to easily select a nuclide, in this case molybdenum-99, and display basic properties. More detail on the nuclide is available by double clicking on the nuclide square.

FIG. 2. Hall of small angle neutron scattering beam lines of CARR (source: CIAE).

of parameters required as input to model codes for theoretical calculations less difficult and time consuming. A wide range of data is now interactively available on-line (*http://www-nds.iaea.org/RIPL-3/*), greatly simplifying the work of theoreticians.

In supporting fusion technology, the Agency continued its coordination of the development of the XML Schema for Atoms, Molecules and Solids (XSAMS) standard for the exchange of atomic, molecular and plasma–material interaction data. Another activity in 2010 included the development of a new knowledge base for atomic, molecular and plasma–material interaction data for fusion (*http://www-amdis.iaea.org/w*).

A CRP was initiated in 2010 to generate data for spectroscopic and collisional properties of tungsten as an impurity in fusion plasma. Tungsten is foreseen as the main wall material for a fusion power plant.

The Agency organized three training workshops in 2010 in cooperation with the Abdus Salam ICTP entitled 'Nuclear Reaction Data for Advanced Reactor Technologies', 'Nuclear Structure and Decay Data: Theory and Evaluation' and 'Nuclear Science and Technology: Analytical Applications'. A workshop to train new EXFOR compilers was also organized in Vienna. In all, about 90 participants were trained at these events.

Research Reactors

Improving Utilization

Collaborative efforts between Member States (both with and without research reactors) were further enhanced in 2010 with the creation in September of the Mediterranean Research Reactor Network (MRRN) and the initiation of a research reactor network in the Asia–Pacific region under AONSA (Asia–Oceania Neutron Scattering Association). In addition, the Australian Nuclear Science and Technology Organisation, with its state of the art neutron beam facilities at the OPAL research reactor, was redesignated as an IAEA Collaborating Centre (IAEA-CC) for Neutron Scattering Applications. The Agency contributed equipment, staff training and expertise for one of the neutron scattering beam lines of the China Advanced Research Reactor (CARR) (Fig. 2) that attained first criticality on 13 May 2010.

"Collaborative efforts between Member States … were further enhanced in 2010 with the creation … of the Mediterranean Research Reactor Network (MRRN) and the initiation of a research reactor network in the Asia–Pacific region …"

A technical meeting on the 'Assessment of Core Structural Materials and Surveillance Programme of Research Reactors' helped establish an information exchange platform for implementation of surveillance programmes to predict age related degradation mechanisms that may cause unplanned research reactor outages.

An improved version of the IAEA Research Reactor Database (RRDB) featuring updated information for 115 of the 237 facilities in operation was released through the NUCLEUS web portal (*http://nucleus.iaea.org/RRDB/*).

Addressing the Shortage of Molybdenum-99 Supplies

Interruptions in the production of molybdenum-99 (Mo-99) resulted in worldwide delays to patient care from August 2008 until September 2010. This was particularly the case in the last six months of that period, when the facilities of the two largest producers were shut down. As part of ongoing efforts to counteract the shortage of Mo-99 supplies from research reactors using HEU, the Agency organized a meeting in August to assess opportunities for international collaboration to support the transition to Mo-99 production based on LEU. The meeting focused on the specific challenges confronting major HEU based producers and identified opportunities for potential multilateral cooperation on high density LEU target development, front end adaptive processing and back end waste management. Furthermore, the meeting proposed the formation of an international expert group, under Agency auspices, to coordinate further actions.

"Interruptions in the production of molybdenum-99 (99Mo) resulted in worldwide delays to patient care from August 2008 until September 2010."

The Agency also began a comparative assessment of non-HEU technologies for Mo-99 production, due for completion in 2011, which will supplement the OECD/NEA High-level Group's report on economic comparison, one of two OECD/NEA reports on this topic to which the Agency has contributed. And under an ongoing CRP related to the production of Mo-99 using LEU targets, a workshop was held in November in Santiago, Chile, where participants shared experience and quality assurance aspects of waste management in the LEU production of Mo-99.

Research Reactors in Education and Training

The Agency assisted the Jordan University of Science and Technology (JUST) and North Carolina State University (NCSU) in the USA in implementing the first international 'remote reactor' programme, funded through an extrabudgetary contribution from the USA. Signals from NCSU's PULSTAR research reactor are sent to JUST and the displays at PULSTAR are replicated in the classroom in Jordan. Video conferencing permits real time interaction with instructors in the USA.

In 2010, a second Research Reactor Group Fellowship Training Course to assist Member States interested in initiating research reactor projects was organized by the Eastern European Research Reactor Initiative (EERRI), supported by the Agency. The six week course included theoretical classes, technical visits and hands-on experiments.

Research Reactor Fuel

The Agency published *Corrosion of Research Reactor Aluminium Clad Spent Fuel in Water* (IAEA-TECDOC-1637), which presents work performed as part of both a CRP and a technical cooperation regional project on 'Management of Spent Fuel from Research Reactors' in Latin America. The publication is also intended to support the efforts of research reactor operators to improve practices used for interim wet storage of spent fuel.

The Agency also published *Cost Aspects of the Research Reactor Fuel Cycle* (IAEA Nuclear Energy Series No. NG-T-4.3). This report provides methodologies for the economic analysis of research reactor operations as well as related case studies.

Support continued to Member States and international programmes to return research reactor fuel to its country of origin. As part of the Russian Research Reactor Fuel Return (RRRFR) programme, five shipments amounting to approximately 109 kg of fresh HEU fuel were repatriated from Belarus, the Czech Republic and Ukraine under contracts arranged by the Agency. The Agency also assisted in the repatriation of around 376 kg of spent HEU fuel from Belarus, Poland, Ukraine and Serbia (13.2 kg from Vinča, Serbia, as reported below).

A technical cooperation project to repatriate spent fuel from the Vinča Institute in Serbia to the Russian Federation was successfully completed in 2010. The return of 2.5 tonnes of spent fuel, including approximately 13 kg of HEU, to the Russian

FIG. 3. Aerial view of the Elettra facility, Trieste, Italy.

Federation signified the elimination of all HEU from Serbia.

Accelerators for Materials Science and Analytical Applications

In cooperation with the Abdus Salam ICTP, the Agency organized several workshops and training courses in 2010. One course, in particular, focused on 'Synchrotron and Free-Electron-Laser Sources and their Multidisciplinary Applications', which was hosted by Elettra, an IAEA Collaborating Centre (Fig. 3).

In addition, a series of technical meetings on a broad range of accelerator related subjects was held to support Member States in the areas of capacity building, knowledge transfer and networking.

A CRP that ended in 2010 facilitated the creation of a broad network of low–medium energy facilities which will assist users in neutron based research where new techniques require access to spallation neutron sources with a neutron intensity enhanced by two further orders of magnitude. In addition, the network will provide a source of information on new techniques and training opportunities for users and operators of small neutron facilities. It will also give major neutron facilities access to smaller facilities to test new techniques and designs.

A technical meeting on the 'Role of Nuclear based Techniques in Development and Characterization of Materials for Hydrogen Storage and Fuel Cells' was held in August in Quebec, Canada. Such techniques are expected to play a role in global energy security in the future.

Nuclear Instrumentation and Spectrometry

The development of X ray fluorescence (XRF) techniques for the analysis of materials remained a major focus of the Agency's Laboratories, Seibersdorf.

"A CRP that ended in 2010 facilitated the creation of a broad network of low–medium energy facilities which will assist users in neutron based research …"

A number of methodological improvements in the energy dispersive XRF technique were made, including optimization of the method for determining major, minor and trace elements in soil samples. A principal component analysis was applied for the interpretation of a large set of XRF data in support of soil erosion studies. For the characterization of the depth profile of thin film solar cells, synchrotron radiation based XRF techniques were developed in cooperation with a facility in Germany. Computer based modules for learning and teaching in the field of total reflection XRF were developed, and quality management tools were revised and upgraded

FIG. 4. Laboratory based teaching at the Agency's Laboratories, Seibersdorf.

to comply with the latest developments in ISO guidelines.

Under technical cooperation projects, 60 scientists attended training courses and workshops on the application of XRF techniques for cultural heritage and environmental pollution monitoring. Another 250 were trained, through 11 regional and 9 national training courses at Member State laboratories and at the Agency's Laboratories, Seibersdorf, in the effective utilization of nuclear instrumentation and in the development and utilization of information and communication technology based teaching materials for nuclear sciences and applications (Fig. 4). In addition, new guidelines for the establishment of a network of laboratories for environmental monitoring and other applications were prepared.

Under technical cooperation projects, 60 scientists attended training courses and workshops on the application of XRF techniques for cultural heritage and environmental pollution monitoring.

Nuclear Fusion

The 23rd IAEA Fusion Energy Conference, held in October in Daejeon, the Republic of Korea, attracted over 1000 participants (Fig. 5) from 38 Member States and four international organizations. Approximately 600 papers were

FIG. 5. An exhibition at the Agency's Fusion Energy Conference in Daejeon, the Republic of Korea.

presented. The conference summary highlighted materials development for ITER and fusion power plants, and the development of steady state physics and technology for nuclear fusion systems as key areas for urgent R&D efforts.

Under the IAEA–ITER cooperation agreement, the first joint technical meeting on the 'Analysis of ITER Materials and Technologies' was held in November in Monaco to develop a knowledge base of materials and technologies specific to ITER. The meeting was instrumental in articulating detailed ITER needs and requirements to a relevant community of materials scientists and engineers and highlighted areas of urgent R&D efforts.

Food and Agriculture

Objective

To promote and contribute to the improvement of food security and safety to enhance Member State capabilities in the application of nuclear techniques for sustainable agricultural development.

Animal Production and Health

The value of the early application of rapid and sensitive diagnostic technologies to control transboundary animal diseases (TADs) has been confirmed by the substantial contribution of the Agency in the eradication of rinderpest, a devastating disease of cattle. With the Agency's support through the use of nuclear and nuclear related techniques over a period of more than 20 years, rinderpest has been eliminated with a net benefit to Africa alone of more than $1 billion per year, as estimated by FAO. The last reported rinderpest case was in 2003, and in 2010 data for all countries were prepared and finalized, clearing the way for the official global declaration of rinderpest eradication by FAO and the World Organisation for Animal Health (OIE) in 2011.

"With the Agency's support … over a period of more than 20 years, rinderpest has been eliminated with a net benefit to Africa alone of more than $1 billion per year, as estimated by FAO."

The same nuclear and nuclear related immunological and molecular technologies were successfully used in 2010 to diagnose and control other animal diseases. These included: Rift Valley fever in the Democratic Republic of the Congo and Mauritania; foot-and-mouth disease in Bulgaria, Mongolia and the Republic of Korea; African swine fever in Tajikistan and Turkey; and animal fascioliasis in Bolivia and Mexico.

In working to control other TADs in 2010, the Agency carried out full genome isotope labelling characterization of several field and vaccine strains of Capripox viruses. The technique was used to identify genes associated with virulence factors that can be used in the development of safer and more efficient vaccines. The Agency also made a major advance in the characterization of peste des petits ruminants (PPR) by developing a new, highly efficient and rapid system for isolating the virus in vitro, which will aid in investigations of this re-emerging infectious disease. This technology is being field tested in several Member State laboratories (for example, in Côte d'Ivoire and Mali). Also in 2010, Botswana, China, Uganda and Zambia participated in field testing of the loop mediated isothermal amplification technology, a nuclear related isothermal amplification technology to increase the possibility to detect PPR, avian influenza and contagious bovine pleuropneumonia. Additionally, in conjunction with partners in Member States, the Agency began developing protocols for radiation attenuation to produce improved vaccines against TADs.

Genetic approaches are being used to understand the mechanisms of disease resistance in indigenous poultry. A radiation hybrid map, using radioisotope tracers and labels, was developed to facilitate rapid, large scale physical mapping of the goat genome to assist in identifying genes involved in economically important traits and genes associated with infectious disease resistance. In Cameroon, for example, more than 200 farms received assistance in 2010 to improve facilities for health, management, feeding and artificial insemination. Brucellosis has been controlled, an Artificial Insemination Centre was established and veterinary services were provided using integrated farm management approaches.

In Mongolia, the Agency improved animal nutrition and reproductive management using radioimmunoassay technologies to assess fertility and isotopic tracing and labelling methods to evaluate the nutritive value of feed. These Agency inputs have assisted not only in providing more animal feed for the winter, but also in reducing overall dairy input costs by almost 67%. Through the Agency's artificial insemination and genetic breeding programme, Mongolia is in the process of selecting animal traits and locally adapted breeds that will be more tolerant to the harsh local environmental conditions. Great efforts were made by the Agency to mitigate the devastating foot-and-mouth disease outbreak that threatened the hoofed livestock industry of Mongolia in 2010. The highly

FIG. 1. A study site in Vietnam testing the use of the CSSI technique to identify critical areas of land degradation.

sensitive and specific nuclear and nuclear related technologies helped in identifying, monitoring and characterizing the specific serotype (type O) involved in the epidemiological spread of the outbreak. The improved diagnostic technologies were essential in selecting the appropriate vaccine candidate to contain the outbreak and to control the rapid spread of the foot-and-mouth virus in Mongolia.

Soil and Water Management and Crop Nutrition

In 2010, fallout radionuclide (FRN) techniques to assess land degradation and improve land productivity were transferred to 40 countries. In Cuba, for example, 2400 hectares of farmland with varying degrees of degradation in the western and southern parts of the country was assessed and appropriate land use measures were developed to restore soil health, leading to a 10% increase in crop productivity. Another success was the use of FRN through a collaborative project led by UNEP and UNU, and including the Agency, Germany, the Russian Federation and Switzerland, to establish a databank of land degradation and soil erosion in Tajikistan and the vast mountainous territories (High Pamir and Pamir-Alai Mountains) of Central Asia. This databank currently forms the basis for the development of policy on conservation measures adapted to the agro-ecological conditions in the region to increase land productivity and socioeconomic conditions of poor farmers.

An innovative isotopic tool was developed by an Agency coordinated research network to identify areas of critical land degradation in agricultural landscapes for effective implementation of precision conservation measures. The tool involves the use of both the compound specific stable isotope (CSSI) technique (for example, carbon-13 signature of fatty acids) and FRNs (caesium-137, lead-210 and beryllium-7) (Fig. 1). Nine countries (Australia, Austria, Canada, China, New Zealand, Poland, Russian Federation, United Kingdom and Vietnam) joined a network initiated by the Agency to provide plant samples for establishing a library of CSSI 'fingerprints'. This databank was used, together with the innovative tool described above, to identify the main sources of soil erosion in degraded landscapes. For example, in eastern Australia, cropland and pasture were identified as a minor source of land degradation, compared with forestland, in a coastal catchment of 370 000 hectares.

"In 2010, fallout radionuclide (FRN) techniques to assess land degradation and improve land productivity were transferred to 40 countries."

Through a regional project on 'Enhancing the Productivity of High Value Crops and Income Generation with Small-Scale Irrigation Technologies', isotopic (nitrogen-15 and oxygen-18) and nuclear (soil moisture probe) techniques were used to

FIG. 2. A drip irrigation setup being demonstrated to farmers in Kenya.

develop timely and accurate applications of low cost drip irrigation scheduling to high value crops in 19 African countries (Fig. 2). In collaboration with the Ghanaian Biotechnology and Nuclear Agriculture Research Institute (BNARI), appropriate irrigation scheduling via drip irrigation was introduced to 130 farming communities, leading to water savings of up to 60–70%. This is equivalent to an economic benefit of $533/hectare, resulting in additional income for the smallholder farmers.

"There is increasing demand for biological insect pest management methods that are more sustainable than insecticide based methods. "

Sustainable Management of Major Insect Pests

There is increasing demand for biological insect pest management methods that are more sustainable than insecticide based methods. In 2010, the Agency provided assistance to Member States through the development and integrated application of pest control tactics utilizing nuclear techniques. These environment friendly techniques, including the sterile insect technique (SIT), the inherited sterility technique and the release of natural enemies, require large scale rearing of the pest or host. In this regard, the Agency organized the 12th International Workshop on Arthropod Mass Rearing and Quality Control in Vienna, where more than 100 delegates from 29 countries discussed issues related to the rearing and quality assurance of entomophagous and phytophagous insects and mites, and entomopathogenic nematodes (Fig. 3).[1] The meeting resulted in a strengthened network of rearing experts and a worldwide road map for future arthropod mass rearing and quality control.

In Croatia, a new rearing and release facility for the Mediterranean fruit fly, *Ceratitis capitata*, became operational in 2010. The facility has a capacity for the packing, handling and release of 20 million sterile male flies per week and will mainly be used to apply SIT to the Neretva River valley of Croatia, and Bosnia and Herzegovina (Fig. 4). This project has as its objective the suppression of fruit flies, which have caused serious damage to citrus and stone fruits, thereby significantly reducing the use of insecticides and resulting in a larger volume of fresh fruit exports.

Major improvement of sterile male fruit fly performance was achieved as a result of a five year CRP completed in 2010 that benefitted operational

[1] *Entomophagous*: feeding mainly on insects, insectivorous; *phytophagous*: feeding mainly on plants; *entomopathogenic nematodes*: lethal obligatory parasites of insects.

FIG. 3. Parasitoid female of Diachasmimorpha longicaudata *probing into fruit to inject her eggs into the pest host infesting the commodity. These biological control agents and other mass reared insects were the subject of an international workshop on arthropod mass rearing and quality control.*

SIT programmes in all continents. The project's main focus was to improve the post-factory management of mass produced sterile fruit flies until the point of field release using hormonal, nutritional and behaviour modifying supplements, ultimately reducing the cost and increasing the effectiveness of operational SIT programmes in Member States.

Mutation Breeding

The Agency supports national breeding programmes through technology transfer, training and the provision of radiation and expert services. As a result, seven new mutant varieties were registered in 2010 in the Agency's mutant variety database (*http://mvgs.iaea.org*). These included a commercial tomato variety, 'Lanka Cherry', developed in Sri Lanka that is currently in high demand. Hybrid maize mutation breeding was a great success in eastern Europe in 2010. Through the Agency's support,

"… seven new mutant varieties were registered in 2010 in the Agency's mutant variety database …"

FIG. 4. The citrus production area in the Neretva River valley, Croatia, where an SIT pilot project is being implemented.

about 300 advanced mutant lines of 11 plant species are being utilized in national breeding programmes to develop improved varieties. This includes two mutant hybrid tomatoes in the Republic of Moldova, which were evaluated in 2010 during second year national pre-release trials, prior to the expected official release in 2011.

The Agency developed and distributed technology kits based on in vitro and molecular techniques, which will allow scientists in Member States to enhance the results of crop mutation induction. In 2010, kits for low cost mutation detection developed at the Agency's Laboratories in Seibersdorf were transferred to six Member States for integration into their mutant breeding programmes. In Algeria, for example, the techniques were applied to barley fungal resistance, reducing the mutant germplasm screening from weeks to half a day (biological assay with life pathogen), obviating the need for a screen house and quarantine. In Mauritius, this inexpensive technology package allowed for quick discrimination among local accessions and thus selection of parent varieties for a mutation breeding programme, something which formerly could not be done. The method can also be used in seed propagated crops.

"The Agency developed and distributed technology kits based on in vitro and molecular techniques, which will allow scientists in Member States to enhance the results of crop mutation induction."

Food Safety and Food Control

The information obtained from biomonitoring through the use of nuclear techniques, such as radiotracers and stable isotopes, provides analytical laboratories with a wide range of options for integrated monitoring of agricultural practices within agricultural catchments that is cost effective for the mitigation of adverse environmental impacts at the source. Specific protocols for the biomonitoring of contaminants in water were finalized in 2010 through a regional project for Latin America and the Caribbean on 'Implementing a Diagnosis System to Assess the Impact of Pesticide Contamination in Food and Environmental Compartments at a Catchment Scale'. The two different protocols addressed the biomonitoring of water quality related to aquatic macroinvertebrate diversity and bioassays in the field (in situ) and in the laboratory.

In 2010, a food safety laboratory from the University of Peradeniya, Sri Lanka, with Agency assistance, achieved accreditation in line with the ISO 17025 standard for calibration and testing laboratories. This is the only laboratory in Sri Lanka accredited for testing veterinary drug residues that provides testing of locally produced aquaculture and poultry products, both for domestic consumption and for export, using nuclear and related methods. Laboratory accreditation means that the analytical results, which provide assurances of food safety and the effectiveness of their food safety systems, are credible and acceptable by regulatory bodies worldwide.

Human Health

Objective

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

Human Health Campus

The 'Human Health Campus', an educational web site for health professionals in radiation medicine, was launched in 2010 (Fig. 1). Using expert advice and support from physicians, physicists, nutrition specialists and experts in education, the web site offers training materials designed to integrate the entire curriculum in the field of radiation medicine. It has detailed sections on nuclear medicine, radiopharmacy, radiation oncology, medical physics and nutrition, and is available at *http://humanhealth.iaea.org*.

Stable Isotope Techniques in Nutrition for Improved Health

One of the Agency's key contributions is to assist in building capacity in Member States. Capacity building efforts in 2010 included the provision of laboratory infrastructure and staff training in Africa, Asia and Latin America in the use of stable isotope techniques to assess human milk intake in breastfed infants and body composition in lactating mothers. A major achievement during this year was the designation of the first IAEA Collaborating Centre in nutrition at St John's Research Institute, in Bengaluru, India (Fig. 2). In many countries, studies are focusing on the revised WHO guidelines regarding breastfeeding by HIV positive women receiving antiretroviral therapy. This issue was addressed in Bangui, Central African Republic, where the most recent stable isotope laboratory in Africa was established in 2010. Training of medical and technical staff was provided by well established facilities in Burkina Faso and Morocco, demonstrating effective South–South collaboration in this field (Fig. 3).

"The 'Human Health Campus', an educational web site for health professionals in radiation medicine, was launched in 2010."

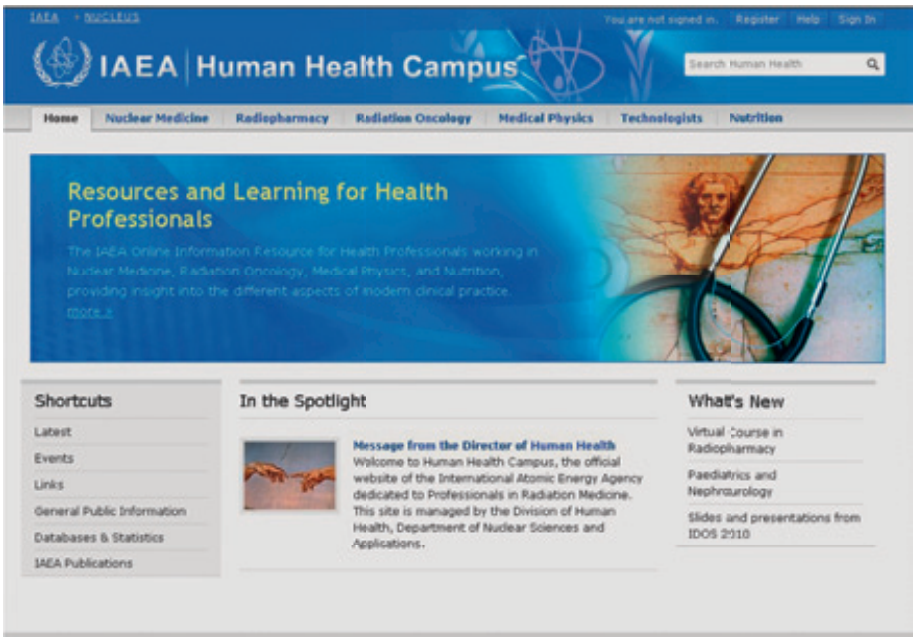

FIG. 1. The 'Human Health Campus', a new web site set up by the Agency in 2010 for the education and training of professionals in radiation medicine.

FIG. 2. Thermal ionization mass spectrometer and staff at St John's Research Institute, Bengaluru, India.

FIG. 3. Stable isotope laboratory in Bangui, Central African Republic.

The Agency's strong focus on nutrition and health during early life was highlighted by its hosting of a technical meeting on 'Biomarkers of Nutrition for Development (BOND)', organized in collaboration with the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the US National Institutes of Health.

"A technical meeting on 'Trends in Nuclear Medicine', held in Vienna, noted an increase in the use of nuclear medicine procedures to diagnose cancer and heart disease."

Nuclear Medicine and Diagnostic Imaging

A technical meeting on 'Trends in Nuclear Medicine', held in Vienna, noted an increase in the use of nuclear medicine procedures to diagnose cancer and heart disease. The meeting also emphasized the need for appropriate human resource development in this area. In addition, concern was expressed regarding the availability of radioisotopes, which has been severely reduced owing to the shortage of molybdenum-99 (Mo-99) that continued to affect low and middle income countries in 2010. There was consensus that the role of hybrid imaging — positron emission tomography/computed tomography, and single photon emission computed tomography — will increase in the coming

years to improve the diagnostic accuracy of imaging techniques using radiation. Meeting participants supported the networking of available resources to help meet the future challenges of development in nuclear medicine and diagnostic imaging.

The Agency emphasized to Member States the importance of quality assurance, encouraging them to commit to quality imaging through a peer review and educational process. This message was disseminated at the annual congresses of major scientific societies such as the World Federation of Nuclear Medicine and Biology, the European Association of Nuclear Medicine, and the Society of Nuclear Medicine of India. In addition, the Agency organized train the trainers courses to augment efforts to disseminate quality management practices.

During 2010, the Agency produced publications on *Planning a Clinical PET Centre* and *Appropriate Use of FDG-PET for the Management of Cancer Patients*, as well as brochures on *Positron Emission Tomography — A Guide for Clinicians* and *Positron Emission Tomography — A Guide for Policy and Funding Agencies*.

Collecting detailed information about the practice of nuclear medicine from around the world is a challenging task. The Agency's nuclear medicine database, NUMDAB, is the only source of such data. In 2010, the Agency continued to encourage nuclear medicine centres in Member States to provide information on global developments in nuclear medicine practices

Radiation Oncology

Thirteen new Quality Assurance Team for Radiation Oncology (QUATRO) audit missions took place in 2010 in Bulgaria, El Salvador, Honduras, Indonesia, Israel, Panama, Poland, Qatar, Romania, Saudi Arabia and Thailand.

In close collaboration with the European Society for Therapeutic Radiology and Oncology, a second train the trainers cycle started in August 2010. This led to a number of local courses for radiation therapists in European countries, the creation of a professional society for radiation therapy in Serbia and the initiation of a national radiation therapy training programme in Estonia.

A publication issued in 2010 entitled *Radiation Biology: A Handbook for Teachers and Students* completed the series of Agency syllabuses on the training of radiotherapy professionals, including radiation oncologists, medical radiation physicists, radiation therapists and radiation oncology nurses.

FIG. 4. The Applied Sciences of Oncology Distance Learning Course *is an educational tool produced by the Agency.*

The publication is complemented by the *Applied Sciences of Oncology Distance Learning Course*, which was updated in 2010 (available cost free from *http://www.iaea.org/newscenter/news/2010/aso.html*) (Fig. 4).

Quality Assurance and Metrology in Radiation Medicine

The Agency published a Spanish language IAEA Human Health Report on assessment criteria and recommendations for education, clinical training and certification of medical physicists. Endorsed by PAHO and targeted at the Latin American region, the book harmonizes educational and clinical training requirements and is also relevant for Member States in Asia and Africa.

During 2010, the Agency continued to offer its dosimetry services aimed at Member States that have no opportunity, other than through the Agency, to calibrate their national measurement standards and verify the calibration of their radiotherapy beams used to treat cancer patients. The number of beams checked in 2010 exceeded that planned for, mostly due to a steadily growing demand from new radiotherapy facilities. The newly installed X ray calibration facilities have been fully operational

"In close collaboration with the European Society for Therapeutic Radiology and Oncology, a second train the trainers cycle started in August 2010."

since November 2010. During the year, the Agency calibrated 26 national measurement standards for radiotherapy and 13 for radiation protection from 21 Member States, providing a link from their measurements to the international measurement system.

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

The Agency organized an international symposium on 'Standards, Applications and Quality Assurance in Medical Radiation Dosimetry' in Vienna in November, in cooperation with several international and professional organizations. The objectives were to foster the exchange of information along the entire dosimetry chain and to highlight recent developments in the field.

Programme of Action for Cancer Therapy

The Agency's Programme of Action for Cancer Therapy (PACT) seeks to assist developing countries in integrating radiotherapy into the broader framework of cancer control. In 2010, efforts focused

Clinical Education in Radiation Medical Physics

In 2010, a pilot programme to test training materials was completed in Thailand, with ongoing programmes in Bangladesh, Malaysia and the Philippines. The teaching materials are supplemented by information available on the Agency web site: *http://humanhealth.iaea.org*. The programmes are coordinated with the Queensland University of Technology, Australia, which allows for practical training and mentoring to guide participants and strengthen outcomes. Additional training materials were provided for the clinical audit programmes offered by the Agency; for example, *Comprehensive Clinical Audits of Diagnostic Radiology Practices: A Tool for Quality Improvement* (IAEA Human Health Series No. 4) was published in 2010.

Clinical training workshop for medical physicists specializing in diagnostic radiology held in Manila, the Philippines.

Clinical training in nuclear medicine physics was conducted in 2010 with the Abdus Salam ICTP through a joint course on internal dosimetry held in Trieste, Italy. The Agency's gamma camera laboratory in Seibersdorf was another venue where training programmes allowed medical physicists to gain valuable clinical skills.

FIG 5. India donated a teletherapy unit for cancer treatment to Sri Lanka through PACT.

on building partnerships with health and cancer control organizations and maximizing the benefits of the WHO/IAEA Joint Programme on Cancer Control, established in 2009 to accelerate cancer control programme development in Member States.

Reviews and assessments of national cancer control capacity and needs are also major PACT objectives. By the end of 2010, the Agency had received requests from 86 Member States for its imPACT (integrated missions of PACT) reviews. In coordination with WHO, imPACT reviews were conducted in Burkina Faso, Côte d'Ivoire, El Salvador, Ethiopia, Guatemala, Indonesia, Kenya, Madagascar, Mauritania, Montenegro, Namibia, Niger, Senegal, Serbia, Zambia and Zimbabwe. Follow-up missions took place at PACT Model Demonstration Sites (PMDSs) in Albania, Ghana, Mongolia, Nicaragua, Sri Lanka, the United Republic of Tanzania and Vietnam. The PMDS projects continued to combine the individual strengths and resources of the ministries of health and their national counterparts in participating Member States through the WHO/IAEA Joint Programme on Cancer Control with the support of other partners and stakeholders to assist health authorities in the development of

"By the end of 2010, the Agency had received requests from 86 Member States for its imPACT (integrated missions of PACT) reviews."

FIG 6. Health workers in Ghana taking part in the VUCCnet pilot project.

their national cancer control programmes. In 2010, Mongolia became the eighth Member State to set up a PMDS.

The Bhabhatron telecobalt unit, donated through PACT by the Government of India to Vietnam, was commissioned and a tripartite agreement was signed for the donation of an additional Bhabhatron unit to Sri Lanka (Fig. 5). Within the framework of a grant from the OPEC Fund for International Development, agreements for implementation of PMDS activities were signed with Albania, Nicaragua and the United Republic of Tanzania.

"… the Agency launched a project to explore the possibility of establishing a Virtual University for Cancer Control in Africa."

The shortage of qualified cancer care professionals is a major bottleneck in developing countries. At a regional consultative meeting with African Member States organized in Ghana in May 2010, the Agency launched a project to explore the possibility of establishing a Virtual University for Cancer Control in Africa (VUCCnet Africa). Following an analysis by the Agency, Ghana, Uganda, the United Republic of Tanzania and Zambia were selected as the pilot sites (Fig. 6). This initiative will facilitate the education and training of cancer care professionals in their home countries by utilizing African e-learning infrastructure and a regional training network relying on existing designated centres.

In addition to contributions from the USA, financial resources were received in 2010 through an agreement with F. Hoffmann-La Roche Ltd, a research based health care company in Switzerland.

Responding to the inequity that persists in access to radiation therapy in the developing world, the Agency launched an Advisory Group on Increasing Access to Radiotherapy Technologies (AGaRT). Intended as a forum to bring together users and suppliers of diagnostic and radiotherapy technologies and other stakeholders, the group seeks to encourage the production of safe, affordable and reliable equipment for the specific requirements of radiotherapy centres in developing countries. Over 60 participants, including business representatives from 14 radiotherapy manufacturers, attended the first meeting in Vienna in 2010.

Water Resources

Objective

To enable Member States to sustainably use and manage their water resources through the use of isotope technology.

Water and the Millennium Development Goals

In 2010, the United Nations reviewed progress made in achieving the Millennium Development Goal (MDG) adopted in 2000 related to reducing by half the number of people without access to safe drinking water. The conclusion was that progress has been uneven, with some regions having less than 60% access to safe water. Critical areas were identified that can help accelerate progress in implementing this goal. The Agency's contributions within the MDG framework involved the promotion of isotope hydrology techniques including: (1) coordinated efforts to improve integrated water resources management; (2) improved hydrological data collection, assessment and information dissemination; and (3) strengthening of hydrological and meteorological monitoring networks, which are critical for addressing water management and climate change issues. Key Agency activities and achievements in 2010 related to these three areas are described below.

Water Resources Assessments

The Agency began implementation of the IAEA Water Availability Enhancement (IWAVE) project, which supports the MDGs by enabling Member States to conduct science based, comprehensive assessments of national water resources. These assessments will support policy decisions for allocating water to competing priorities and allow a more sustainable management of surface and groundwater resources. Three pilot studies are anticipated in order to develop a methodology to be utilized by other Member States. The first pilot study was initiated in the Philippines by holding a workshop that brought together multiple stakeholders and government entities dealing with water. Deliberations led to the identification of a number of 'gaps' in knowledge and capacity required for the desired level of water resources assessment. In addition, two meetings were held in Vienna to discuss the Agency's approach in this project and to identify interested international partners.

"… new isotope data sets were compiled for different continents and made available to hydrologists and isotope experts on the Agency's web site …"

In the area of global isotope monitoring networks for precipitation and rivers, new isotope data sets were compiled for different continents and made available to hydrologists and isotope experts on the Agency's web site (*www.iaea.org/water*). There is

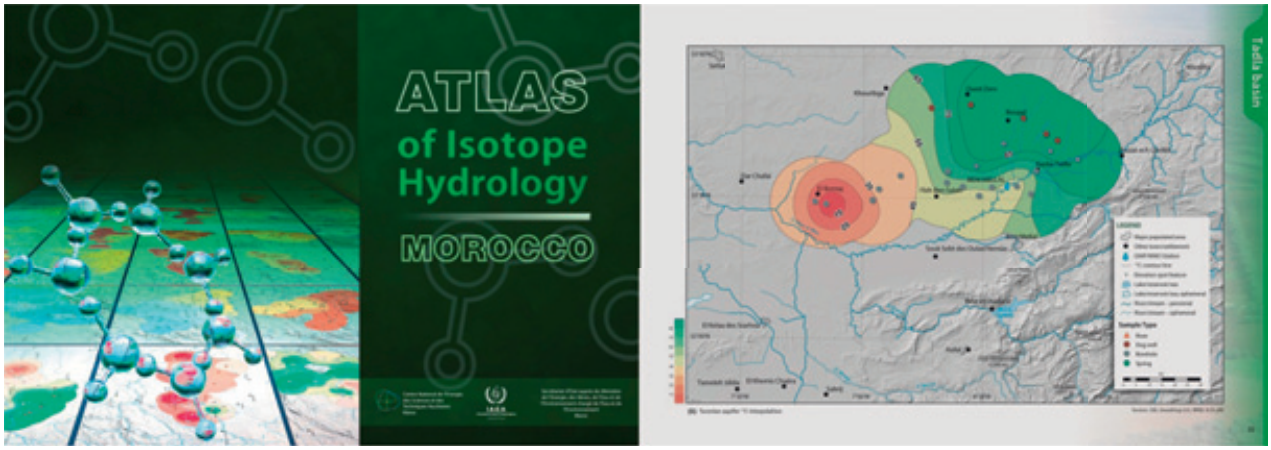

FIG. 1. An isotope hydrology atlas focusing on Morocco was published in 2010.

Addressing the Challenges of Capacity Building

Increasing the use of isotope hydrology to support water resources management and policy decision making is a challenge because trained personnel are needed for field sampling, analyses, and interpretation and communication of results. In 2010 the Agency adopted a multi-pronged approach to address this capacity building challenge. With regard to field work, a new Agency isotope field sampling guide was published, and most of the isotope hydrology training courses taught in 2010 contained a field demonstration component. To address analytical needs, the Agency produced a 45-minute video providing an Overview of Laboratory Isotope Analysis Methods for Water Resources Studies (IAEA-IWSA) to increase Member State capacity to perform their own isotope analyses. The video describes many of the key analytical methods used for isotope hydrology studies. In addition, two training courses were conducted at Agency Headquarters on the use of laser absorption based stable isotope analysers. In addition, fellowships were supported through various technical cooperation projects. Isotope data interpretation and presentation issues were addressed primarily through regional and national training courses and technical cooperation fellowships. Highlights included: an advanced regional training course on 'Isotope Techniques for Assessment of Shallow Groundwater and their Interactions with Surface Waters', organized in collaboration with the Argonne National Laboratory in the USA; regional training courses on isotope hydrology in India, Mexico and Morocco; and national training courses in the Democratic Republic of the Congo, Ethiopia, Ghana, Thailand and Uganda.

Water testing and sampling for isotope analysis in a rural environment (left), and a training course held in Morocco on the use of a laser absorption analyser to determine stable isotope contents in water samples (right).

increasing demand for globally distributed isotope data to support hydrological studies and to help understand the effects of land use and climate change.

A CRP on geostatistical analysis of spatial isotope variability to map the sources of water for hydrological studies was completed. The participants developed improved isotope maps and statistical analyses, contributing to more reliable interpretations of isotope results.

The *Atlas of Isotope Hydrology — Morocco* was published in 2010 (Fig. 1). Developed in collaboration with the Agency's Moroccan counterparts, the atlas describes results from ten different isotope hydrology projects across Morocco. It is both a national and regional resource and serves as an example of how isotope hydrology can be integrated into national water resources assessments. One important new aspect of the atlas is the inclusion of isotope interpolation maps for various hydrological basins. These maps allow an easy, visual characterization of groundwater systems, including recharge areas and locations of modern and fossil groundwater. The interpolation approach was developed by the Agency, and the resultant maps are helping to demonstrate to water managers and policy makers the value added by isotope data in hydrological investigations.

Strengthening Member State Capabilities

In 2010, analyses of groundwater resources in Brazil and the United Republic of Tanzania were conducted to demonstrate how the technique of tritium/helium-3 dating, and other noble gases, can be used as a 'reconnaissance characterization' method. Results from the United Republic of Tanzania revealed important characteristics about a recently discovered groundwater system that had not previously been detected and are now being used by that Member State to determine the potential for water supply development.

The assessment of groundwater resources in Madagascar was completed through a national technical cooperation project as part of the National Programme for Borehole Drilling in the Provinces of Fianarantsoa and Tuliar. The objective was to ensure a sustainable source of potable water in southern Madagascar. Data from isotope and hydrochemical analyses indicated that there are two main aquifer types: one is relatively isolated and possibly protected from pollution; the other is characterized by a higher rate of recharge, and is thus more vulnerable to pollution. The results of this work are expected to contribute to the development of safer drinking water supplies in Madagascar.

In Latin America, a regional technical cooperation project on coastal aquifers was completed in 2010. The goal was to improve the capability of six Latin American Member States (Argentina, Costa Rica, Cuba, Ecuador, Peru and Uruguay) to assess the dynamics of coastal groundwater systems and water quality deterioration by means of isotope and geochemical techniques. Isotope data were used to identify recharge areas, to assess groundwater dynamics and to prove the relevance of hydraulic connections between river water and groundwater.

"In Latin America, a regional technical cooperation project on coastal aquifers was completed in 2010."

Environment

Objective

To enhance the capacity for understanding environmental dynamics, and the identification and mitigation of problems in the marine and terrestrial environments caused by radioactive and non-radioactive pollutants using nuclear techniques.

Ocean Acidification

Ocean acidification refers to the ongoing decline in the pH of the Earth's oceans caused by their uptake of human made (anthropogenic) carbon dioxide from the atmosphere. The Agency focused during 2010 on the role of radiotracers to better understand ocean acidification effects on marine biota, in particular vulnerable environments such as the Arctic, tropical coral ecosystems and temperate coastal regions (Fig. 1). The results that were published by the Agency were archived at the World Data Center for Marine Environmental Sciences as a resource to be used by the scientific community and presented to the IPCC in support of their assessment of the environmental impacts and socioeconomic consequences of ocean acidification.

"The Agency focused during 2010 on the role of radiotracers to better understand ocean acidification effects on marine biota, …"

In related work, the Agency convened an international workshop in Monaco on bridging the gap between ocean acidification impacts and economic valuation, to more comprehensively assess the socioeconomic impact of ocean acidification on fisheries and aquaculture, marine biodiversity, and the tourism industry. The workshop participants concluded that the major economic impact of ocean acidification will likely be on finfish and shellfish fisheries, and on coral reef ecosystems. The impact on human welfare cannot yet be quantified and evaluated in monetary terms. For this, special tools will be needed to guide policy makers in ascertaining the economic impact of ocean acidification and the economic value of different adaptation strategies.

Environmental Gamma Spectrometric Data Quality

Environmental radioactivity laboratories are facing growing data quality requirements and increased difficulty in reliably analysing gamma emitting radionuclides in the environment. The difficulty is related to the currently low levels of

FIG. 1. Ocean acidification simulations included a transplantation experiment at volcanic carbon dioxide vents at Ischia Island in the Gulf of Naples using the commercially important mollusc Mytilus galloprovincialis.

anthropogenic radionuclides in the environment at large, as well as to advances in detector technology which require adapted calibration and analysis approaches for both natural and human made radionuclides.

A technical visit on coincidence summing and geometry corrections in gamma spectrometry was organized at the Agency's Laboratories, Seibersdorf, in July 2010, where advanced training allowed 32 participants from 20 Member States to tackle theoretical and practical aspects of advanced gamma spectrometry.

Characterization of Radioactive Particles

Radioactive particles have a major impact on human health, as well as significant ecological impacts. In the past, serious analytical problems have hindered the full assessment of such impacts. In response, an Agency CRP on 'Radiochemical, Chemical and Physical Characterization of Radioactive Particles in the Environment' developed standardized analytical methodologies to identify and characterize particles to support source term identification.

In 2010, the Agency conducted research using synchrotron radiation based X ray techniques (involving the determination of compositions and chemical states/forms of these elements) and radiometrical methods (that is, radionuclide and radioactivity compositions). The results from these experiments are essential for radiological work and modelling. The radioactive particles originated from sites where contamination has occurred from different release scenarios such as nuclear weapon tests, nuclear accidents and releases from nuclear installations. In 2010, the Agency designated the National Accelerators Centre in Seville, Spain, as an IAEA Collaborating Centre to focus on 'Accelerator Based Analytical Techniques for the Study of Long-Lived Radionuclides in Marine Samples'. Radioactive particles from nuclear weapon accidents in Palomares, Spain, in 1966, and in Thule, Greenland, in 1968, were investigated using the particle induced X ray emission technique. Collaboration with the Institute for Transuranium Elements, in Karlsruhe, Germany, was reinforced. In order to reveal the source term and the nuclear fingerprint of contaminated sites, micrometre size radioactive particles from these sites were

"Radioactive particles have a major impact on human health, as well as significant ecological impacts."

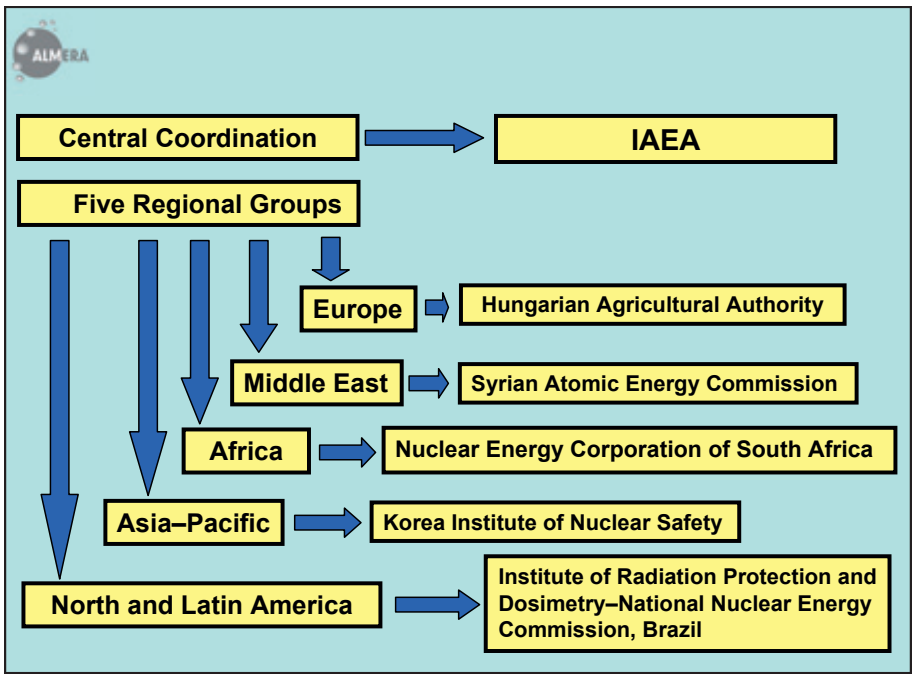

FIG. 2. Structure of the ALMERA network.

sampled and analysed using secondary ion mass spectrometry.

ALMERA Network

The IAEA's network of Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) was established in 1995 to maintain a worldwide collaborative group of radioanalytical laboratories. The network is subdivided into five regional groups that are intended to work together in the case of an event of international significance. Each regional group is coordinated by an ALMERA regional coordinating centre (see Fig. 2).

"The Agency's Environment Laboratories in Monaco produce reference materials for terrestrial and aquatic environments as well as reference materials characterized for stable isotopes."

In 2010, the ALMERA network reached 125 members covering all regions. Quality assurance activities, for example regular proficiency tests and provision of Agency recommended analytical procedures, support the operability and comparability of participating laboratories.

Production of Reference Materials

The Agency's Environment Laboratories in Monaco produce reference materials for terrestrial and aquatic environments as well as reference materials characterized for stable isotopes (Fig. 3). In 2010, the storage and dispatch facilities at the Agency's Laboratories, Seibersdorf, were expanded. An interactive web portal for purchasing, tracking and reporting of results was launched (*http://nucleus.iaea.org/rpst/ReferenceProducts/About/index.htm*). Around 2000 units of reference materials were ordered in 2010.

Understanding and Protecting the Terrestrial and Atmospheric Environments

In 2010, the Agency issued two publications: *Protecting the Terrestrial and Atmospheric Environments* and *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments.*

The Agency supported several training events, including a regional training course on radioecology and radiation protection of the environment and an international workshop on dissemination of modern experience in remediation of areas affected by the Chernobyl accident. The workshop stressed the importance of applying modern remediation strategies in affected areas to return them to normal use.

FIG. 3. Reference material storage at the Environment Laboratories in Monaco.

Low Level Long Lived Radionuclides and Trace Elements in Marine Samples

The Agency's development in 2010 of low level methods for isotopic and elemental analysis, based on the metrological concepts of uncertainty, traceability and validation, represents an important step in better understanding the quality of the measurement data related to studies on the pollution sources of long lived radionuclides and trace elements in the marine environment. Some of the analytical methods developed in 2010 are based on isotope dilution sector field high resolution inductively coupled plasma mass spectrometry (ID–ICP–MS). Measuring low level uranium and mercury in seawater using ID–ICP–MS leads to more accurate results even at very low concentration levels, which are typical of marine waters.

"The Agency's development … of low level methods for isotopic and elemental analysis … represents an important step in better understanding the quality of the measurement data related to studies on the pollution sources of long lived radionuclides … in the marine environment."

Radioisotope Production and Radiation Technology

Objective

To contribute to improved health care and to safe and clean industrial development in Member States by strengthening national capabilities in the production of radioisotope products and in the use of radioisotopes and radiation technology.

Radioisotopes and Radiopharmaceuticals

Progress in nuclear medicine is currently being driven by advances in imaging technology and associated development of specific radiopharmaceuticals. The combination of positron emission tomography (PET) and single photon emission computed tomography (SPECT) cameras with computed tomography (CT) into new hybrid systems is now a standard method for diagnostic imaging and has enhanced the scope for better utilization of some diagnostic tracers.

"One area that has emerged recently and has attracted significant interest from clinicians is dedicated imaging systems for breast cancer detection."

One area that has emerged recently and has attracted significant interest from clinicians is dedicated imaging systems for breast cancer detection. Hybrid imaging scanners used in conjunction with appropriate molecular imaging products help surgeons to detect the spread of cancerous cells, possibly affecting the first lymph node closest to the tumour. Localization of this first lymph node, a diagnostic procedure commonly known as sentinel lymph node detection (SLND), permits histological analysis after surgical removal to assess the presence of metastatic cells. This evaluation is of critical importance for determining the most appropriate therapeutic treatment for the patient. To facilitate the widespread use of this diagnostic methodology in Member States, a CRP ending in 2010 developed new molecular imaging agents for SLND labelled with technetium-99m (Fig. 1). The 18 participating research groups also developed two novel technetium-99m tracers. Another important result was the production

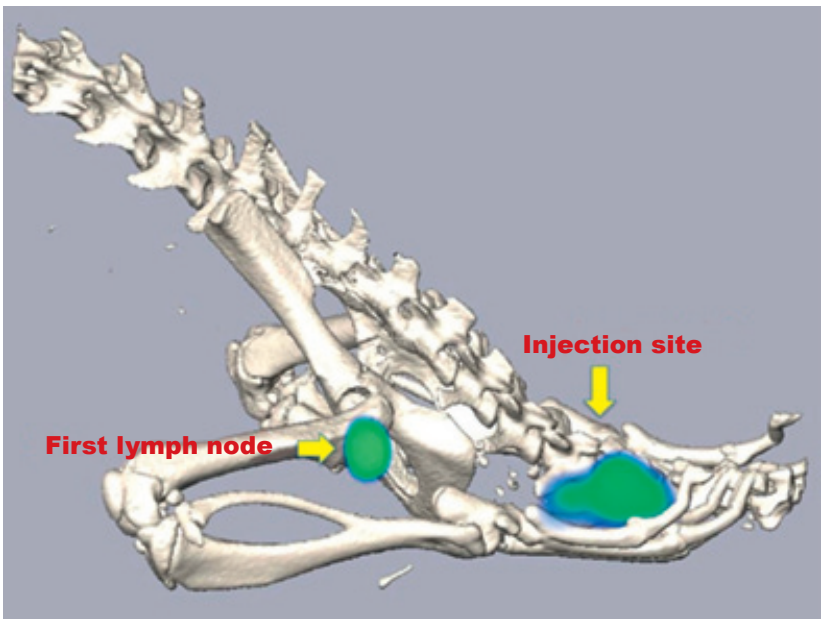

FIG. 1. SPECT–CT image of the first sentinel node in a rat obtained with a small animal tomograph after subcutaneous administration of a new imaging agent for SLND (image courtesy of Y. Arano).

of two freeze-dried kit formulations for easy preparation of the new tracers suitable for clinical use.

Therapy with radionuclides remains an active field of research, although only a few therapeutic radiopharmaceuticals are currently in use for the treatment of cancer. In view of the crucial importance of such therapy, the Agency hosted a technical meeting in Vienna in May 2010 at which the prospects and requirements for promoting the use of a number of interesting beta emitting radionuclides, as well as the challenges involved in developing effective therapeutic agents for cancer therapy, were discussed.

A new CRP was initiated in 2010 with the goal of developing an easy to use kit for labelling antibodies and peptides with lutetium-177 for the treatment of certain primary cancers such as non-Hodgkin's lymphoma and cerebral gliomas.

Through its technical cooperation programme, the Agency concluded a project in 2010 in Cuba that strengthened the indigenous production of radiolabelled monoclonal antibodies, thereby improving nuclear medicine services to cancer patients.

To facilitate better understanding of the issues and requirements in the production and utilization of some parent nuclides for generators, a new publication was issued in 2010 entitled *Production of Long Lived Parent Radionuclides for Generators: ^{68}Ge, ^{82}Sr, ^{90}Sr and ^{188}W* (IAEA Radioisotopes and Radiopharmaceuticals Series No. 2).

Radiation Technology Applications

Radiation induced grafting is a powerful technique for the preparation of value added materials based on readily available and low cost synthetic and natural polymers. There is a growing interest in developing materials as special adsorbents and membranes for use in environmental and industrial applications. A CRP concluded in 2010 focused on the use of gamma rays, electron beams and swift heavy ions for the grafting of various monomers onto natural and synthetic polymers for the development of novel adsorbents and membranes for environmental and industrial applications, an area of growing interest. A network of 16 Member State laboratories developed methodologies for the preparation of radiation grafted adsorbents, for example membranes to remove heavy metal ions and toxic compounds from wastewater and water. Also developed in this CRP were a low cost sensor to detect extremely low (parts per billion) levels of

"There is a growing interest in developing materials as special adsorbents and membranes for use in environmental and industrial applications."

FIG. 2. Electron beam treatment of wastewater (image courtesy of B. Han, Eb-tech).

heavy metal ions in treated wastewater, radiation grafted surfaces for biomedical applications, such as laboratory scale antibacterial bandages, and protein separators and radiation grafted membranes for fuel cells and batteries.

Chronic water shortages have stimulated interest in appropriate technologies for treating wastewater for reuse, for example for urban irrigation, industrial uses (cooling, boilers and laundry), gardens and parks, and cleaning purposes. Wastewater treatment is also required due to new environmental policies which require stricter discharge regulations and lower permissible contaminant levels in industrial waste streams. The standard biological treatment processes commonly used are not always capable of treating many of the complex organic chemicals that are found in varying quantities in wastewater (for example, persistent organic pollutants). A new CRP was started in 2010 with the objective of evaluating radiation treatment as an add-on option in wastewater management, with a particular focus on wastewater containing organic pollutants (Fig. 2). The 16 participating teams from 15 Member States will study the applicability of radiation technology (in combination with other processes) to treat wastewater contaminated with organic compounds, validate analytical methods to characterize and evaluate effects of by-products in treated wastewater, and develop guidelines for selection of areas where the radiation treatment will have a high probability of successful application.

"Chronic water shortages have stimulated interest in appropriate technologies for treating wastewater for reuse, …

In 2010, the Institute of Nuclear Chemistry and Technology (INCT) in Poland became a new IAEA Collaborating Centre (IAEA-CC) for Radiation Processing and Industrial Dosimetry (RAPID). The role of this IAEA-CC is to help implement industrial dosimetry intercomparison exercises for the effective and efficient application of radiation processing technology. In addition, the centre is supporting the feasibility assessment of emerging applications of radiation processing. The Malaysian Nuclear Agency, which has again been designated for the period 2010–2014 as the IAEA-CC for Radiation Processing of Natural Polymer and Nanomaterials, demonstrated the radiation aided production of non-toxic, environment friendly palm oil acrylates for printing applications.

An Agency technical cooperation project on radiation technology helped the Philippines to upgrade its gamma irradiation plant facility and increase the cobalt-60 source strength. The cobalt sources in this facility needed to be refurbished so that they would continue to be strong enough for a range of manufacturing applications. Following the upgrade, the facility started pilot scale production of hydrogel for wound dressings, to be marketed in collaboration with a private company.

To assist Member State electron beam facilities in designing processes to treat materials, the Agency published the first volume in its new IAEA Radiation Technology Series, entitled *Use of Mathematical Modelling in Electron Beam Processing: A Guidebook.* Aimed at those who wish to have a better understanding of irradiation methodology and process development for new products, the guide focuses on the application of mathematical modelling in industrial irradiation methodologies, with extensive reference to the existing literature and applicable standards.

To facilitate the availability of advanced non-destructive testing (NDT) methods in Member States, the Agency is helping to build national capabilities for the development of an affordable computer aided radiographic testing (RT) method. The participants in a CRP that ended in 2010 on optimization of digital industrial radiology (DIR) techniques designed and developed an affordable, low cost digital fluoroscopic system that can be built at a cost about 10–20% of that for comparable commercial digital radiographic systems with similar image quality. There was agreement among the CRP participants — Argentina, Germany, India, Malaysia, Pakistan, Romania, Syrian Arab Republic, Uruguay and Uzbekistan — that the system would be beneficial for developing countries adopting digital radiographic technology. The advantages of this technology include economy of storage, reduced radiation risks, and efficiency in the communication of images, which can also be sent through a network to experts for real time evaluation and verification.

Safety and Security

Incident and Emergency Preparedness and Response

Objective

To establish effective and compatible national, regional and international emergency preparedness and response capabilities and arrangements for early warning and timely response to actual, potential or perceived nuclear or radiological incidents and emergencies independent of whether the incident or emergency arises from an accident, negligence or malicious act; to improve provision/sharing of information on incidents and emergencies among Member States, international organizations and the public/media.

Emergency Preparedness and Response in 2010

The Agency continued to strengthen global emergency preparedness arrangements and capabilities by: (a) promoting compliance with current standards; (b) developing or refining safety standards and guidelines based on the lessons learned from past responses; and (c) implementing regional and national training and exercises (focusing on nuclear newcomer countries).

The final report on the International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies was completed in 2010. The Action Plan process resulted in the identification of a number of important activities in the areas of international assistance, emergency communications and infrastructure that need to be addressed by Member States, stakeholders and the Agency for the implementation and long term sustainability of the international emergency preparedness and response system. The final report provides a path forward and a strategy aimed at improving the flow and security of data exchanged with Member States and international organizations.

The Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE), for which the Agency serves as the coordinating body, coordinates preparedness arrangements of the relevant international organizations. In 2010, the Working Group on Preventing and Responding to Weapons of Mass Destruction Attacks, part of the United Nations Counter-Terrorism Implementation Task Force, issued a report entitled *Interagency Coordination in the Event of a Nuclear or Radiological Terrorist Attack: Current Status, Future Prospects* acknowledging the role of the Agency in prevention, preparedness and response to such events.

The Agency continued to improve its Incident and Emergency System. For example, the team of on-call specialists available around the clock was expanded to include an external event specialist from the IAEA International Seismic Safety Centre, who is responsible for relaying information on earthquakes to the Emergency Response Manager.

Event Reporting

The Agency continued development of the Unified System for Information Exchange in Incidents and Emergencies (USIE). This will replace the Agency's Early Notification and Assistance Conventions (ENAC) web site and the current Nuclear Events Web based System (NEWS) (*http://www-news.iaea.org/news/*). In 2010, preview versions of the system were made available for review by a limited group of users at national authorities. Following this test period, it is expected that the system will become fully operational in early 2011.

"The final report on the International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies was completed in 2010."

In October 2010, a technical meeting was held in Vienna to discuss an information system for sharing emergency radiation monitoring results in real time. Participants from 15 Member States presented their experience and discussed the benefits and key features of such a system. The meeting report focused on the need for a global emergency radiation monitoring information system and included key features of the system and proposals for possible operational arrangements and implementation steps.

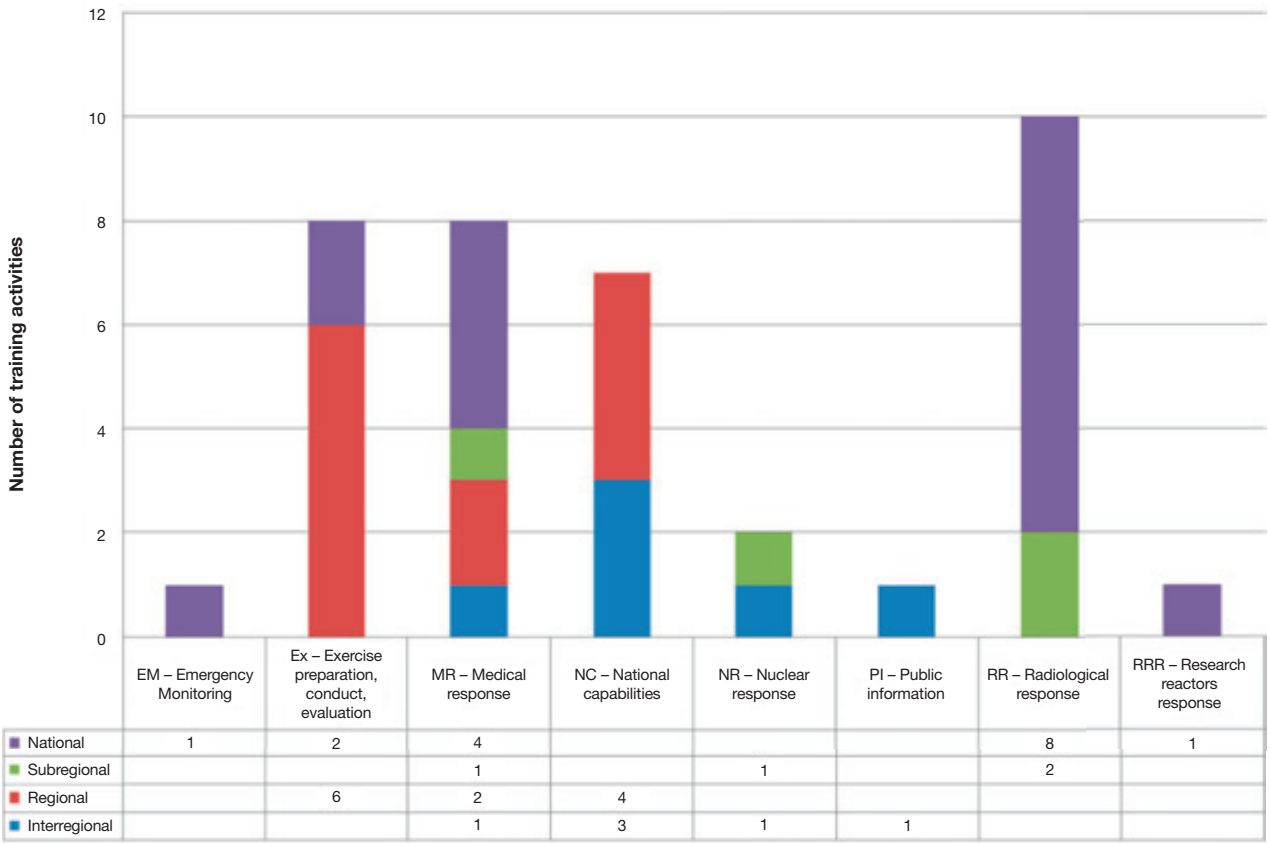

FIG. 1. Workshops and courses devoted to emergency preparedness and response by field of training in 2010.

Capacity Building and Assistance to Member States

The Agency organized 38 training events that included workshops and courses on various aspects of emergency preparedness and response. Figure 1 provides details on the areas in which the training events were held.

"The Agency organized 38 training events that included workshops and courses on various aspects of emergency preparedness and response."

In 2010, the Agency, through the Incident and Emergency Centre (IEC), conducted regular exercises with Member States to test: whether they have a contact point that can respond to incoming messages promptly at all times; whether the competent authorities in Member States can be activated on short notice; and whether those competent authorities are familiar with the notification procedures according to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention) and the Convention on Early Notification of a Nuclear Accident (Notification Convention). The results indicated that fax messages could not be delivered to 23% of the contact points. Furthermore, only half of the contact points responded to the exercise messages and only 21% of them responded within 30 minutes. However, 78% of the competent authorities that were alerted responded promptly within the time frame.

An evaluation of Member State self-assessments of national emergency preparedness and response capabilities underlined the need to continue efforts to strengthen these measures. In 2010, six Member States (Azerbaijan, Belarus, Philippines, Qatar, Romania and Thailand) demonstrated their willingness to improve their preparedness and response programmes by requesting IAEA Emergency Preparedness Review (EPREV) missions. The IEC also carried out 13 missions to assist Member States in the development and strengthening of different aspects of national emergency preparedness and response systems.

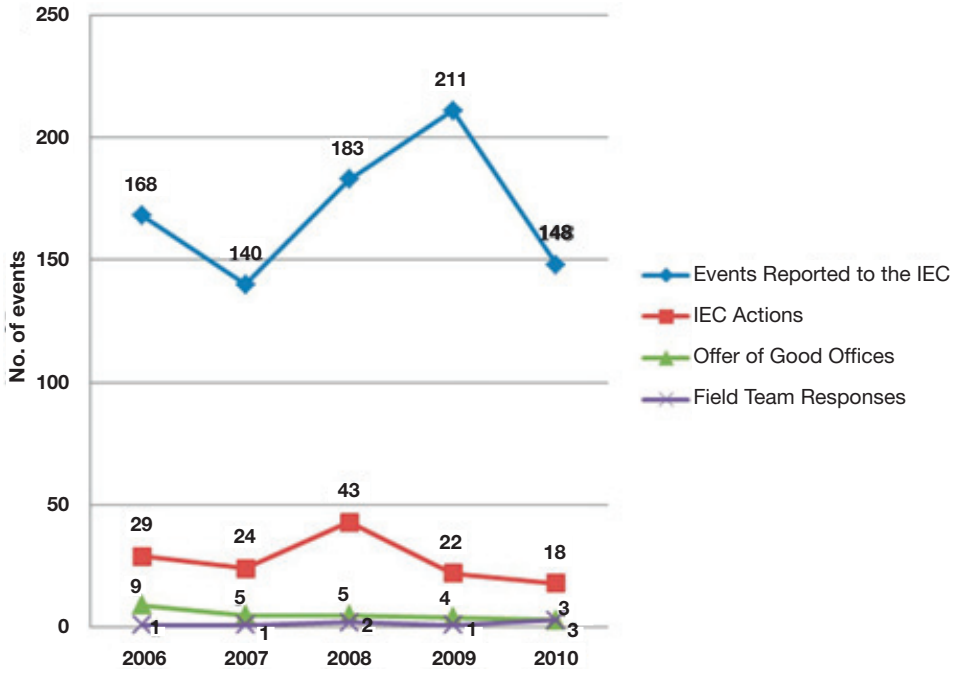

FIG. 2. Responses by the Agency's IEC, 2006–2010.

Event Response

In 2010, the Agency's IEC was directly informed, or became aware indirectly through the media, of 148 events involving or suspected to involve ionizing radiation. In 18 cases, the Agency took action, such as authenticating and verifying information with external counterparts, sharing and providing official information, offering its services, or deploying field teams (Fig. 2). In three cases, in Latin America, the Agency responded to requests for assistance under the Assistance Convention as a result of: (1) severe overexposure of an individual's hands involving injury to tissue from an industrial radiography source; (2) overexposure of a patient during an interventional radiology procedure; and (3) discovery of a radioactive source in a public place.

Using its Response and Assistance Network (RANET), the Agency facilitated two assistance missions, biodosimetry analysis, and medical advice and treatment. Based on a review of the spectrum of events that have occurred — from the detection of orphan sources in scrap metal, to severe radiation burns to individuals following the improper handling of industrial radiography sources, to earthquakes affecting areas where radiation sources might be located — two key conclusions were drawn: (a) natural disasters require follow-up in terms of the information exchanged and offers of the Agency's good offices for possible support to the stricken countries; and (b) a number of events were reported in countries where operators possess extensive experience and capabilities.

Key Emergency Preparedness and Response Publications

The Agency published the fifth edition of the *Joint Radiation Emergency Management Plan of the International Organizations (EPR-JPLAN 2010)*. This publication updated the roles and responsibilities of the 13 sponsoring international organizations as well as coordination of international activities in responding to a nuclear or radiological emergency.

"The Agency published the fifth edition of the Joint Radiation Emergency Management Plan of the International Organizations (EPR-JPLAN 2010)."

The publication on the *IAEA Response and Assistance Network (EPR-RANET 2010)* was updated to include changes in the concept of the network. Based on past experience, the functional areas of assistance were restructured to facilitate easier registration. The duties of the assistance team leader were also clarified.

Safety of Nuclear Installations

Objective

To enhance the global nuclear safety regime and to ensure the highest levels of safety throughout the total lifetime of all types of nuclear installations in Member States by ensuring the availability of a consistent, needs-based and up to date set of safety standards, and assistance in their applications; to enable Member States seeking to embark on nuclear power production programmes to develop appropriate safety infrastructures through the availability of Agency guidance, assistance and networking; to enable Member States to build improved competence frameworks for the safety of nuclear installations and to enhance their capabilities for capacity building as the foundation for strong safety infrastructure.

The first version of a document on *Strategies and Processes for the Establishment of the IAEA Safety Standards (SPESS)* was completed. It implements the safety standards roadmap, providing an improved structure and format for Safety Requirements and serving as a reference for Safety Guides.

Regulatory Safety Services

The Agency continued to reinforce and strengthen regulatory safety by facilitating international peer reviews of Member State regulatory bodies. In 2010, full scope Integrated Regulatory Review Service (IRRS) missions were carried out in China, the Islamic Republic of Iran and the USA, with a follow-up mission in Ukraine. The Ukraine mission identified several demonstrable improvements that were a direct result of incorporating lessons learned from the previous mission conducted in 2008.

"The Agency continued to reinforce and strengthen regulatory safety by facilitating international peer reviews of Member State regulatory bodies."

A 'Self-Assessment Tool' was developed to facilitate the regular evaluation by Member States of their regulatory infrastructure for nuclear and radiation safety, using the Agency's safety standards as a basis. The tool was released to Member States in 2010.

Nuclear Safety Infrastructure for Countries Embarking on Nuclear Power Programmes

Substantial efforts were made in 2010 to assist countries embarking on new nuclear power programmes. Efforts to build nuclear safety infrastructures and to strengthen regulatory systems were the primary areas of focus in Member States; training, sharing knowledge and experience, networking, and publishing Safety Guides were some of the ways the Agency assisted in this undertaking.

In 2010, the Agency launched the Regulatory Cooperation Forum (RCF) to further promote international coordination and collaboration between mature regulatory bodies and the regulatory bodies of Member States considering a nuclear power programme for the first time. The Forum was convened in June 2010.

Key training activities included the 'Basic Professional Training Course on Nuclear Safety', and courses on regulatory control and on training the trainers. These courses were held regionally and were tailored to fit the needs of each area. For example, courses were held in Bangladesh (in cooperation with the Asian Nuclear Safety Network), the Islamic Republic of Iran, Nigeria and the Syrian Arab Republic. In addition, new multimedia video presentations were produced to enhance the public visibility of the Agency's safety activities. Video presentations on siting, probabilistic safety assessments (PSAs) and the safety standards were posted on the web. Finally, the Agency launched a web page containing all nuclear safety and security training resources (*http://www-ns.iaea.org/training/default.asp?s=9&l=78*).

A Safety Guide on the *Licensing Process for Nuclear Installations* (IAEA Safety Standards Series No. SSG-12) was published in 2010. In December, a workshop was held on establishing a safety infrastructure for a nuclear power programme at the Argonne National Laboratory, USA. A training

resources and services web page on this topic was also set up for those countries embarking on new nuclear power programmes.

One of the training tools offered by the Agency is the Systematic Assessment of Regulatory Competence Needs (SARCoN). The SARCoN guidelines are intended to help analyse the training and development needs of regulatory bodies. In 2010, the guidelines were updated and were applied in Belarus, Morocco and Nigeria.

Operational Safety Services

The Agency's Operational Safety Review Team (OSART) programme provides advice, on request, on selected operational aspects and on the safe management of nuclear power plants. In 2010, four OSART missions were undertaken to Belgium, France, Slovakia and Sweden. Six OSART follow-up missions — to France, Japan, the Russian Federation, Sweden, Ukraine and the USA — and a follow-up Peer Review of Operational Safety Performance Experience (PROSPER) mission to the United Kingdom demonstrated successful resolution of issues identified during earlier missions. New review areas for long term operation and for the transition from operation to decommissioning were requested by plants for missions to Armenia and Slovakia, respectively. In addition, additional review areas for the application of PSAs and accident management were made available to customize the scope of the reviews. One follow-up review mission focusing on the Safety Aspects of Long Term Operation of Water Moderated Reactors peer review service was conducted in the Republic of Korea.

Operating Experience

In 2010, the Incident Reporting System was renamed the International Reporting System for Operating Experience (IRS) to reflect its expanded scope and the use of operating experience feedback. The IRS is operated jointly by the Agency and the OECD/NEA to collect information from around the world on safety significant unusual events in nuclear power plants. The information is analysed and fed back to operators to prevent similar occurrences at other plants. The database currently has more than 3650 reports. During the year, recommendations raised in events reported to the IRS database were reviewed to confirm that lessons learned from significant events have been, or will be, covered in the Agency's safety standards.

Enhancing the Safety of Research Reactors and Fuel Cycle Facilities

The Agency continued its efforts to encourage Member States to apply the Code of Conduct on the Safety of Research Reactors, together with the IAEA safety standards. In this regard, the Agency held four regional meetings on application of the Code of Conduct in Africa, Asia, Europe and Latin America. Two technical meetings were also conducted to implement the Code of Conduct with regard to the safety of core management and fuel conversion, and the safety of experiments.

Workshops were held on regulatory supervision, safety culture, operational radiation protection, ageing management, synergy between safety and security, and use of a graded approach in the application of safety requirements. In addition, a Safety Guide on *Ageing Management for Research Reactors* (IAEA Safety Standards Series No. SSG-10) was published.

The Agency seeks to enhance the operational safety of research reactors and fuel cycle facilities through the Fuel Incident Notification and Analysis System (FINAS) (*http://www-ns.iaea.org/tech-areas/fuel-cycle-safety/finas-home.asp*). FINAS is operated by the Agency in cooperation with the OECD/NEA and currently has 18 participating Member States. It also offers the Safety Evaluation During Operation of Fuel Cycle Facilities (SEDO) Safety Review Service. A follow-up SEDO mission was conducted to a fuel fabrication facility in Brazil; it was concluded that satisfactory progress had been achieved in addressing all of the SEDO mission recommendations.

"One of the training tools offered by the Agency is the Systematic Assessment of Regulatory Competence Needs (SARCoN)."

Safety Assessment Services

In 2010, the Agency established the Global Safety Assessment Network (G-SAN) (*http://san.iaea.org/*) to support international efforts to harmonize nuclear safety. The network links experts around the world and facilitates collaboration on safety assessment,

particularly in expanding and developing nuclear programmes. A number of activities were carried out in 2010, including 75 consultants meetings, expert missions and training seminars to support the transfer of knowledge to both regulators and operators in Bulgaria and Romania.

The Agency continued to develop the Safety Assessment Education and Training (SAET) Programme, which is now part of G-SAN. Workshops on deterministic and probabilistic safety assessment as well as risk informed decision making were organized in Croatia and Italy. In addition, a web conference function (Webinar) was commissioned in 2010 for conducting distance learning courses under the auspices of the SAET Programme.

"The Agency's International Probabilistic Safety Assessment Review Team (IPSART) provides a peer review service to strengthen PSAs for safety related decision making during plant design and operation …"

The Agency's International Probabilistic Safety Assessment Review Team (IPSART) provides a peer review service to strengthen PSAs for safety related decision making during plant design and operation, particularly since development of a PSA is a requirement for nuclear power plants in most countries. An IPSART and follow-up IPSART mission were conducted to review the PSA of the Borssele plant in the Netherlands and the new Belene nuclear power plant in Bulgaria.

International Seismic Safety Centre

The scope of the Agency's International Seismic Safety Centre (ISSC) encompasses site selection and evaluation of nuclear installations, including external (natural and human induced) events and environmental impact topics. In 2010, one Safety Guide on Seismic Hazards in Site Evaluation of Nuclear Installations (IAEA Safety Standards Series No. SSG-9) was published and two Safety Guides on volcanic hazard assessments and meteorological and hydrological hazard assessments were completed. Extrabudgetary projects on seismic and tsunami hazards were also completed.

Progress was made in the development of the External Events Notification System, in cooperation with the US Nuclear Regulatory Commission, the US Geological Survey and the US National Oceanic and Atmospheric Administration. This included the incorporation of new tools, the implementation of related databases and the coordination of emergency response to external events with the Agency's Incident and Emergency Centre.

Through the ISSC, the Agency coordinated the assimilation of experience from the 2004 Indian Ocean tsunami and the 2007 Niigataken-Chuetsu-oki (NCO) earthquake and assisted in the development of tsunami assessment simulations and the installation of warning systems in India, the Republic of Korea and Pakistan. The NCO earthquake records continue to be used to calibrate seismic methods to assist Member States with future earthquake evaluations.

Radiation and Transport Safety

Objective

To achieve global harmonization of the development and application of the Agency's radiation and transport safety standards, and to increase the safety and security of radiation sources and thereby raise the levels of protection of people, including Agency staff, against the harmful effects of radiation exposure.

Approval of the Revised Basic Safety Standards

In 2010, agreement was reached within the Agency's four Safety Standards Committees[1] on the remaining technical issues concerning the revised International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS). These issues included: exemption and clearance; dose constraints; exposure to radon in homes and workplaces; non-medical imaging; and exposure of air crew to cosmic radiation. Moreover, at their meetings in November and December the Committees approved the revised BSS for submission to the Commission on Safety Standards for endorsement.

"In 2010, agreement was reached within the Agency's four Safety Standards Committees on the remaining technical issues concerning the revised International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS)."

Reducing Unnecessary and Unintended Exposures in Medicine

As part of its efforts in 2010 to reduce unnecessary radiation exposure from medical imaging, the Agency initiated an international campaign on the 'three As': awareness (through effective communication about risk), appropriateness (through up to date referral guidelines) and audit (through clinical audit of risk–benefit considerations) as recommended by the Steering Panel for the International Action Plan on the Radiation Protection of Patients, which met in Vienna in March 2010 (Fig. 1). The Agency also

FIG. 1. Radiologists perform non-surgical intervention on a patient using fluoroscopic guidance.

[1] The Nuclear Safety Standards Committee; the Radiation Safety Standards Committee; the Transport Safety Standards Committee; and the Waste Safety Standards Committee.

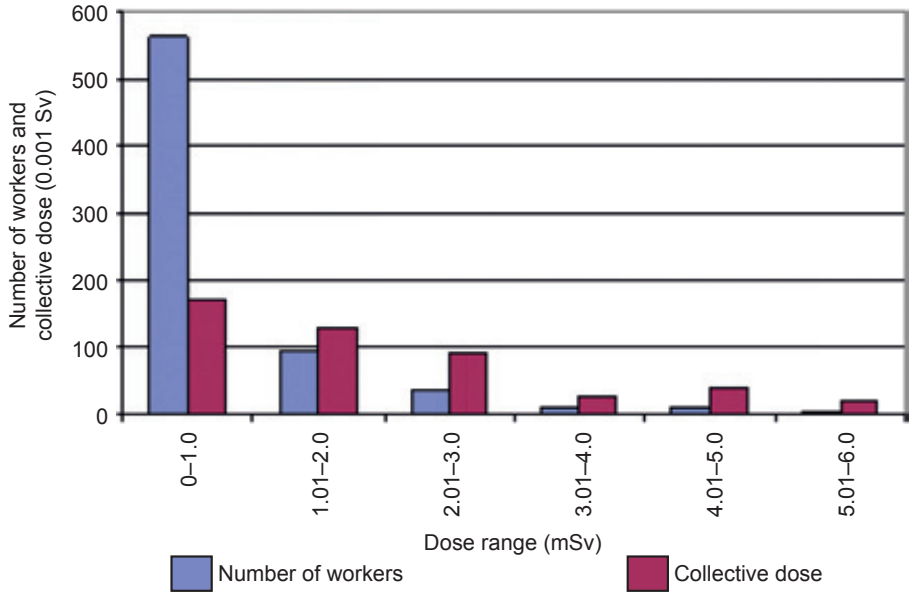

FIG. 2. Distribution of dose received by Agency staff in 2009. The figure shows that the Agency complies with existing dose limits in conducting its activities and that the majority of the doses recorded are well below the occupational dose limit.

provided recommendations for Member States and professional societies on the tracking of radiation exposure of patients through its 'SmartCard/SmartRadTrack' initiative. A number of technical cooperation projects were also conducted to assist in the reduction of patient doses.

"The Agency's patient protection web site (rpop.iaea.org) recorded ten million hits (with some 150 000 unique visitors) in 2010."

To enhance safety in the use of ionizing radiation in medicine, the Scientific Forum, at the 2010 General Conference, and the Senior Regulators Meeting devoted topical sessions and discussions to standards and good practices to protect against unintended exposures in medicine. The Agency's patient protection web site (*rpop.iaea.org*) recorded ten million hits (with some 150 000 unique visitors) in 2010.

Strengthening of Radiation Protection Services

The Agency's Radiation Monitoring and Protection Services support implementation of IAEA radiation safety regulations. In 2010, a quality management system was implemented and the monitoring methods used for assessing occupational and workplace exposures were accredited according to ISO 17025 standards.

As part of the Action Plan for Occupational Radiation Protection, the Agency inaugurated a web site on occupational radiation protection (ORPNET, *http://www-ns.iaea.org/tech-areas/communication-networks/norp/default.asp*) in October 2010. This site links all regional as low as reasonably achievable networks and other important systems in radiation protection such as the IAEA–OECD/NEA Information System on Occupational Exposure, the Information System on Occupational Exposure in Medicine, Industry and Research, and the Agency's web site on the radiation protection of patients (*rpop.iaea.org*).

In 2010, the workplace monitoring and individual monitoring of Agency staff occupationally exposed to radiation showed an average annual effective dose below 1 mSv, which is the internationally agreed dose limit for the public. This low dose confirms the high level of protection of staff during assignments and is a result of the extensive training delivered to minimize the occupational risk involved. The dose distribution of Agency staff in 2009, the last year for which figures are available, is given in Fig. 2.

Strategic Plan for Education and Training

The *Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011–2020,*

a revised and updated version of the 2001–2010 strategy, was noted in September by the Agency's Board of Governors. This revised strategy emphasizes the importance of Member State commitment in taking the lead in developing and implementing their national strategies for education and training based on identified needs in order to achieve the desired level of competence in radiation, transport and waste safety.

Control of Radioactive Sources

In 2010, the Agency, in cooperation with Member States, initiated a programme on strengthening regulatory control of radioactive sources. The aim is to avoid unnecessary human exposure to radioactive sources. A new Safety Requirements publication on the *Governmental, Legal and Regulatory Framework for Safety* (IAEA Safety Standards Series No. GSR Part 1) was issued in 2010, which covers the key requirements for establishing a regulatory body and for taking other actions necessary to ensure the effective regulatory control of facilities and activities, including those involving radioactive sources.

Work continued on Safety Guides dealing with national strategies to regain control over orphan sources and other radioactive material in the metal recycling and production industries. The Agency conducted appraisal and advisory missions in Angola, Bosnia and Herzegovina, Brunei, Cambodia, the Democratic Republic of the Congo, Gabon, Laos, Lesotho, Malawi, Mali, Mauritius, South Africa and The Former Yugoslav Republic of Macedonia to review or advise on national infrastructures for the control of radioactive sources.

In addition, expert missions were conducted and training courses organized to promote the use of relevant tools for regulatory bodies, including workshops on the Self-Assessment Tool (SAT) and Methodology in Australia, Bulgaria, Georgia, Hungary, Montenegro, Poland, Romania, South Africa, Tajikistan and The Former Yugoslav Republic of Macedonia. The Agency organized regional training courses on the Regulatory Authority Information System (RAIS) in Botswana and the United Arab Emirates, and on authorization and inspection of radiation sources in Algeria, Ethiopia, Greece and Ukraine.

As of November 2010, 100 States have explicitly stated their commitment to use the Code of Conduct on the Safety and Security of Radioactive Sources as guidance in the development and harmonization of their policies, laws and regulations.

Assessment of National Radiation Exposure and Radioecological Reviews

In 2009, the Government of France requested that the Agency conduct a peer review of the methodology used by French experts to assess radiation doses to populations in French Polynesia that had been exposed to the atmospheric nuclear tests conducted by France between 1966 and 1974. The assessment of doses by France is aimed at establishing a technical context for the consideration of compensation to exposed groups in French Polynesia who developed potentially radiogenic diseases later in life. An ad hoc panel of international experts convened by the Agency reviewed the information submitted in a process that ended in July 2010. The conclusion of the panel was that the general approach to dose estimation by the French experts had been to choose the higher available measured values and that as a result the exposures actually received by the populations in French Polynesia were likely to be lower than the values provided in the assessment by the French experts.

"As of November 2010, 100 States have explicitly stated their commitment to use the Code of Conduct on the Safety and Security of Radioactive Sources as guidance in the development and harmonization of their policies, laws and regulations."

At the request of the Government of Kazakhstan, an Agency review team visited the Semipalatinsk Test Site in order to determine whether the release of this site would comply with the Agency's safety standards. The review team's report, which will serve as a basis for the decision on eventual release of the site for use, was submitted to the regulatory body of Kazakhstan, the Atomic Energy Committee.

Transport Safety

Publication of Transport Safety Guides

The central pillar of Agency work in the safe transport of radioactive material is the provision of consensus based safety standards. In 2010, *Schedules of Provisions of the IAEA Regulations for the Safe*

Transport of Radioactive Material (2005 Edition) (IAEA Safety Standards Series No. TS-G-1.6), the final Safety Guide in the current series, was published

"The future of the Agency's transport regulations was discussed by the Transport Safety Standards Committee in December …"

completing the set of one Safety Requirements publication and six Safety Guides. This publication provides a road map to the regulations for those involved in transport operations.

The future of the Agency's transport regulations was discussed by the Transport Safety Standards Committee in December, leading to a decision to work closely over the next two years with the United Nations Economic Commission for Europe, International Maritime Organization and International Civil Aviation Organization to ensure greater harmony between the various international provisions.

PATRAM Conference Highlights

The 16th international symposium on the 'Packaging and Transport of Radioactive Materials' was held in London in October 2010. Hosted by the United Kingdom, in cooperation with the Agency, the International Maritime Organization and the World Nuclear Transport Institute, the conference discussed a range of technical issues related to the Agency's transport regulations, including: emerging regulatory issues; long term storage and transport; denials and delays of shipment; and public acceptance of shipments.

Management of Radioactive Waste

Objective

To achieve global harmonization in policies, criteria and standards governing waste safety and public and environmental protection, together with provisions for their application, including state of the art technologies and methods for demonstrating their adequacy.

Uranium Mining Legacy Sites in Central Asia

In 2010, the Agency completed a report entitled *Assessment and Proposals for Uranium Production Legacy Sites in Central Asia: An International Approach* that identified the needs and priorities for environmental impact assessments at legacy uranium production sites in Central Asia. The report has been used by the European Commission, the European Bank for Reconstruction and Development, United Nations Development Programme, and the Organization for Security and Co-operation in Europe for providing assistance for remediation projects in the region.

In October 2010, the Agency launched the International Working Forum on Regulatory Supervision of Legacy Sites (RSLS), in cooperation with the Norwegian Radiation Protection Authority. This forum will provide support to regulators addressing legacy site issues by promoting the exchange of ideas, information and methods. Initially, the forum will be oriented towards remediation of the uranium mining legacy in Central Asia, but its scope will broaden to cover other types of legacy sites and facilities in other parts of the world.

Radioactive Waste Management: Networking Activities

In 2010, the Agency established the International Network of Laboratories for Nuclear Waste Characterization (LABONET, *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_LABONET_homepage.html*) to improve the effectiveness of information exchange on good practices in the management of radioactive waste. Network participants were drawn from States with both advanced and limited nuclear programmes. Steps were taken to improve linkages between LABONET and other Agency networks addressing near surface disposal (DISPONET, *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_DISPONET_homepage.html*), deep geological disposal (Underground Research Facilities Network (URF), *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_URF_homepage.html*), the decommissioning of nuclear facilities (IDN, *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_IDN_homepage.html*), and environmental remediation of contaminated sites (ENVIRONET, *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_ENVIRONET_homepage.html*). These improvements are aimed at fostering the use of new electronic media and enhancing communication channels.

The Contact Expert Group (CEG) for International Radwaste Projects in the Russian Federation was established under the auspices of the Agency in 1996 to promote international cooperation and assistance in resolving problems caused by the nuclear legacy of the Cold War. The CEG comprises 13 Member States (the G8 countries plus five additional European States). At the end of 2010, CEG partners had defuelled and dismantled 191 old Russian nuclear submarines. CEG members are now focusing on the safe removal of submarine spent fuel that had been stockpiled at former navy bases in the north-western and far eastern regions of the Russian Federation. The CEG has overseen the removal of all radioisotope thermoelectric generators previously used for navigation purposes on the country's north-west and Pacific coasts and is working on the creation of two regional centres for the conditioning and storage of legacy radioactive waste.

"In 2010, the Agency established the International Network of Laboratories for Nuclear Waste Characterization …"

As a complement to networking, the Agency conducted a six week pilot course at the Technical University of Clausthal, Germany, in the area of training in radioactive waste management. The course syllabus covered predisposal radioactive waste management, decommissioning, remediation, disposal, naturally occurring radioactive material waste and radioactive waste from mining and milling. Member States that participated in the course included China, Croatia, Estonia, Iraq, Romania and South Africa.

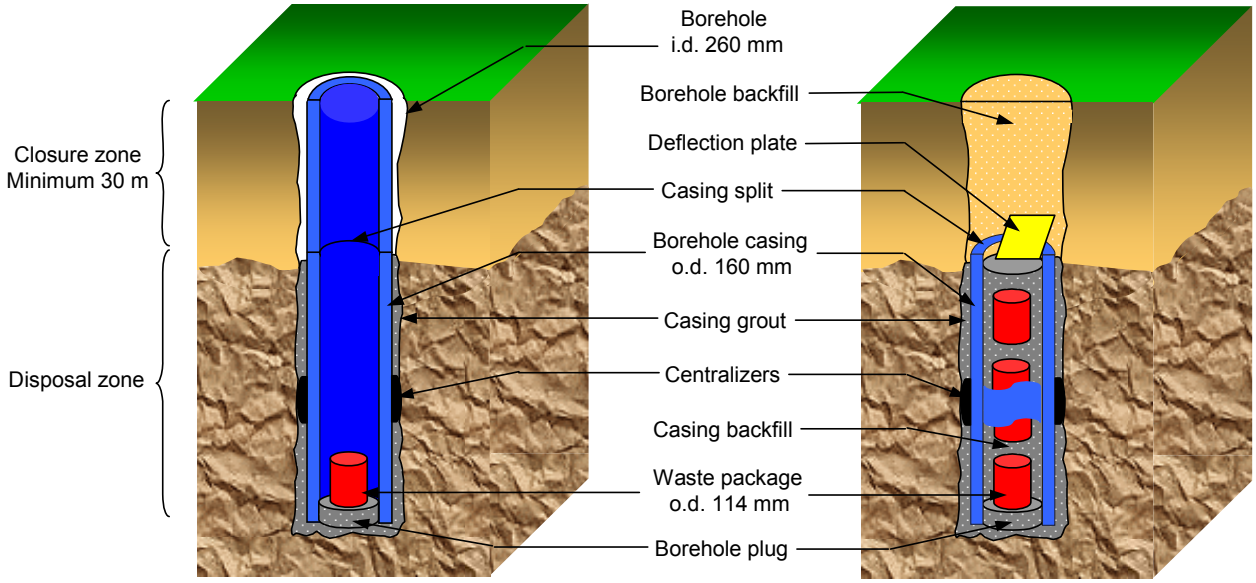

FIG. 1. Schematic of the borehole disposal concept.

Borehole Disposal

The disposal of disused sources continues to be costly and technically difficult for high activity sources. To assist countries lacking the financial, human and technical resources to ensure adequate long term management and disposal, the Agency has developed the borehole disposal system, a simple and economically viable option for use by any interested country. In 2010, implementation of this option was begun in a demonstration project in Ghana (Fig. 1).

Nuclear Security

Objective

To contribute to global efforts to achieve worldwide, effective security wherever nuclear or other radioactive material is in use, storage and/or transport, and of associated facilities, by supporting States, upon request, in their efforts to establish and maintain effective nuclear security through assistance in capacity building, guidance, human resource development, sustainability and risk reduction; to assist adherence to and implementation of nuclear security related international legal instruments; to strengthen the international cooperation and coordination of assistance given through bilateral programmes and other international initiatives in a manner which also would contribute to enabling a broader use of nuclear energy and of applications with radioactive substances.

Through its nuclear security programme, the Agency continued to provide assistance to Member States, primarily through the implementation of the *Nuclear Security Plan 2010–2013*. The increase in the regular budget for nuclear security enabled greater predictability in programme implementation, but the programme continued to be dependent on extrabudgetary contributions.

Strengthening Global Safety and Security

Over the past year, the Agency continued to strengthen synergies and interfaces between safety and security through, inter alia, the joint task force of the Advisory Group on Nuclear Security (AdSec) and the Commission on Safety Standards (CSS). The joint task force was assigned the remit of studying the feasibility of establishing a single set of standards covering both nuclear safety and nuclear security.

Guidance on Nuclear Security for Member States

Four high level publications were completed in 2010. The top level publication, entitled *Fundamentals of a State's Nuclear Security Regime: Objectives and Essential Elements*, was issued for final review by Member States. It contains objectives, concepts and principles of nuclear security and provides the basis for recommendations on nuclear security. Three second level publications — *Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)*, *Nuclear Security Recommendations on Radioactive Material and Associated Facilities*, and *Nuclear Security Recommendations on Nuclear and Other Radioactive Material out of Regulatory Control* — were completed and will be published in 2011. These IAEA Nuclear Security Series publications present best practices that should be adopted by States in the application of the Nuclear Security Fundamentals.

In consultation with Member States, the Agency continued to develop comprehensive guidance on nuclear security. For example, *Educational Programme in Nuclear Security* was issued in the IAEA Nuclear Security Series. Providing an overview of nuclear security and guidance on Master of Science and certificate programmes, it is intended for use by academic institutions in establishing or expanding their nuclear security curriculums.

Nuclear Security Assessments

Nuclear security advisory missions are key tools for assessing the nuclear security needs of States. During 2010, the Agency conducted 17 such missions. More than half dealt with physical protection and with legal, regulatory and practical measures for controlling nuclear and other radioactive material. Several additional missions reviewed the arrangements by States for detecting illicit nuclear trafficking and for responding to nuclear security emergencies and incidents. The Agency also conducted a number of technical visits, addressing security needs at locations including border crossings, medical facilities, scientific institutes and industrial sites.

"In consultation with Member States, the Agency continued to develop comprehensive guidance on nuclear security."

Human Resource Development

To assist States in developing their human resource capabilities in the area of nuclear security, the Agency conducted 72 training events involving the participation of more than 1750 people from 120 countries.

Essential to the establishment and maintenance of nuclear security is the availability of human resources with in-depth knowledge of nuclear security practices, principles and policy. Dedicated nuclear security education is key to cultivating such expertise. An important advance in this regard was the creation, in March 2010, of the International Nuclear Security Education Network (INSEN), a forum for collaboration between the Agency, educational institutions and research bodies. INSEN members work together to develop instructional texts and computer tools, conduct joint research activities and arrange for student and faculty exchange programmes.

Nuclear Security at Major Public Events

The Agency continued to help States to meet the unique nuclear security challenges associated with major public events. In 2010, the Agency assisted Colombia in security arrangements for the 2010 IX South American Games in Medellín, Colombia, by loaning radiation detection instruments and providing training and on-site technical assistance. The Agency also supported South Africa in its efforts to ensure the security of the 2010 FIFA World Cup by providing information support on illicit trafficking as well as more than 250 pieces of radiation detection equipment, and by conducting seven training events covering aspects of nuclear security related to major public events.

"Essential to the establishment and maintenance of nuclear security is the availability of human resources with in-depth knowledge of nuclear security practices, principles and policy."

In addition, the Agency assisted Mexico in its nuclear security arrangements for the major public events associated with the XVI Pan American Games, to take place in 2011. Poland and Ukraine also received assistance with their security preparations for the 2012 UEFA European Football Championship. The latter work included coordinating the donation by Finland of a sophisticated On-Site Nuclide Identification vehicle to Ukraine.

Provision of Equipment to Member States

A major element of the Agency's nuclear security assistance to States is the provision of equipment for detecting and responding to the unauthorized movement of nuclear and other radioactive material, including illicit trafficking. In this regard, the Agency coordinated the donation to States of 823 radiation detection instruments as well as the loan of an additional 474 instruments. In addition, Agency staff participated in 35 field missions, including those relating to the deployment of equipment and to activities to ensure the nuclear security of major public events. The Agency also contributed to nuclear security human resource development by hosting several graduate students and conducting on the job training courses for professionals.

Risk Reduction

As part of its efforts to assist States in establishing systems and technical measures for protecting nuclear material and associated facilities and transport, as well as radioactive sources and waste, against illicit access, the Agency helped to complete upgrades of three nuclear facilities in three States and of eight facilities housing other radioactive material in four States. Upgrades were under way at four additional nuclear facilities in three States and at 22 sites housing other radioactive material in seven States.

In 2010, the Agency was an implementing partner in operations to repatriate to the Russian Federation more than 109 kg of fresh high enriched uranium (HEU) fuel from Belarus, the Czech Republic and Ukraine. The Agency also assisted in the repatriation of around 376 kg of spent HEU fuel from Belarus, Poland, Ukraine and Serbia (13.2 kg from Vinča, Serbia, as reported below).

On 22 November 2010, a six year Agency project culminated in the repatriation shipment of HEU and low enriched uranium (LEU) spent fuel elements from the RA research reactor at Serbia's

FIG. 1. Two views of shipping containers containing HEU and LEU spent fuel elements being transported from the RA research reactor at Serbia's Vinča Institute of Nuclear Sciences to the Russian Federation.

Vinča Institute of Nuclear Sciences to the Mayak Fissile Material Storage Facility in the Russian Federation. Because the material had degraded significantly during several decades of storage, it was necessary to repackage all 8030 fuel elements using custom designed equipment prior to shipment, which contributed substantially to the complexity and duration of the project. Extensive physical protection upgrades were implemented to protect the material while the preparations for shipment were made. Nearly 400 Serbian and international experts, including 76 Agency staff members, participated in the work, which was the largest fuel repatriation project in the Agency's history (Fig. 1). Securing this spent nuclear fuel — which had been identified as being among the world's most vulnerable to illicit access — marked an important step in placing nuclear material in a secured facility beyond the reach of terrorists or other criminals.

Illicit Trafficking Database

Membership in the Agency's Illicit Trafficking Database (ITDB) expanded in 2010 to reach 110 Member States and one non-Member State. As of 31 December 2010, States had reported, or otherwise confirmed, a total of 1980 incidents to the database; 207 incidents were reported by States in 2010, of which 147 had occurred during the year. Of the latter, 13 incidents involved illegal possession and attempts to sell nuclear material or radioactive sources, and one incident was an attempted swindle to this effect that did not involve authentic nuclear or other radioactive material. In 22 cases, thefts or losses of radioactive sources were reported. The remaining 111 incidents involved discoveries of uncontrolled material, unauthorized disposals and the inadvertent, unauthorized movement or storage of nuclear material, radioactive sources and/or radioactively contaminated material.

Facilitating Adherence to the 2005 Amendment to the CPPNM

On 18 November 2010, the Secretariat convened a meeting on Facilitating Adherence to the 2005 Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM). A total of 55 Member States and Euratom participated in the meeting, as well as representatives from the OSCE and the UNODC. The meeting examined the status of international support for the Amendment, which, five years after its adoption, still had not entered into force. The meeting recognized that, upon its entry into force, the Amendment would make a strong addition to the complement of legal instruments for strengthening nuclear security, though it acknowledged that each State faced a different situation with regard to the ratification process. Meeting participants also noted the

"On 18 November 2010, the Secretariat convened a meeting on Facilitating Adherence to the 2005 Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM)."

importance of promoting States becoming parties to the Amendment to the CPPNM. In this regard, information was shared regarding assistance available from the Agency and other sources to States wishing to adhere to the Convention.

Contributions to the Nuclear Security Fund

New contributions were made to the Nuclear Security Fund by Belgium, Denmark, Estonia, Germany, Finland, France, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, the Russian Federation, Spain, the United Kingdom and the United States of America. The agreements with Germany, the Netherlands, Norway and the Russian Federation contain the provision for contributions to be made over a number of years. In addition, an instalment of a previously announced contribution was made by the European Union. Details of income to the Nuclear Security Fund in 2010 are set out in Note X to *The Agency's Accounts for 2010* (GC(55)/4).

Nuclear Verification

Safeguards

Objective

To draw independent, impartial and timely safeguards conclusions, in order to provide credible assurances to the international community that States are abiding by their safeguards obligations; to contribute, as appropriate, to verifying nuclear arms control and reduction agreements.

Safeguards Conclusions for 2010

At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force. This conclusion is based on a continuous, iterative State evaluation process that integrates and assesses all of the safeguards relevant information available to the Agency. By basing the planning, conduct and evaluation of safeguards on an ongoing analysis of all available relevant information, the Agency is able to focus its verification activities in the field and at Headquarters more effectively. The safeguards system being implemented by the Agency is thus described as 'information driven'.

With regard to States with comprehensive safeguards agreements (CSAs), the Agency seeks to conclude that all nuclear material has remained in peaceful activities. To draw such a conclusion, the Secretariat must ascertain that: (i) there are no indications of diversion of declared nuclear material from peaceful activities (including no misuse of declared facilities or other declared locations to produce undeclared nuclear material); and (ii) there are no indications of undeclared nuclear material or activities for the State as a whole.

To ascertain that there are no indications of undeclared nuclear material or activities in a State, and ultimately to be able to draw the broader conclusion that *all* nuclear material has remained in peaceful activities, the Agency assesses the results of its verification and evaluation activities under CSAs and additional protocols (APs). Thus, for the Agency to draw such a broader conclusion for a State, both a CSA and an AP must be in force for that State, and the Agency must have completed all necessary verification and evaluation activities.

For States that have a CSA but not an AP in force, the Agency draws a conclusion for a given year only with respect to whether *declared* nuclear material remained in peaceful activities; as the Agency does not have sufficient tools to provide credible assurances regarding the absence of undeclared nuclear material and activities in a State as a whole.

For those States for which the broader conclusion has been drawn and a State level integrated safeguards approach has been approved, the Agency implements integrated safeguards: an optimized combination of measures available under CSAs and APs to maximize effectiveness and efficiency in meeting the Agency's safeguards obligations. In accordance with the State level safeguards approach and annual implementation plan approved for each State, integrated safeguards were implemented during the entirety of 2010 in 47 States.[1]

In 2010, safeguards were applied for 175[2] States with safeguards agreements in force with the Agency.[3] Of the 99 States that had both a CSA and an AP in force, the Agency concluded that all nuclear material remained in peaceful activities in 57 States;[4] for the remaining 42 States the Agency had not yet completed all the necessary evaluations and thus was unable to draw the same conclusion. For these 42 States, and for the 68 States with a CSA but not an AP in force, the Agency concluded only

"At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force."

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1 Armenia, Australia, Austria, Bangladesh, Belgium, Bulgaria, Burkina Faso, Canada, Chile, Croatia, Cuba, the Czech Republic, Denmark, Ecuador, Estonia, Finland, Germany, Ghana, Greece, the Holy See, Hungary, Indonesia, Ireland, Italy, Jamaica, Japan, the Republic of Korea, Latvia, Lithuania, Luxembourg, Madagascar, Mali, Malta, Monaco, the Netherlands, Norway, Palau, Peru, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Uruguay and Uzbekistan.

2 The 175 States do not include the Democratic People's Republic of Korea, where the Agency did not implement safeguards and, therefore, could not draw any conclusion.

3 The status with regard to the conclusion of safeguards agreements, APs and small quantities protocols is given in Table A6 in the annex to this report.

4 And Taiwan, China.

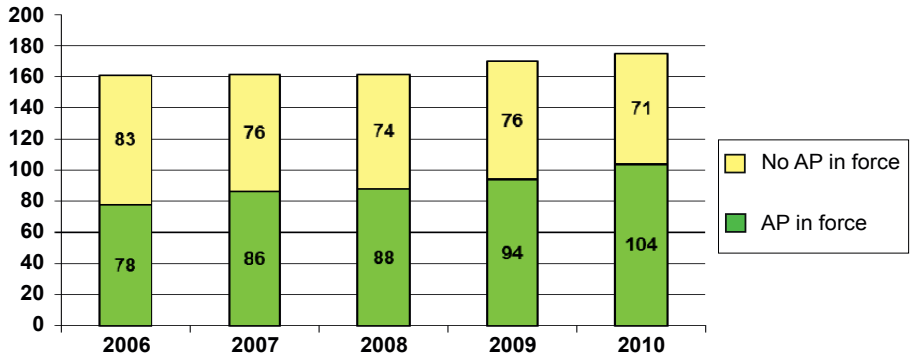


FIG. 1. Status of APs for States with safeguards agreements in force, 2006–2010 (the Democratic People's Republic of Korea is not included).

that declared nuclear material remained in peaceful activities.

Safeguards were also implemented with regard to declared nuclear material in selected facilities in the five nuclear weapon States under their respective voluntary offer agreements. For these five States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities or had been withdrawn as provided for in the agreements.

"The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of small quantities protocols."

For the three States that had item specific safeguards agreements in force based on INFCIRC/66/Rev.2, the Agency concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities.

As of 31 December 2010, 17 non-nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) had yet to bring CSAs into force pursuant to Article III of the Treaty. For these States, the Secretariat could not draw any safeguards conclusions.

Conclusion of Safeguards Agreements and Additional Protocols

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of small quantities protocols (SQPs).[5] During 2010, CSAs entered into force for five States,[6] and APs entered into force for ten States with CSAs.[7] One State[8] acceded to the safeguards agreement and AP thereto between the Agency, Euroatom and the non-nuclear-weapon States of Euratom. The status of safeguards agreements and APs as of 31 December 2010 is shown in Fig. 1. During the year, four other States[9] signed CSAs and seven States[10] signed APs. The Board of Governors approved an additional CSA for one State[11] and APs for two States.[12]

The Secretariat continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2010. During the year, the

5 Many States with minimal or no nuclear activities have concluded a small quantities protocol (SQP) to their CSA. Under an SQP based on the original standard text submitted to the Board of Governors in 1974 (GOV/INF/276/Annex B), the implementation of most of the safeguards procedures in Part II of a CSA is held in abeyance as long as certain criteria are met. In 2005, the Board of Governors took the decision to revise the standardized text of the SQP and change the eligibility criteria for an SQP, making it unavailable to a State with an existing or planned facility and reducing the number of measures held in abeyance (GOV/INF/276/Mod.1 and Corr.1). The Agency initiated exchanges of letters with all States concerned in order to give effect to the revised SQP text and the change in the criteria for an SQP.

6 Andorra, Angola, Chad, Gabon and Rwanda.

7 Albania, Angola, Chad, the Dominican Republic, Gabon, Lesotho, Philippines, Rwanda, Swaziland and the United Arab Emirates.

8 Romania.

9 Angola, the Republic of the Congo, Djibouti and Mozambique.

10 Angola, Bahrain, the Republic of the Congo, Djibouti, Lesotho, Mozambique and Swaziland.

11 Angola.

12 Angola and Gambia.

Secretariat convened two outreach events — a briefing on Agency safeguards held in New York in May in the margins of the 2010 Review Conference of the Parties to the NPT; and an interregional seminar on the Agency's safeguards system for Portuguese speaking States with limited nuclear material and activities, conducted in Lisbon, in June. In addition, consultations on the amendment of SQPs and the conclusion and entry into force of safeguards agreements and APs were held throughout the year with representatives from Member and non-Member States.

Amendment of Small Quantities Protocols

The Secretariat continued to communicate with States in order to implement the Board's 2005 decisions regarding SQPs with a view to amending or rescinding SQPs to reflect the revised standardized text and changed eligibility criteria. During the year, SQPs with three States[13] were amended and three[14] States brought into force SQPs based on the revised text.

Development of the State Evaluation Process

The drawing of soundly based safeguards conclusions is of utmost importance to the Agency. Therefore, in 2010 the Agency also continued its work on the conceptual framework for safeguards, aimed at further improving the State evaluation process.

Key to the process of drawing conclusions and determining the requisite verification activities is the State evaluation process (including the preparation and review of State evaluation reports). In 2010, as part of its ongoing efforts to strengthen this process, the Agency continued to develop and implement more effective and efficient approaches to verification, including through the development of a safeguards system that is fully driven by the use of all the safeguards relevant information available to the Agency. The Agency, therefore: is moving to a system of collaborative analysis by multidisciplinary State evaluation groups; has established a team, consisting of senior safeguards staff, to review the quality of several recent State evaluation reports in order to identify and recommend corrections to generic weaknesses in the process; and has introduced a prioritized system for preparing such reports. During 2010, State evaluation reports covering 110 States were completed and reviewed.

Cooperation with State and Regional Safeguards Authorities

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

To help States build their capacity to comply fully with their safeguards obligations, the Agency conducted two IAEA SSAC Advisory Service (ISSAS) missions in 2010. It also held ten international, regional and national training courses for personnel responsible for the implementation of safeguards agreements and SSACs, and participated in meetings supporting the development of relevant national infrastructures. In addition to providing assistance to States in meeting their safeguards obligations, the Agency also evaluated the means by which cooperation between States and the Agency could further enhance the effectiveness and efficiency of safeguards implementation.

"In 2010 … the Agency continued to develop and implement more effective and efficient approaches to verification, …"

Implementing Safeguards in the Islamic Republic of Iran (Iran)

During 2010, the Director General submitted four reports to the Board of Governors on the

[13] Iceland, Senegal and Swaziland.

[14] Angola, Chad and Rwanda.

implementation of the NPT safeguards agreement and relevant United Nations Security Council resolutions in the Islamic Republic of Iran (Iran). In 2010, while the Agency continued to verify the non-diversion of declared nuclear material at the nuclear facilities and locations outside facilities declared by Iran, the Agency was not able to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran was in peaceful activities. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran: did not implement the provisions of its AP; implement the modified Code 3.1 of the subsidiary arrangements general part to its CSA; suspend its enrichment related activities; suspend its heavy water related activities; and clarify the remaining outstanding issues which give rise to concerns about possible military dimensions to its nuclear programme. In 2010, Iran announced that it had selected the sites for new enrichment facilities and that construction of one of these facilities would start in 2011.

"During 2010, the Agency continued the upgrading of safeguards equipment, mainly through adding remote monitoring capabilities, updating obsolete and outdated components, and improving user documentation."

Implementing Safeguards in the Syrian Arab Republic (Syria)

In 2010, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement in the Syrian Arab Republic (Syria). The Agency continued its verification activities in relation to the allegations that an installation destroyed by Israel at Dair Alzour in Syria in September 2007 had been a nuclear reactor under construction. Syria has yet to provide a credible explanation for the origin and presence of anthropogenic natural uranium particles found at the Dair Alzour site.[15] Syria has not cooperated with the Agency since 2008 in connection with the unresolved issues related to the Dair Alzour site and the three other locations to which it is allegedly functionally related. In 2009, the Agency found anthropogenic natural uranium particles at the Miniature Neutron Source Reactor (MNSR) near Damascus. A plan of action was agreed between Syria and the Agency, the aim of which is to resolve the inconsistencies between Syria's declarations and the Agency's findings.

Implementing Safeguards in the Democratic People's Republic of Korea (DPRK)

Since December 2002, the Agency has not implemented safeguards in the Democratic People's Republic of Korea (DPRK) and, therefore, cannot draw any safeguards conclusion regarding the DPRK. Since 15 April 2009, the Agency has not implemented any measures under the ad hoc monitoring and verification arrangement agreed between the Agency and the DPRK and foreseen in the Initial Actions agreed at the Six-Party Talks. Although not implementing any verification in the field, the Agency continued to monitor the DPRK's nuclear activities by using open source information, satellite imagery and trade information. In this regard, the Agency learned with great regret of the report on the uranium enrichment facility at Yongbyong. The Agency also continued to further consolidate its knowledge of the DPRK's nuclear programme with the objective of maintaining operational readiness to resume safeguards implementation in the State, to implement ad hoc monitoring and verification arrangements and to resolve any issues that may have arisen due to the long absence of Agency safeguards. In 2010, the Agency continued to regard the DPRK nuclear issue and that country's nuclear tests as a serious threat to the international nuclear non-proliferation regime and regional and international peace and stability.

Equipment Development and Implementation

During 2010, the Agency continued the upgrading of safeguards equipment, mainly through adding remote monitoring capabilities, updating obsolete and outdated components, and improving user documentation. The reliability of the Agency's standard equipment systems is ensured through an ongoing programme of preventive maintenance.

[15] 'Anthropogenic' refers to nuclear material that has been produced as a result of chemical processing.

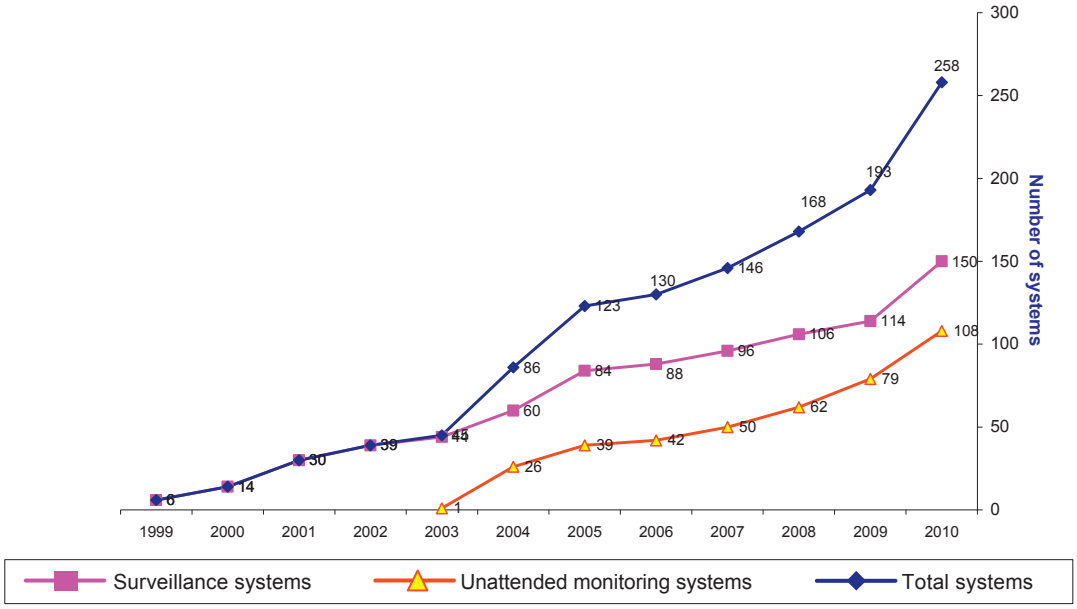


FIG. 2. Number of remote monitoring systems in use, 1999–2010.

In 2010, 1113 portable and attended non-destructive assay (NDA) systems were used in the field during inspections, and numerous related technical support activities were performed. The design of a universal NDA data acquisition platform was completed and a new device to verify spent fuel underwent field trials.

By the end of 2010, the Agency had 1173 cameras connected to 602 systems operating at 248 facilities in 33 States.[16] The Agency continued to install surveillance equipment at new facilities in India and MOX facilities in Japan. During the year, the Agency also participated in technical discussions with the ABACC concerning the future application of surveillance technology in the region.

In December, the development of the next generation surveillance system (NGSS) was completed and is now undergoing equipment authorization testing with a view to its routine use by the end of 2011. During the year, pre-production prototypes of the remotely monitored sealing array, the purpose of which is to provide an effective and safe sealing method in dry storage facilities, were completed.

Remote Monitoring

The increased use of remote monitoring systems continues to enhance the effectiveness and efficiency of safeguards implementation. During 2010, 258 safeguards systems with remote monitoring were implemented at 102 facilities in 19 States.[17] Figure 2 shows the increased use of remote monitoring over the past 12 years. Actual savings of inspection effort achieved through the implementation of remote monitoring are difficult to quantify accurately because it has become an integral part of many safeguards approaches and its impact on safeguards implementation cannot be viewed in isolation. Nevertheless, it was estimated that approximately 277 PDIs (person days of inspection) were saved due to remote monitoring in 2010.

"The increased use of remote monitoring systems continues to enhance the effectiveness and efficiency of safeguards implementation."

All safeguards relevant data from the Rokkasho Reprocessing Plant in Japan is now remotely transferred to the Agency's Headquarters on a daily basis through 26 surveillance and unattended monitoring systems. A project jointly conducted with the European Space Agency to establish the feasibility of setting up secure satellite communications for safeguards data transmission

[16] And Taiwan, China.

[17] And Taiwan, China.

was concluded in 2010, and the existing infrastructure was used to resume communications for selected remote sites. The handover of this system, achieved at minimal cost, means that the Secretariat now has at its disposal a fully secure, self-supported satellite network capable of global coverage. An advanced system to establish remote monitoring capabilities for monitoring of spent fuel transfers at on-load reactors was also installed at several facilities in 2010, which is expected to reduce significantly the need for on-site inspector presence when these transfers recommence in 2011. The total number of electronic seals transmitting data remotely to the Agency's Headquarters increased to 147 in 2010 (89 of which are the new electro-optical sealing system type seal).

Enhancing Sample Analysis

The safeguards analytical service provides logistical support to the safeguards programme for the sampling, transport and analysis of nuclear material and environmental samples. Sample analysis is performed by the Agency's Safeguards Analytical Laboratory (SAL), the Rokkasho On-Site Laboratory and the Network of Analytical Laboratories (NWAL), comprising SAL and 19 national laboratories located in Member States. In 2010, a laboratory in Brazil joined NWAL, thereby increasing the network's geographical distribution.[18]

"The safeguards analytical service provides logistical support to the safeguards programme for the sampling, transport and analysis of nuclear material and environmental samples."

In 2010, in line with its results based approach to programme management, the Agency brought responsibility for SAL (comprising the Nuclear Material Laboratory and the Environmental Sample Laboratory, both in Seibersdorf) as well as NWAL and the Rokkasho On-Site Laboratory under one administration.

[18] Laboratories in Belgium, France and the USA are currently being qualified for nuclear material analysis and are expected to join NWAL.

Information Analysis

Throughout the year, the Agency continued to enhance its capabilities to acquire and process data, analyse and evaluate information, generate knowledge, and distribute information securely in ways that contribute to an effective safeguards system that is 'information driven'.

To ascertain that there are no indications of diversion of declared nuclear material, and no indications of undeclared activities, it is necessary to process, analyse and evaluate large quantities of data. For instance, more than 17 000 State reports and declarations were received and evaluated; around 440 000 nuclear material transactions were confirmed, resulting in more than 500 official statements on nuclear material inventories and transactions provided to the States. In addition, 160 material balance evaluations for 44 bulk handling facilities were conducted; 460 destructive assay samples were evaluated and more than 865 items verified by quantitative NDA; and results from laboratory analysis of 490 environmental samples collected from 45 States were evaluated. To improve the quality of State reports, specific training was provided to States on nuclear material accounting and reporting as well as on measurements and material balance concepts.

In cooperation with international experts, the Agency issued a new edition of the *International Target Values* (ITV 2010) for analysis of nuclear material. ITV 2010 is the international reference for assessing the quality of accountancy measurement systems.

In support of the State evaluation process to verify the completeness of State declarations and in-field verification activities, the Agency produced 45 trade analysis reports. In addition, Member States provided the Agency with information concerning 196 nuclear trade related procurement enquiries in 2010 for further clarification (as well as 141 enquiries relating to the previous year). In September, 12 Member States participated in a workshop, entitled 'Collecting Safeguards Relevant Trade Information', as part of the Agency's outreach programme to further enhance the provision of such information.

In 2010, 377 commercial satellite images were acquired and evaluated in support of safeguards verification activities, taking advantage of new, higher resolution commercial sensors to improve capabilities for monitoring sites and facilities worldwide. Imagery was acquired from 22 different

Earth observation satellites. New imagery providers were contracted in order to diversify sources and ensure the integrity and authenticity of satellite imagery. The use of imagery analysis continued to be a great asset, particularly where access to sites was either restricted or denied. The ongoing demand for mapping products resulted in the production of more standardized maps, three-dimensional visualization products and interactive geospatial tools to assist the Agency's verification work.

The Open Source Information System was expanded through the addition of around 8600 new items of information. Notification of significant safeguards events was provided by the internal dissemination of over 3000 articles during the course of the year through daily and weekly information bulletins. Open source research also supported the analysis of satellite imagery and clandestine procurement networks, and the evaluation of incidents of nuclear material trafficking.

Significant Safeguards Projects

IRP

The IAEA Safeguards Information System Reengineering Project (IRP) will ensure the establishment of an integrated information environment that will support an easy and cost effective evolution of departmental business processes towards a safeguards system which is fully information driven. In 2010, significant progress was made in the implementation of key IRP services, such as reference data management, State supplied data handling and integrated scheduling as well as planning and information tracking systems.

In order to ensure proper adaptation to the information requirements of the department, IRP necessitated a comprehensive evaluation of the contents of existing data systems and associated processes. In 2010, comprehensive 'role based' access control tools were introduced as part of IRP implementation to permit access to information in the Secretariat on a 'need to know' basis. Following significant 'data cleansing', a significant proportion of information stored on the mainframe has already been migrated to the new environment. Another significant project aimed at providing the Agency with a geospatial exploitation system facilitating the analysis and dissemination of information also commenced in 2010.

Japan MOX Fuel Fabrication Plant

The construction of the Japan MOX fuel fabrication plant (J-MOX) began in October 2010, with commissioning (involving uranium and MOX powder) expected to start in the middle of 2015, and commercial operation scheduled for mid-2016. In 2010, the Agency started detailed design and production of some of the equipment that will be required at the plant, the installation of which is expected in 2013–2014.

Novel Technologies Project

Within the framework of the Novel Technologies Project, concepts for advanced technologies capable of detecting undeclared activities and of providing general support to safeguards implementation were identified and developed. The project focused mainly on: novel safeguards technologies for geological repositories; on-site atmospheric gaseous compound detection (for the purpose of verifying the status of reprocessing facilities as well as the absence of unreported activities); identification of nuclear fuel cycle indicators and signatures that would be useful for safeguards purposes; and the application of commercial laser based sampling and analysis techniques.

"Within the framework of the Novel Technologies Project, concepts for advanced technologies capable of detecting undeclared activities and of providing general support to safeguards implementation were identified and developed."

Chernobyl

The objective of the Chernobyl Safeguards Project is to develop safeguards approaches and instrumentation for routine safeguards implementation at the facilities at the Chernobyl site. A new surveillance system was selected and procured in 2010, and surveillance and radiation monitoring and detection equipment already installed was upgraded.

FIG. 3. Safeguards inspectors at a nuclear facility.

ECAS

To maintain and strengthen its capabilities to provide independent and timely analysis of nuclear material and environmental samples, the Agency continued with the project entitled 'Enhancing Capabilities of the Safeguards Analytical Services (ECAS)'.

In April 2010, construction began on the extension of the Clean Laboratory to accommodate a large geometry secondary ion mass spectrometer (LG-SIMS). Partially funded by the Agency's regular budget and with generous contributions from a number of Member States[19], by the year's end structural work for the building had been completed and the mechanical and electrical outfitting had begun. It is expected that the LG-SIMS, which will enhance and ensure the sustainability of the Agency's particle analysis capabilities for environmental samples, will be installed in 2011.

"Also in 2010, the conceptual design for a new Nuclear Material Laboratory (NML) to analyse nuclear material samples was completed and the detailed design was started …"

Also in 2010, the conceptual design for a new Nuclear Material Laboratory (NML) to analyse nuclear material samples was completed and the detailed design was started; subject to funding, construction is scheduled to begin in 2011. The design phase of the NML has been partially funded by the Agency's regular budget, with additional contributions from Member States. Further contributions are required to achieve full funding for project completion (intended in 2014).

Support

Developing the Safeguards Workforce

To ensure the maintenance of a workforce capable of meeting future as well as current needs, the Agency must continually develop the skills of its staff (Fig. 3). As demands on the safeguards workforce evolve, so does the Agency's training curriculum. During the year, some 70 training courses were held.

To induct a new generation of 20 newly recruited inspectors, an 'Introductory Course on Agency Safeguards' (ICAS) was held, along with other basic training, including exercises at specific types of facilities, courses on safeguards techniques, and on enhanced observational and communication skills. The Agency also organized advanced training across a range of more specialized topics, including: satellite imagery; proliferation indicators of different types of nuclear fuel cycle facilities; spent fuel verification; and plutonium verification techniques. New or updated courses that were offered during the year focused mainly on providing country officers and

[19] Canada, the Czech Republic, Germany, Ireland, Japan, the Republic of Korea, Spain and the USA.

analysts with the knowledge and skills necessary for performing State evaluations.

The Agency also organized a ten month Safeguards Traineeship Programme for six young graduates and junior professionals from developing countries. The programme's objectives are to prepare trainees for employment in their home countries in the peaceful use of atomic energy, as well as to increase the number of qualified candidates from developing countries for possible hire as safeguards inspectors, either by the Agency or by their national nuclear related organizations.

Quality Management

In 2010, the Agency continued to implement its quality management system. Specific training was provided in order to raise staff awareness of the system, to increase the use of the corrective action report system, to support continual process improvement and to improve the document control system. Knowledge management efforts focused on retaining critical job related knowledge of retiring staff. The Agency conducted audits on the process for annual reporting on safeguards implementation and on the use of role based security concepts in information systems. Moreover, the Agency completed, peer reviewed and validated a cost calculation methodology which enables it to establish and monitor the cost of carrying out safeguards and to compare the costs of different safeguards implementation options.

Standing Advisory Group on Safeguards Implementation

The Standing Advisory Group on Safeguards Implementation (SAGSI) held two meetings in 2010 at which it considered: remote monitoring concepts; the verification of the front end of the nuclear fuel cycle; Agency activities on novel technologies and 'safeguards by design'; strategic planning activities; efforts to further the State level concept for all States, based on a safeguards system that is fully information driven; and safeguards training and knowledge management at the Agency.

The Future

Strategic Planning

In 2010, the Agency continued to implement the long range strategic planning methodology for the safeguards programme. It carried out a risk assessment of issues of potential strategic importance and developed strategies to address them in the coming years. Approved within the Secretariat in August 2010, *The Long-Term Strategic Plan (2012–2023)* addresses the conceptual framework for safeguards, legal authority, technical capabilities (expertise, equipment and infrastructure), and human and financial resources for Agency verification. It also considers communication, cooperation and partnerships with the Agency's stakeholders and sets in motion various improvement initiatives. The plan was presented at the symposium on international safeguards held in November 2010 and will be subject to periodic review and updating.

Towards a Fully Information Driven Safeguards System

In order to make the safeguards system fully information driven, the Agency accelerated its work to strengthen the links between the State evaluation process and inspection related activities with a view eventually to merge them. The objective is to ensure that all safeguards relevant information regarding a State's nuclear programme, including feedback from in-field activities, is evaluated collaboratively by multidisciplinary teams of experts within the Agency. The aim is not only to draw safeguards conclusions, but also to determine the optimal set of State specific safeguards activities to be conducted, both in the field and at the Agency's Headquarters.

"In November, the Agency held its 11th symposium on international safeguards in Vienna."

Safeguards Symposium

In November, the Agency held its 11th symposium on international safeguards in Vienna. Around 670 participants from 64 States and 17 international organizations attended the event. The objective was to foster dialogue and information exchange between the Secretariat, Member States, the nuclear industry and members of the broader safeguards and nuclear non-proliferation community on the theme of 'Preparing for Future Verification Challenges'. The

Secretariat presented its plan for the implementation of a safeguards system that is more objectives based, focused at the State level and driven by all available safeguards relevant information. Drawing from *The Long-Term Strategic Plan (2012–2023)*, participants discussed in key sessions the Agency's strategic priorities in addressing the forthcoming challenges in the areas of: advancing cooperation between the Agency and its Member States; strengthening the Agency's technical capabilities (safeguards approaches, technologies and infrastructure); bolstering its State evaluation capabilities (for example, information collection and evaluation); developing its organizational culture; and managing the safeguards workforce and knowledge.

Research and Development Programme

Research and development activities, carried out with the assistance of Member State Support Programmes (MSSPs), are essential to meet the safeguards challenges of the future. At the end of 2010, 21 States and intergovernmental organizations[20] had formal support programmes with the Agency supporting over 300 tasks, valued at over €20 million per annum.

"Research and development (R&D) activities, carried out with the assistance of Member State Support Programmes (MSSPs), are essential to meet the safeguards challenges of the future."

The *Research and Development Programme for Nuclear Verification 2010–2011*, which reflects the need to achieve greater efficiency and effectiveness, consists of 24 projects in such areas as verification technology development, safeguards concepts, information processing and analysis, and training. During 2010, the Secretariat finalized the review of its R&D activities implemented in the previous two years and presented the findings in the *Biennial Report on the Research and Development Programme for Nuclear Verification 2008–2009*. To enable planning, in 2010 the Agency decided to prepare a long term R&D plan.

During 2010, the Agency organized a number of meetings and workshops, notably, a biennial MSSP coordinators meeting, and interacted with other safeguards R&D organizations, such as the European Safeguards Research and Development Association (ESARDA) and the Institute of Nuclear Materials Management (INMM).

Safeguards for Future Facilities

For the effective and efficient implementation of safeguards at a new facility, safeguards concepts need to be considered in the initial design planning stages. This not only improves the facility's proliferation resistance, it also enables design changes to be effected when the costs of such changes are reasonably low.

The Agency is already preparing to safeguard new types of facilities in the future (for example, geological repositories and pyroprocessing facilities). In this regard, the Agency, inter alia, evaluated safeguards approaches for specific facility types, assessed the proliferation resistance of nuclear energy systems, and considered what safeguards measures are required early in the design stages of a facility.

In 2010, the Agency, Euratom, and the State authorities and nuclear operators of Finland and Sweden continued the development of safeguards approaches for the transfer of spent fuel from reactors to encapsulation plants and geological repositories for final disposal.

The Agency contributed to assessments of proliferation resistant nuclear energy systems through the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and the Generation IV International Forum (GIF), participating in meetings and helping to finalize a report on Proliferation Resistance: Acquisition/ Diversion Pathway Analysis (PRADA).

The concept of 'safeguards by design' drew growing interest in 2010, and the Agency led efforts to build consensus on stakeholders' objectives and to refine the overarching principles. For instance, the issue was discussed at numerous sessions of the safeguards symposium in November, and the Agency provided key support to those working groups dedicated to refining the concept at the 'Third International Meeting on Next Generation Safeguards' held in December 2010 in Washington, D.C.

[20] Argentina, Australia, Belgium, Brazil, Canada, China, the Czech Republic, the European Commission, Finland, France, Germany, Hungary, Japan, the Republic of Korea, the Netherlands, the Russian Federation, South Africa, Spain, Sweden, the United Kingdom and the USA.

Technical Cooperation

Management of Technical Cooperation for Development

Objective

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

The Agency's technical cooperation programme works to build human and institutional capacities in Member States so that they can respond to local needs and address global issues through the safe utilization of nuclear technologies.

The programme focuses on: improving health care (Fig. 1); supporting agricultural production and food security; advancing water resources management; addressing environmental challenges; and supporting sustainable energy development, including the use of nuclear power for electricity generation. It also goes beyond these development priorities to address transboundary issues for the global good, such as the promotion of safety and security, and building capacities in Member States that ensure that nuclear technology is used in a manner consistent with the highest standards of safety. The programme contributes to the achievement of several of the Millennium Development Goals.

Managing the Agency's Technical Cooperation Programme

In 2010, the Agency completed the second year of its current technical cooperation cycle. Nine new out of cycle national projects were initiated at the start of the year. During the course of the year, 384 completed projects were closed. Active projects at the end of 2010 totalled 890, with an additional 210 in the process of being closed. Member State priorities, reflected in the thematic distribution of the programme, were human health, food and agriculture, and safety related issues.

> *"The Agency's technical cooperation programme works to build human and institutional capacities in Member States …"*

Country Programme Frameworks and UNDAFs

The development of Country Programme Frameworks (CPFs) is a key component of strategic

FIG. 1. Technical cooperation projects around the world are helping to create a new corps of trained professionals who are already on the frontline of the fight against cancer.

pre-planning work for the technical cooperation programme cycle, as it provides a context for technical cooperation activities at the national level. The Agency continued to strengthen alignment with development activities of the United Nations at all levels, and to this end continued to participate in the development of United Nations Development Assistance Frameworks (UNDAFs). As of the end of 2010, 14 UNDAFs had been signed, and technical cooperation country officers (Programme Management Officers (PMOs)) were engaged in a further 48 UNDAF processes. Internal briefing papers on linkages between CPFs and national UNDAFs were prepared for 75 Member States. Preparatory work of this nature helps to: ensure that the application of nuclear techniques is integrated with existing development initiatives and plans; identify areas where such techniques might be usefully deployed; and recognize potential areas for cooperation with external partners.

Preparations for the 2012–2013 Programme Cycle

Activities in preparation for the 2012–2013 technical cooperation programme cycle focused on the identification of national development priorities as well as on cohesive country planning and results based programming, laying the foundations for effective monitoring, self-assessment and independent evaluation. All Member States received the *Guidelines for the Planning and Design of the IAEA Technical Cooperation Programme*. These guidelines are intended to assist stakeholders in the planning and design process for the programme, and to ensure consistently high quality in all project documents and throughout the entire technical cooperation programme. For the first time, each Member State was asked to submit a Country Programme Note (CPN) rather than a set of individual project concepts. A CPN provides a unified overview of the planned national programme and contains information regarding the consultation process and the identification of priorities, as well as an outline of the status of the national safety regulatory infrastructure. It also contains the country's proposed project concepts, ordered according to priority. The CPN allows a Member State to define its priorities in an integrated manner and supports a more strategic and cohesive country programme that is aligned with national development needs and with the technical support offered by the Agency. In all, 117 CPNs were received, containing 807 national project concepts. In addition, 280 regional and 28 interregional project concepts were submitted in the form of consolidated programme notes.

"The technical cooperation programme planning and design process was reviewed and improved to shift emphasis from the project level to the programme level."

Programme Cycle Management Framework

The technical cooperation programme planning and design process was reviewed and improved to shift emphasis from the project level to the programme level. The new Country, Regional and Interregional Programme Notes support this methodology. This holistic approach to programme planning is expected to lead to a more interconnected, strategic technical cooperation programme.

Review criteria to ensure the quality of programme and project design were further developed and incorporated into the Programme Cycle Management Framework (PCMF) IT platform in support of the preparations for the 2012–2013 programme cycle.

Interdepartmental Coordination

The technical cooperation Fields of Activity (FoAs), which are used to mark the thematic focus of proposed projects and to identify the technical support required for project implementation, were reviewed over the course of 2010. The number of FoAs was reduced from 131 to 30, ensuring a more streamlined Agency response to the needs of Member States. The new fields are being used in the development of the 2012–2013 programme. They are available on the PCMF IT platform.

InTouch

The first phase of 'InTouch' (*http://intouch.iaea.org*), an interactive on-line communication platform for the technical cooperation community, was piloted in 2010. InTouch currently allows registered users to complete and maintain their professional profile on-line, and to apply for a fellowship, scientific visit, training course or meeting, or for expert/lecturer

assignments. It also offers an on-line history of the participation of registered users in the technical cooperation programme. In addition, InTouch features a database of institutions offering training and expertise, as well as programme information and guidelines.

Integration with AIPS

As the development, implementation and monitoring of the technical cooperation programme relies heavily on a suite of specialized IT tools, considerable energy was expended in 2010 on ensuring smooth implementation of the Agency-wide Information System for Programme Support (AIPS). Particular attention was paid to interactive processes with Member States in the design and implementation of the technical cooperation programme.

Coordination with International Organizations

The Agency cooperated with the countries affected by the consequences of the legacy of uranium production sites in Central Asia, and with several United Nations agencies and international partners. The focus of these activities was on designing and implementing appropriate countermeasures aimed at improving the existing exposure situation and reducing the associated environmental risk. It also cooperated with Kazakhstan in the completion of the radiological characterization of the Semipalatinsk Test Site to provide the national authorities with comprehensive information to support decision making.

Technical and management leadership is being fostered in Latin America by promoting bilateral cooperation agreements and increasing support for the management structure of the regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL).

In Africa, efforts continued to strengthen the partnership with the African Union Commission (AUC) in connection with the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) Coordination Office, and to enhance institutional collaboration and synergies with the AUC Department of Peace and Security following entry into force of the Pelindaba Treaty on 15 July 2009. The AUC intends to seek active advisory support from the Agency to operationalize the African Commission on Nuclear Energy (ACNE) established by the Treaty, and to facilitate future collaboration between ACNE and the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA).

Regional Agreements and Programming

Regional agreements with Member State groups promote horizontal cooperation and further the goals of self-reliance and sustainability. Collaboration with these groups has led to stronger regional programmes, focused on priorities identified at the regional level, and ensured balance and complementarity between national and regional programmes.

In 2010, the Agency supported follow-up actions to the AFRA High Level Policy Review Seminar. The emphasis is on implementation of the AFRA Regional Strategic Cooperative Framework (RCF), the AFRA strategy on human resource development and nuclear knowledge management, and on AFRA funding and partnership development.

In the Asia–Pacific region, the Medium Term Strategy of the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) was updated and a strategic profile adopted that identifies priorities for 2012–2017. The Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) is developing its own strategic profile. A regional cooperative framework for Agency technical cooperation activities in Asia and the Pacific was developed. The framework identifies potential areas and opportunities for regional cooperation, as well as the means and modalities for concrete implementation and knowledge sharing.

"In 2010, the Agency supported follow-up actions to the AFRA High Level Policy Review Seminar."

In Europe, Member States adopted a strategy in February 2010 for the technical cooperation programme in the region. This strengthens the alignment of the programme with Agency policy, programmatic quality criteria and regional cooperation, and promotes triangular cooperation in the region.

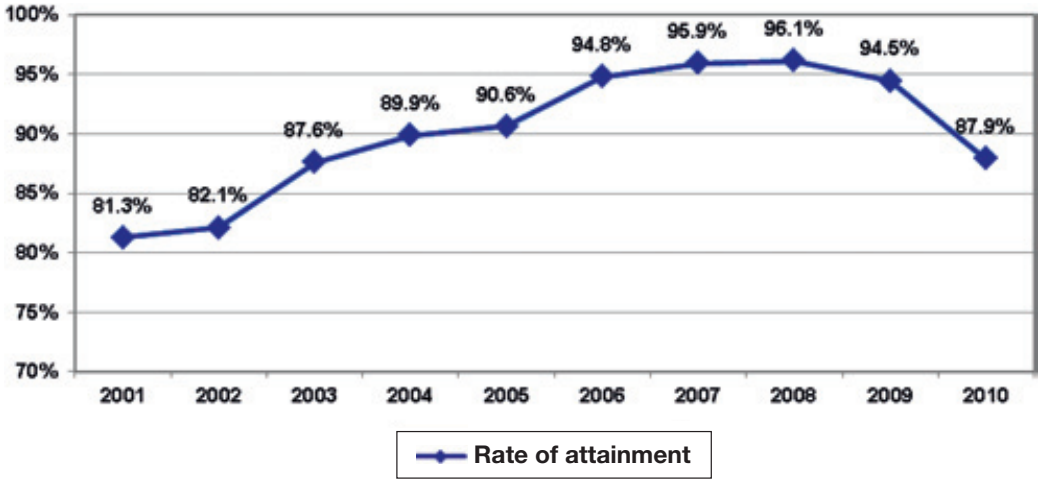


FIG. 2. Rate of attainment on payments to the TCF, 2001–2010, as of 31 December 2010.

In Latin America, the number of designated centres supporting the implementation of the ARCAL programme increased from 33 to 35. Activities in the region are focused on ARCAL initiatives such as a communications platform and implementation of the Strategic Alliance Plan of Action.

Outreach and Communication

The Secretariat's outreach activities in 2010 focused on a series of informal meetings and briefings for Member States. For example, a seminar on technical cooperation activities provided Permanent Missions with a comprehensive overview of the programme. The Agency also extended its outreach activities by establishing a Twitter presence and highlighting technical cooperation activities on its Facebook page. YouTube was used to share short training videos on the PCMF in English, French and Spanish with National Liaison Officers.

"Through its technical cooperation programme, the Agency continued to provide legislative assistance in response to requests from Member States."

Financial Highlights

Pledges for the TCF totalled $78.4 million (not including national participation costs (NPCs) and assessed programme costs (APCs)) against the target of $85 million, with the rate of attainment at the end of 2010 at 92.3%. Payments against the 2010 TCF target at the end of 2010 totalled $74.7 million, with a rate of attainment (on payments) of 87.9% (Fig. 2). The difference between pledges and payments ($3.7 million) is mainly due to the receipt of 2010 TCF contributions in early January 2011. The use of these resources resulted in an implementation rate of 73.9%.

For the programme as a whole (including extrabudgetary contributions, NPCs, APCs, in-kind contributions and miscellaneous income), new resources stood at $127.6 million. Implementation in 2010, measured against the adjusted programme, for the TCF and extrabudgetary part, reached a rate of 76.6%.

Legislative Assistance

Through its technical cooperation programme, the Agency continued to provide legislative assistance in response to requests from Member States. In particular, four international and regional workshops were organized. Additionally, the Agency provided country specific bilateral legislative assistance — essentially by means of written comments and advice on drafting national nuclear legislation — to 26 Member States.

At the request of Member States, the Agency organized short term scientific visits to Headquarters for a number of individuals. In addition, longer term fellowships were granted, allowing individuals to gain practical experience in nuclear law.

The Agency continued to take part in academic activities organized at the World Nuclear University and the International School of Nuclear Law through the provision of lecturers and the funding of participants through appropriate technical cooperation projects.

Annex

Note: Tables A22–A27 are available on the attached CD-ROM.

Table A1. Allocation and utilization of regular budget resources in 2010 (unless otherwise indicated, the amounts in this table are in euros)

Programme / Major Programme	Budget		Expenditure			Unused (over-expended) Adjusted Budget	Balance
	Original at $1.0000	Adjusted at $1.3248[a]	Excluding transfers to Major Capital Investment Fund	Amounts transferred to Major Capital Investment Fund[b]	Total		
	(1)	(2)	(3)	(4)	(3) + (4) (5)	(2) – (5) (6)	(7)
Operational and Recurrent Portion of the Regular Budget							
1. Nuclear Power, Fuel Cycle and Nuclear Science							
Overall Management, Coordination and Common Activities	1 056 341	999 304	987 933	410 000	1 397 933	(398 629)	–
Nuclear Power	6 683 614	6 270 745	5 779 608	–	5 779 608	491 137	–
Nuclear Fuel Cycle and Materials Technologies	3 130 847	2 921 764	2 794 087	–	2 794 087	127 677	–
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	11 226 453	10 649 659	9 841 795	–	9 841 795	807 864	–
Nuclear Science	9 693 404	9 238 570	8 666 768	–	8 666 768	571 802	–
Subtotal — Major Programme 1	**31 790 659**	**30 080 042**	**28 070 191**	**410 000**	**28 480 191**	**1 599 851**	**–**
2. Nuclear Techniques for Development and Environmental Protection							
Overall Management, Coordination and Common Activities	4 502 838	4 322 420	3 997 287	480 000	4 477 287	(154 867)	–
Management of the Coordinated Research Activities	688 359	657 853	650 225	–	650 225	7 628	–
Food and Agriculture	11 209 046	10 725 409	10 797 544	–	10 797 544	(72 135)	–
Human Health	9 015 728	8 555 042	8 181 915	–	8 181 915	373 127	–
Water Resources	3 291 307	3 135 165	3 052 746	–	3 052 746	82 419	–
Environment	5 723 602	5 439 714	5 467 557	–	5 467 557	(27 843)	–
Radioisotope Production and Radiation Technology	2 120 951	2 006 405	1 865 841	–	1 865 841	140 564	–
Subtotal — Major Programme 2	**36 551 831**	**34 842 008**	**34 013 115**	**480 000**	**34 493 115**	**348 893**	**–**
3. Nuclear Safety and Security							
Enhancing the Global Nuclear Safety and Security Regime	755 029	713 059	832 745	380 000	1 212 745	(499 686)	–
Fostering Safety and Security Infrastructure and Improving Capacity Building	224 350	216 951	200 638	–	200 638	16 313	–
Strengthening Communication and Knowledge Management	236 661	229 224	127 589	–	127 589	101 635	–
Incident and Emergency Preparedness and Response	3 307 712	3 109 572	2 994 154	–	2 994 154	115 418	–
Safety of Nuclear Installations	9 405 649	8 899 745	8 491 819	–	8 491 819	407 926	–
Radiation and Transport Safety	5 710 816	5 420 311	5 290 557	–	5 290 557	129 754	–
Management of Radioactive Waste	6 714 011	6 340 880	6 179 329	–	6 179 329	161 551	–
Nuclear Security	3 194 822	3 013 073	3 007 924	–	3 007 924	5 149	–
Subtotal — Major Programme 3	**29 549 050**	**27 942 815**	**27 124 755**	**380 000**	**27 504 755**	**438 060**	**–**
4. Nuclear Verification							
Overall Management, Coordination and Common Activities	1 148 036	1 087 833	1 449 248	1 580 000	3 029 248	(1 941 415)	–
Safeguards	120 394 548	114 253 999	107 143 416	–	107 143 416	7 110 583	–
Subtotal — Major Programme 4	**121 542 584**	**115 341 832**	**108 592 664**	**1 580 000**	**110 172 664**	**5 169 168**	**–**
5. Policy, Management and Administration Services	**77 594 649**	**74 973 176**	**71 401 824**	**1 010 000**	**72 411 824**	**2 561 352**	**–**
Subtotal — Major Programme 5	**77 594 649**	**74 973 176**	**71 401 824**	**1 010 000**	**72 411 824**	**2 561 352**	**–**
6. Management of Technical Cooperation for Development							
Management of Technical Cooperation for Development	18 455 888	17 607 080	16 795 120	240 000	17 035 120	571 960	–
Subtotal — Major Programme 6	**18 455 888**	**17 607 080**	**16 795 120**	**240 000**	**17 035 120**	**571 960**	**–**
Total Operational Budget	**315 484 661**	**300 786 953**	**285 997 669**	**4 100 000**	**290 097 669**	**10 689 284**	**–**
Major Capital Investment Funding Requirements							
1. Nuclear Power, Fuel Cycle and Nuclear Science	–	–	–	–	–	–	–
2. Nuclear Techniques for Development and Environmental Protection	–	–	–	–	–	–	–
3. Nuclear Safety and Security	–	–	–	–	–	–	–
4. Nuclear Verification	–	–	–	–	–	–	–
5. Policy, Management and Administration Services	102 200	102 200	102 200	–	102 200	–	–
6. Management of Technical Cooperation for Development	–	–	–	–	–	–	–
Total Capital Budget	**102 200**	**102 200**	**102 200**	**–**	**102 200**	**–**	**–**
Total Agency Programmes	**315 586 861**	**300 889 153**	**286 099 869**	**4 100 000**	**290 199 869**	**10 689 284**	**–**
Reimbursable Work for Others	2 801 848	2 738 223	3 048 693	–	3 048 693	–	(310 470)[c]
Grand Total	**318 388 709**	**303 627 376**	**289 148 562**	**4 100 000**	**293 248 562**	**10 689 284**	**(310 470)**

[a] General Conference Resolution GC(53)/RES/6 of September 2009 — revalued at the UN average rate of exchange of $1.3248 to €1.00.

[b] In accordance with *The Agency's Budget Update for 2011* (GC(54)/2) dated August 2010, €4.1 million was transferred to the Major Capital Investment Fund to support major infrastructural investments.

[c] The amount of (€310 470) represents the costs of additional services provided to other VIC based organizations and to projects financed from the TCF and extrabudgetary resources.

Table A2. Extrabudgetary funds in support of the regular budget 2010 (unless otherwise indicated, the amounts in this table are in euros)

Programme / **Major Programme**	Extrabudgetary budget figures[a]	Resources			Expenditure as at 31 December 2010	Unused balance
		Unused balance as at 1 January 2010	New resources in 2010	Total available in 2010		
	(1)	(2)	(3)	(2) + (3) (4)	(5)	(4) – (5) (6)
1. Nuclear Power, Fuel Cycle and Nuclear Science						
Overall Management, Coordination and Common Activities	–	–	918 810	918 810	–	918 810
Nuclear Power	2 844 979	3 044 598	3 764 896	6 809 494	2 476 690	4 332 804
Nuclear Fuel Cycle and Materials Technologies	343 657	173 680	631 713	805 393	316 582	488 811
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	–	114 700	269 692	384 392	110 699	273 693
Nuclear Science	336 332	1 508 535	868 927	2 377 462	640 390	1 737 072
Subtotal — Major Programme 1	**3 524 968**	**4 841 513**	**6 454 038**	**11 295 551**	**3 544 361**	**7 751 190**
2. Nuclear Techniques for Development and Environmental Protection						
Overall Management, Coordination and Common Activities	–	124 319	–	124 319	77 021	47 298
Management of the Coordinated Research Activities	–	–	–	–	–	–
Food and Agriculture	–	452 937	1 723 882	2 176 819	1 344 572	832 247
Human Health	2 167 839	813 184	2 381 796	3 194 980	886 709	2 308 271
Water Resources	1 096 273	203 000	454 589	657 589	132 041	525 548
Environment	–	15 403	588 599	604 002	392 522	211 480
Radioisotope Production and Radiation Technology	321 404	3 811	(4 108)[b]	(297)	–	(297)
Subtotal — Major Programme 2	**3 585 516**	**1 612 654**	**5 144 758**	**6 757 412**	**2 832 865**	**3 924 547**
3. Nuclear Safety and Security						
Enhancing the Global Nuclear Safety and Security Regime	178 568	2 892	299 150	302 042	241 894	60 148
Fostering Safety and Security Infrastructure and Improving Capacity Building	–	–	535 279	535 279	184 269	351 010
Strengthening Communication and Knowledge Management	3 862 939	2 152 735	1 769 251	3 921 986	1 487 012	2 434 974
Incident and Emergency Preparedness and Response	129 205	1 134 473	639 252	1 773 725	412 038	1 361 687
Safety of Nuclear Installations	4 591 884	4 590 303	8 412 533	13 002 836	5 363 045	7 639 791
Radiation and Transport Safety	940 000	446 620	738 884	1 185 504	735 985	449 519
Management of Radioactive Waste	1 358 492	1 018 637	1 398 788	2 417 425	918 000	1 499 425
Nuclear Security	19 875 940	11 566 004	16 311 048	27 877 052	12 249 324	15 627 728
Subtotal — Major Programme 3	**30 937 028**	**20 911 664**	**30 104 185**	**51 015 849**	**21 591 567**	**29 424 282**
4. Nuclear Verification						
Overall Management, Coordination and Common Activities	–	193 532	85 473	279 005	–	279 005
Safeguards	15 719 809	21 978 419	17 472 315	39 450 734	18 163 510	21 287 224
Subtotal — Major Programme 4	**15 719 809**	**22 171 951**	**17 557 788**	**39 729 739**	**18 163 510**	**21 566 229**
5. Policy, Management and Administration Services	**364 120**	**2 849 176**	**2 689 748**	**5 538 924**	**3 015 175**	**2 523 749**
Subtotal — Major Programme 5	**364 120**	**2 849 176**	**2 689 748**	**5 538 924**	**3 015 175**	**2 523 749**
6. Management of Technical Cooperation for Development	**355 663**	**115 016**	**104 150**	**219 166**	**188 758**	**30 408**
Subtotal — Major Programme 6	**355 663**	**115 016**	**104 150**	**219 166**	**188 758**	**30 408**
Total Extrabudgetary Programme Fund	**54 487 104**[c]	**52 501 974**	**62 054 667**	**114 556 641**	**49 336 236**	**65 220 405**

[a] *The Agency's Programme and Budget 2010–2011* GC(53)/5 of August 2009.

[b] €4108 — prior year donation returned to Member State.

[c] €54 487 104 excludes €6 million for the capital portion in extrabudgetary regular programme.

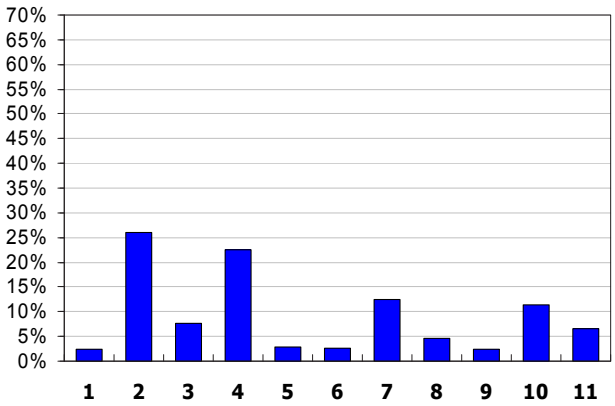
Table A3(a). Disbursements by technical field and region in 2010

Summary of all regions (in thousands of dollars)

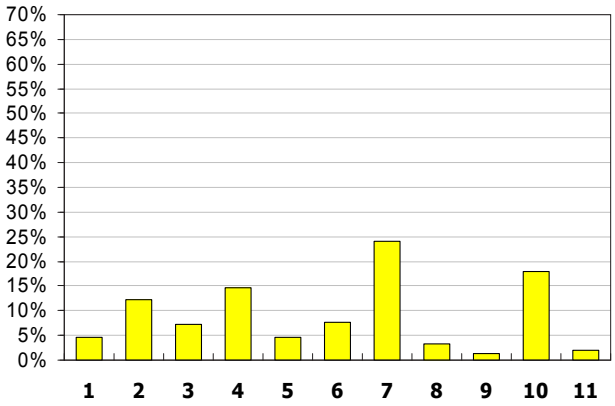
	Technical field	Africa	Asia and the Pacific	Europe	Latin America	Global/Inter-regional	Total
1	Environment	709.5	1 232.9	1 099.4	1 470.5	134.4	4 646.7
2	Food and Agriculture	7 782.7	3 335.2	1 136.6	3 405.5	316.7	15 976.7
3	Human Capacity Development and Programme Support	2 266.3	1 998.8	2 054.5	1 853.9	2 039.3	10 212.8
4	Human Health	6 790.2	3 997.8	5 506.2	4 076.2	64.1	20 434.5
5	Nuclear Fuel Cycle	825.2	1 284.5	3 783.8	782.5	0.0	6 676.0
6	Nuclear Power	770.4	2 077.8	397.3	1 139.7	296.8	4 682.0
7	Nuclear Safety	3 752.3	6 561.4	7 988.4	2 674.7	36.2	21 013.0
8	Nuclear Science	1 404.4	927.4	8 988.8	460.8	31.9	11 813.3
9	Nuclear Security	753.1	379.0	549.0	393.3	0.0	2 074.4
10	Radioisotope Production and Radiation Technology	3 433.7	4 899.9	2 418.4	2 114.4	265.9	13 132.3
11	Water Resources	1 522.8	695.4	372.9	1 013.0	0.0	3 604.1
	Total	30 010.8	27 390.0	34 295.2	19 384.5	3 185.3	114 265.8

Table A3(b). Graphical representation of the information in Table A3(a)

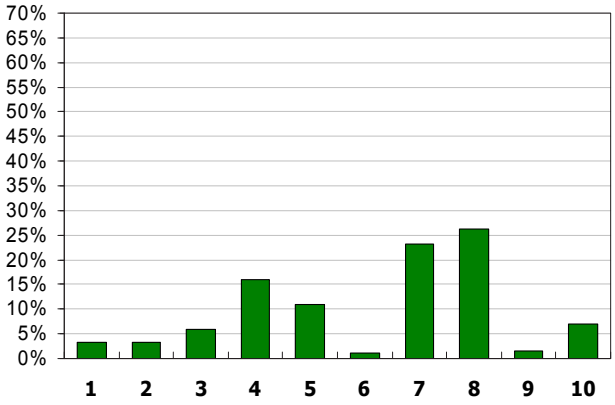
Africa: $30 010.8



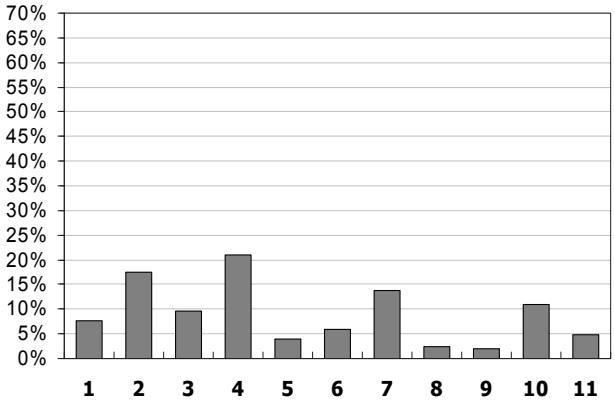
Asia and the Pacific: $27 390.0



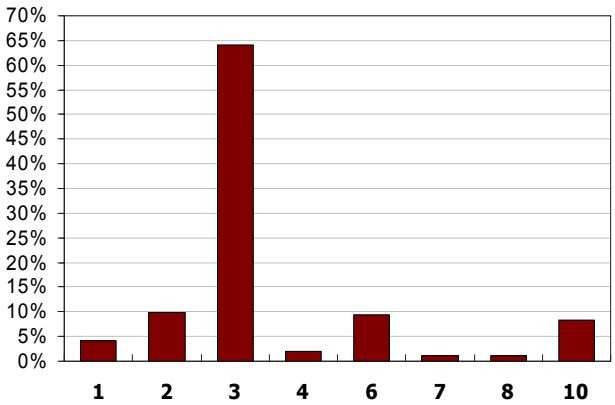
Europe: $34 295.2



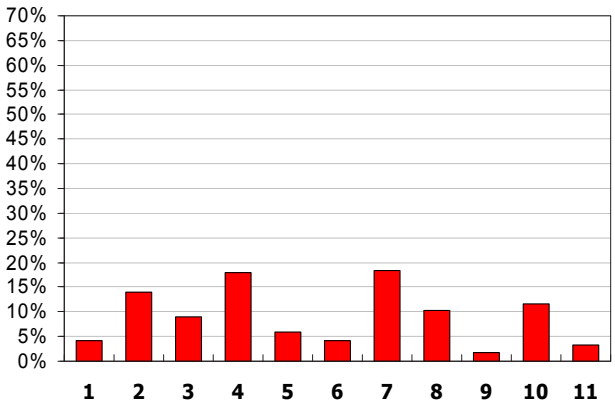
Latin America: $19 384.5



Global / Interregional: $3 185.3



Total: $114 265.8



Note: Numbers on the x axis denote technical fields, which are listed in the summary on the previous page.

Table A4. Amount of nuclear material at the end of 2010 by type of agreement

Nuclear material	Comprehensive safeguards agreement (CSA)[a]	INFCIRC/66[b] type agreement	Voluntary offer agreement	Significant quantities (SQs)
Plutonium[c] contained in irradiated fuel and in fuel elements in reactor cores	114 635.445	1480.153	16 389.829	132 505.427
Separated plutonium outside reactor cores	1489.378	5.016	10 386.525	11 880.919
HEU (equal to or greater than 20% uranium-235)	230.665	1.014	0.243	231.922
LEU (less than 20% uranium-235)	15 916.203	210.014	828.662	16 954.879
Source material[d] (natural and depleted uranium and thorium)	8669.087	203.739	1716.766	10 589.592
Uranium-233	17.551	0.001	0	17.552
Total SQs	**140 958.329**	**1899.937**	**29 322.025**	**172 180.291**

Amount of heavy water at the end of 2010 by type of agreement

Non-nuclear material[e]	Comprehensive safeguards agreement (CSA)[a]	INFCIRC/66[b] type agreement	Voluntary offer agreement	Significant quantities (SQs)
Heavy water	**0.719**[f]	**441.012**	**0**	**441.731**

a Covering safeguards agreements pursuant to the NPT and/or Treaty of Tlatelolco and other CSAs; including facilities in Taiwan, China.
b Covering facilities in India, Israel and Pakistan.
c The quantity includes an estimated amount (11 742 SQs) of plutonium (Pu) in irradiated fuel, which has not yet been reported to the Agency under the agreed reporting procedures (the non-reported Pu is contained in irradiated fuel assemblies to which item accountancy and containment/surveillance measures are applied) and Pu in fuel elements loaded into the core.
d This table does not include material within the terms of subparagraphs 34(a) and 34(b) of INFCIRC/153 (Corrected).
e Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2 type agreements.
f All in Taiwan, China.

Table A5. Number of facilities under safeguards during 2010

Facility type	Number of facilities			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b] type agreements	Voluntary offer agreements	Total
Power reactors	225	9	1	235
Research reactors	147	3	1	151
Conversion plants	17	0	0	17
Fuel fabrication plants	42	2	1	45
Reprocessing plants	11	1	1	13
Enrichment plants	16	0	3	19
Separate storage facilities	114	1	5	120
Other facilities	74	0	0	74
Subtotals	**646**	**16**	**12**	**674**
Locations outside facilities (LOFs)[c]	495	1	0	496
Totals	**1141**	**17**	**12**	**1170**

[a] Covering safeguards agreements pursuant to the NPT and/or the Treaty of Tlatelolco and other CSAs; includes facilities in Taiwan, China.
[b] Covering facilities in India, Israel and Pakistan.
[c] Excludes the two LOFs at the Agency and one LOF in Euratom.

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Afghanistan	X	In force: 20 Feb. 1978	257	In force: 19 July 2005
Albania[1]		In force: 25 March 1988	359	In force: 3 November 2010
Algeria		In force: 7 Jan. 1997	531	Approved: 14 Sept. 2004
Andorra	X	In force: 18 October 2010	808	Signed: 9 Jan. 2001
Angola	In force: 28 April 2010	In force: 28 April 2010	800	In force: 28 April 2010
Antigua and Barbuda[2]	X	In force: 9 Sept. 1996	528	
Argentina[3]		In force: 4 March 1994	435	
Armenia		In force: 5 May 1994	455	In force: 28 June 2004
Australia		In force: 10 July 1974	217	In force: 12 Dec. 1997
Austria[4]		Accession: 31 July 1996	193	In force: 30 April 2004
Azerbaijan	Amended: 20 Nov. 2006	In force: 29 April 1999	580	In force: 29 Nov. 2000
The Bahamas[2]	Amended: 25 July 2007	In force: 12 Sept. 1997	544	
Bahrain	In force: 10 May 2009	In force: 10 May 2009	767	Signed: 21 Sept. 2010
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados[2]	X	In force: 14 Aug. 1996	527	
Belarus		In force: 2 Aug. 1995	495	Signed: 15 Nov. 2005
Belgium		In force: 21 Feb. 1977	193	In force: 30 April 2004
Belize[5]	X	In force: 21 Jan. 1997	532	
Benin	*Amended: 15 April 2008*	*Signed: 7 June 2005*		*Signed: 7 June 2005*
Bhutan	X	In force: 24 Oct. 1989	371	
Bolivia[2]	X	In force: 6 Feb. 1995	465	
Bosnia and Herzegovina[6]		In force: 28 Dec. 1973	204	
Botswana		In force: 24 Aug. 2006	694	In force: 24 Aug. 2006
Brazil[7]		In force: 4 March 1994	435	
Brunei Darussalam	X	In force: 4 Nov. 1987	365	
Bulgaria[8]		Accession: 1 May 2009	193	Accession: 1 May 2009
Burkina Faso	Amended: 18 Feb. 2008	In force: 17 April 2003	618	In force: 17 April 2003
Burundi	In force: 27 Sept. 2007	In force: 27 Sept. 2007	719	In force: 27 Sept. 2007
Cambodia	X	In force: 17 Dec. 1999	586	
Cameroon	X	In force: 17 Dec. 2004	641	Signed: 16 Dec. 2004
Canada		In force: 21 Feb. 1972	164	In force: 8 Sept. 2000
Cape Verde	*Amended: 27 March 2006*	*Signed: 28 June 2005*		*Signed: 28 June 2005*
Central African Republic	In force: 7 Sept. 2009	In force: 7 Sept. 2009	777	In force: 7 Sept. 2009
Chad	In force: 13 May 2010	In force: 13 May 2010	802	In force: 13 May 2010
Chile[9]		In force: 5 April 1995	476	In force: 3 Nov. 2003
China		In force: 18 Sept. 1989	369*	In force: 28 March 2002

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Colombia[9]		In force: 22 Dec. 1982	306	In force: 5 March 2009
Comoros	In force: 20 Jan. 2009	In force: 20 Jan. 2009	752	In force: 20 Jan. 2009
Congo, Republic of the	*Signed: 13 April 2010*	*Signed: 13 April 2010*		*Signed: 13 April 2010*
Costa Rica[2]	Amended: 12 Jan. 2007	In force: 22 Nov. 1979	278	Signed: 12 Dec. 2001
Côte d'Ivoire		In force: 8 Sept. 1983	309	Signed: 22 Oct. 2008
Croatia	Amended: 26 May 2008	In force: 19 Jan. 1995	463	In force: 6 July 2000
Cuba[2]		In force: 3 June 2004	633	In force: 3 June 2004
Cyprus[10]		Accession: 1 May 2008	193	Accession: 1 May 2008
Czech Republic[11]		Accession: 1 Oct. 2009	193	Accession: 1 Oct. 2009
Dem. Rep. of the Congo		In force: 9 Nov. 1972	183	In force: 9 April 2003
Denmark[12]		In force: 21 Feb. 1977	193	In force 30 April 2004
Djibouti	*Signed: 27 May 2010*	*Signed : 27 May 2010*		*Signed : 27 May 2010*
Dominica[5]	X	In force: 3 May 1996	513	
Dominican Republic[2]	Amended: 11 Oct. 2006	In force: 11 Oct. 1973	201	In force: 5 May 2010
D.P.R.K.		In force: 10 April 1992	403	
Ecuador[2]	Amended: 7 April 2006	In force: 10 March 1975	231	In force: 24 Oct. 2001
Egypt		In force: 30 June 1982	302	
El Salvador[2]	X	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	X	*Approved: 13 June 1986*		
Eritrea				
Estonia[13]		Accession: 1 Dec. 2005	193	Accession: 1 Dec. 2005
Ethiopia	X	In force: 2 Dec. 1977	261	
Fiji	X	In force: 22 March 1973	192	In force: 14 July 2006
Finland[14]		Accession: 1 Oct. 1995	193	In force: 30 April 2004
France		In force: 12 Sept. 1981	290*	In force: 30 April 2004
	X	In force: 26 Oct. 2007[15]	718	
Gabon	X	In force: 25 March 2010	792	In force: 25 March 2010
The Gambia	X	In force: 8 Aug. 1978	277	Approved: 3 March 2010
Georgia		In force: 3 June 2003	617	In force: 3 June 2003
Germany[16]		In force: 21 Feb. 1977	193	In force: 30 April 2004
Ghana		In force: 17 Feb. 1975	226	In force: 11 June 2004
Greece[17]		Accession: 17 Dec. 1981	193	In force: 30 April 2004
Grenada[2]	X	In force: 23 July 1996	525	
Guatemala[2]	X	In force: 1 Feb. 1982	299	In force: 28 May 2008
Guinea				
Guinea-Bissau				

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Guyana[2]	X	In force: 23 May 1997	543	
Haiti[2]	X	In force: 9 March 2006	681	In force: 9 March 2006
Holy See	Amended: 11 Sept. 2006	In force: 1 Aug. 1972	187	In force: 24 Sept. 1998
Honduras[2]	Amended: 20 Sept. 2007	In force: 18 April 1975	235	Signed: 7 July 2005
Hungary[18]		Accession: 1 July 2007	193	Accession: 1 July 2007
Iceland	Amended: 15 March 2010	In force: 16 Oct. 1974	215	In force: 12 Sept. 2003
India		In force: 30 Sept. 1971	211	
		In force: 17 Nov. 1977	260	
		In force: 27 Sept. 1988	360	
		In force: 11 Oct. 1989	374	
		In force: 1 March 1994	433	
		In force: 11 May 2009	754	Signed: 15 May 2009
Indonesia		In force: 14 July 1980	283	In force: 29 Sept. 1999
Iran, Islamic Republic of		In force: 15 May 1974	214	Signed: 18 Dec. 2003
Iraq		In force: 29 Feb. 1972	172	Signed: 9 Oct. 2008[19]
Ireland		In force: 21 Feb. 1977	193	In force: 30 April 2004
Israel		In force: 4 April 1975	249/Add.1	
Italy		In force: 21 Feb. 1977	193	In force: 30 April 2004
Jamaica[2]	Rescinded: 15 Dec. 2006	In force: 6 Nov. 1978	265	In force: 19 March 2003
Japan		In force: 2 Dec. 1977	255	In force: 16 Dec. 1999
Jordan	X	In force: 21 Feb. 1978	258	In force: 28 July 1998
Kazakhstan		In force: 11 Aug. 1995	504	In force: 9 May 2007
Kenya	In force: 18 Sept. 2009	In force: 18 Sept. 2009	778	In force: 18 Sept. 2009
Kiribati	X	In force: 19 Dec. 1990	390	Signed: 09 Nov. 2004
Korea, Republic of		In force: 14 Nov. 1975	236	In force: 19 Feb. 2004
Kuwait	X	In force: 7 March 2002	607	In force: 2 June 2003
Kyrgyzstan	X	In force: 3 Feb. 2004	629	Signed: 29 Jan. 2007
Lao P.D.R.	X	In force: 5 April 2001	599	
Latvia[20]		Accession: 1 Oct. 2008	193	Accession: 1 Oct. 2008
Lebanon	Amended: 5 Sept. 2007	In force: 5 March 1973	191	
Lesotho	Amended: 8 Sept. 2009	In force: 12 June 1973	199	In force: 26 April 2010
Liberia				
Libyan Arab Jamahiriya		In force: 8 July 1980	282	In force: 11 Aug. 2006
Liechtenstein		In force: 4 Oct. 1979	275	Signed: 14 July 2006
Lithuania[21]		Accession: 1 Jan. 2008	193	Accession: 1 Jan. 2008
Luxembourg		In force: 21 Feb. 1977	193	In force: 30 April 2004

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Madagascar	Amended: 29 May 2008	In force: 14 June 1973	200	In force: 18 Sept. 2003
Malawi	Amended: 29 Feb. 2008	In force: 3 Aug. 1992	409	In force: 26 July 2007
Malaysia		In force: 29 Feb. 1972	182	Signed: 22 Nov. 2005
Maldives	X	In force: 2 Oct. 1977	253	
Mali	Amended: 18 April 2006	In force: 12 Sept. 2002	615	In force: 12 Sept. 2002
Malta[22]		Accession: 1 July 2007	193	Accession: 1 July 2007
Marshall Islands		In force: 3 May 2005	653	In force: 3 May 2005
Mauritania	X	In force: 10 Dec. 2009	788	In force: 10 Dec. 2009
Mauritius	Amended: 26 Sept. 2008	In force: 31 Jan. 1973	190	In force: 17 Dec. 2007
Mexico[23]		In force: 14 Sept. 1973	197	Signed: 29 March 2004
Micronesia, Fed. States				
Monaco	Amended: 27 Nov. 2008	In force: 13 June 1996	524	In force: 30 Sept. 1999
Mongolia	X	In force: 5 Sept. 1972	188	In force: 12 May 2003
Montenegro	*Signed: 26 May 2008*	*Signed: 26 May 2008*	814	*Signed: 26 May 2008*
Morocco	Rescinded: 15 Nov. 2007	In force: 18 Feb. 1975	228	Signed: 22 Sept. 2004
Mozambique	*Signed: 8 July 2010*	*Signed: 8 July 2010*	813	*Signed: 8 July 2010*
Myanmar	X	In force: 20 April 1995	477	
Namibia	X	In force: 15 April 1998	551	Signed: 22 March 2000
Nauru	X	In force: 13 April 1984	317	
Nepal	X	In force: 22 June 1972	186	
Netherlands	X	In force: 5 June 1975 [15]	229	
		In force: 21 Feb. 1977	193	In force: 30 April 2004
New Zealand[24]	X	In force: 29 Feb. 1972	185	In force: 24 Sept. 1998
Nicaragua[2]	Amended: 12 June 2009	In force: 29 Dec. 1976	246	In force: 18 Feb. 2005
Niger		In force: 16 Feb. 2005	664	In force: 2 May 2007
Nigeria		In force: 29 Feb. 1988	358	In force: 4 April 2007
Norway		In force: 1 March 1972	177	In force: 16 May 2000
Oman	X	In force: 5 Sept. 2006	691	
Pakistan		In force: 5 March 1962	34	
		In force: 17 June 1968	116	
		In force: 17 Oct. 1969	135	
		In force: 18 March 1976	239	
		In force: 2 March 1977	248	
		In force: 10 Sept. 1991	393	
		In force: 24 Feb. 1993	418	
		In force: 22 Feb. 2007	705	

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Palau	Amended: 15 March 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[9]	X	In force: 23 March 1984	316	In force: 11 Dec. 2001
Papua New Guinea	X	In force: 13 Oct. 1983	312	
Paraguay[2]	X	In force: 20 March 1979	279	In force: 15 Sept. 2004
Peru[2]		In force: 1 Aug. 1979	273	In force: 23 July 2001
Philippines		In force: 16 Oct. 1974	216	In force: 26 Feb. 2010
Poland[25]		Accession: 1 March 2007	193	Accession: 1 March 2007
Portugal[26]		Accession: 1 July 1986	193	In force: 30 April 2004
Qatar	In force: 21 Jan. 2009	In force: 21 Jan. 2009	747	
Republic of Moldova	X	In force: 17 May 2006	690	Approved: 13 Sept. 2006
Romania[27]		Accession: 1 May 2010	193	Accession: 1 May 2010
Russian Federation		In force: 10 June 1985	327*	In force: 16 Oct. 2007
Rwanda	In force: 17 May 2010	In force: 17 May 2010	801	In force: 17 May 2010
St Kitts & Nevis[5]	X	In force: 7 May 1996	514	
Saint Lucia[5]	X	In force: 2 Feb. 1990	379	
St V. & the Grenadines[5]	X	In force: 8 Jan. 1992	400	
Samoa	X	In force: 22 Jan. 1979	268	
San Marino	X	In force: 21 Sept. 1998	575	
São Tomé and Príncipe				
Saudi Arabia	X	In force: 13 Jan. 2009	746	
Senegal	Amended: 6 Jan. 2010	In force: 14 Jan. 1980	276	Signed: 15 Dec. 2006
Serbia[28]		In force: 28 Dec. 1973	204	Signed: 3 July 2009
Seychelles	Amended: 31 Oct. 2006	In force: 19 July 2004	635	In force: 13 Oct. 2004
Sierra Leone	X	In force: 4 Dec. 2009	787	
Singapore	Amended: 31 March 2008	In force: 18 Oct. 1977	259	In force: 31 March 2008
Slovakia[29]		Accession: 1 Dec. 2005	193	Accession: 1 Dec. 2005
Slovenia[30]		Accession: 1 Sept. 2006	193	Accession: 1 Sept. 2006
Solomon Islands	X	In force: 17 June 1993	420	
Somalia				
South Africa		In force: 16 Sept. 1991	394	In force: 13 Sept. 2002
Spain		Accession: 5 April 1989	193	In force: 30 April 2004
Sri Lanka		In force: 6 Aug. 1984	320	
Sudan	X	In force: 7 Jan. 1977	245	
Suriname[2]	X	In force: 2 Feb. 1979	269	
Swaziland	Amended: 23 July 2010	In force: 28 July 1975	227	In force: 8 Sept. 2010
Sweden[31]		Accession: 1 June 1995	193	In force: 30 April 2004

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

State	SQP [a]	Safeguards agreements [b]	INFCIRC	Additional protocols (APs)
Switzerland		In force: 6 Sept. 1978	264	In force: 1 Feb. 2005
Syrian Arab Republic		In force: 18 May 1992	407	
Tajikistan[32]	Amended: 6 March 2006	In force: 14 Dec. 2004	639	In force: 14 Dec. 2004
Thailand		In force: 16 May 1974	241	Signed: 22 Sept. 2005
The F.Y.R. of Macedonia	Amended: 9 July 2009	In force: 16 April 2002	610	In force: 11 May 2007
Timor-Leste	*Signed: 6 Oct. 2009*	*Signed: 6 Oct. 2009*		*Signed: 6 Oct. 2009*
Togo	X	*Signed: 29 Nov. 1990*		*Signed: 26 Sept. 2003*
Tonga	X	In force: 18 Nov. 1993	426	
Trinidad and Tobago[2]	X	In force: 4 Nov. 1992	414	
Tunisia		In force: 13 March 1990	381	Signed: 24 May 2005
Turkey		In force: 1 Sept. 1981	295	In force: 17 July 2001
Turkmenistan		In force: 3 Jan. 2006	673	In force: 3 Jan. 2006
Tuvalu	X	In force: 15 March 1991	391	
Uganda	Amended: 24 June 2009	In force: 14 Feb. 2006	674	In force: 14 Feb. 2006
Ukraine		In force: 22 Jan. 1998	550	In force: 24 Jan. 2006
United Arab Emirates	X	In force: 9 Oct. 2003	622	In force: 20 Dec. 2010
United Kingdom		In force: 14 Dec. 1972[33]	175	
		In force: 14 Aug. 1978	263*	In force: 30 April 2004
	X	Approved: 16 Sept. 1992[15]		
United Rep. of Tanzania	Amended: 10 June 2009	In force: 7 Feb. 2005	643	In force: 7 Feb. 2005
United States of America		In force: 9 Dec. 1980	288*	In force: 6 Jan. 2009
	X	In force: 6 April 1989	366[15]	
Uruguay[2]		In force: 17 Sept. 1976	157	In force: 30 April 2004
Uzbekistan		In force: 8 Oct. 1994	508	In force: 21 Dec. 1998
Vanuatu	*Approved: 8 Sept. 2009*	*Approved: 8 Sept. 2009*		*Approved: 8 Sept. 2009*
Venezuela[2]		In force: 11 March 1982	300	
Vietnam		In force: 23 Feb. 1990	376	Signed: 10 Aug. 2007
Yemen, Republic of	X	In force: 14 Aug. 2002	614	
Zambia	X	In force: 22 Sept. 1994	456	Signed: 13 May 2009
Zimbabwe	X	In force: 26 June 1995	483	

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2010) (cont.)

Key

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

This table does not aim at listing all safeguards agreements that the Agency has concluded. Not included are agreements whose application has been suspended in light of the application of safeguards pursuant to a CSA. Unless otherwise indicated, the safeguards agreements referred to are CSAs concluded pursuant to the NPT.

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

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

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

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

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

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

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

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

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

[8] The application of safeguards in Bulgaria under the NPT safeguards agreement INFCIRC/178, in force since 29 February 1972, was suspended on 1 May 2009, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Bulgaria had acceded, entered into force for Bulgaria.

[9] The date refers to a safeguards agreement pursuant to Article 13 of the Treaty of Tlatelolco. Upon approval by the Board of Governors, an exchange of letters entered into force (for Chile on 9 September 1996; for Colombia on 13 June 2001; for Panama on 20 November 2003) confirming that the safeguards agreement satisfies the requirement of Article III of the NPT.

[10] The application of safeguards in Cyprus under the NPT safeguards agreement INFCIRC/189, in force since 26 Jan. 1973, was suspended on 1 May 2008, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193) to which Cyprus had acceded, entered into force for Cyprus.

[11] The application of safeguards in the Czech Republic under the NPT safeguards agreement INFCIRC/541, in force since 11 September 1997, was suspended on 1 October 2009, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193) to which the Czech Republic had acceded, entered into force for the Czech Republic.

[12] The application of safeguards in Denmark under the bilateral NPT safeguards agreement INFCIRC/176, in force since 1 March 1972, was suspended on 5 April 1973, on which date the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Denmark had acceded, entered into force for Denmark. Since 1 May 1974, that agreement also applies to the Faroe Islands. Upon Greenland's secession from Euratom as of 31 Jan. 1985, the agreement between the Agency and Denmark (INFCIRC/176) re-entered into force for Greenland.

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

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

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

[16] 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.

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

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

[19] Pending entry into force, the additional protocol is applied provisionally for Iraq as of 17 February 2010.

[20] The application of safeguards in Latvia under the bilateral NPT safeguards agreement INFCIRC/434, in force since 21 December 1993, was suspended on 1 October 2008, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Latvia had acceded, entered into force for Latvia.

[21] The application of safeguards in Lithuania under the bilateral NPT safeguards agreement INFCIRC/413, in force since 15 October 1992, was suspended on 1 January 2008, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Lithuania had acceded, entered into force for Lithuania.

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

[23] 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.

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

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

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

[27] The application of safeguards in Romania under the NPT safeguards agreement INFCIRC/180, in force since 27 October 1972, was suspended on 1 May 2010, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193) to which Romania had acceded, entered into force for Romania.

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

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

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

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

[32] The SQP ceased to be operational upon entry into force of the amendments to the SQP.

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

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Afghanistan			P		Sr	Sr						P	X	
*	Albania	P		P		P	P						P	X	X
*	Algeria			Pr	CS	Pr	Pr		S				P	X	X
	Andorra			Pr											
*	Angola					P							P		
	Antigua Barbuda			P	CS										
*	Argentina	P	P	Pr		Pr	Pr	S	P	P	P	CS	P	X	X
*	Armenia		P	P		P	P		P				P		
*	Australia	P		P	CS	Pr	Pr		P	P		S			
*	Austria			Pr	CS	P	Pr		Pr	P				X	X
*	Azerbaijan			Pr									S		
	Bahamas			Pr											
*	Bahrain			Pr	CS										
*	Bangladesh			P		P	P		P				P		
	Barbados														
*	Belarus	Pr	P	Pr		Pr	Pr		P	P	P		P	X	X
*	Belgium	Pr		Pr		P	P	S	P	P					
*	Belize												P		
*	Benin	P											P		
	Bhutan														
*	Bolivia	P	P	P		Pr	Pr						P		
*	Bosnia-Herzogovina	Pr	P	P	CS	P	P		P				P		
*	Botswana			P									P		
*	Brazil	P	P	P		P	P		P	P			P	X	X
	Brunei														
*	Bulgaria	Pr	P	P	CS	P	P	P	P	P			P	X	X
*	Burkina Faso			P									P		
*	Burundi														
*	Cambodia			P											
*	Cameroon	P	P	P		P	P	P					P		
*	Canada	Pr		P		Pr	Pr		P	P				X	X

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	Cape Verde			P											
*	Cent. Afr. Rep.			P											
*	Chad														
*	Chile	Pr	Pr	P	CS	P	P	P	P				P		
*	China	Pr		Pr	CS	Pr	Pr		P	Pr			P		
*	Colombia	P	S	P		P	Pr						P		
	Comoros			P											
*	Congo														
*	Costa Rica			P		P	P						P		
*	Côte d'ivoire					S	S						P		
*	Croatia	P	P	P	CS	P	P	P	P	P			P	X	X
*	Cuba	Pr	P	Pr		Pr	Pr		S				P		
*	Cyprus	P		Pr		P	P		P	P			P		
*	Czech Republic	P	P	P	CS	P	P	P	P	P	S	S	P	X	X
	DPRK					Sr	Sr								
*	Dem. Rep. Congo	P		P		S	S						P		
*	Denmark	Pr		P	CSr	P	Pr	P	Pr	Pr				X	X
	Djibouti			P											
	Dominica			P											
*	Dominican Rep.			P		P							P		
*	Ecuador	P		P									P		
*	Egypt	P	P			Pr	Pr	P	S				P		
*	El Salvador			Pr		Pr	Pr						P	X	
	Eq. Guinea			P											
*	Eritrea														
*	Estonia	P	P	P	CS	P	P	P	P	P			P	X	X
*	Ethiopia												P	X	
	Fiji			P	CS										
*	Finland	P		Pr		P	Pr	P	P	P				X	X
*	France			Pr		Pr	Pr	S	P	P				X	X
*	Gabon			P	CS	P	P			P			P		

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	Gambia														
*	Georgia			P		P				P			P		
*	Germany	Pr		Pr	CS	Pr	Pr	P	P	P				X	X
*	Ghana	P		P					S				P		
*	Greece	P		Pr		Pr	Pr	P	P	P			P	X	X
	Grenada			P											
*	Guatemala			Pr		P	P						P		
	Guinea			P											
	Guinea-Bissau			P											
	Guyana			P											
*	Haiti			S									P		
*	Holy See	P				S	S							X	X
*	Honduras			P									P		
*	Hungary	Pr	P	P	CS	P	P	P	P	P	S		P	X	X
*	Iceland	P		P		P	P		P	P			P	X	X
*	India	P		Pr	CS	Pr	Pr		P			S			
*	Indonesia	Pr		Pr	CS	Pr	Pr		P	S	S	S	P		
*	Iran, Isl. Rep. of	P				Pr	Pr						P		X
*	Iraq	P				Pr	Pr						P		
*	Ireland	P		Pr		P	Pr		P	P			P	X	X
*	Israel		Sr	Pr		Pr	Pr		S				P		
*	Italy	Pr		Pr		Pr	Pr	P	P	P	S	S		X	X
*	Jamaica	P		P									P		
*	Japan	P		P		P	Pr		P	Pr				X	X
*	Jordan	Pr		Pr	CS	P	P		P				P		
*	Kazakhstan	P		P		P	P		P	P			P		
*	Kenya			P	CS								P		X
	Kiribati														
*	Korea, Rep. of	Pr		Pr		P	Pr		P	P			P	X	X
*	Kuwait	P		Pr		P	P		P				P		
*	Kyrgyzstan									P			P		

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	Lao P. Dem. Rep.			Pr											
*	Latvia	P	P	P	CS	P	P	P	P	P	P		P	X	X
*	Lebanon		P	P		P	P		P	S	S	S	P		
*	Lesotho			P									P		
*	Liberia														
*	Libyan Arab J.			P	CS	P	P		P				P	X	
*	Liechtenstein			P	CS	P	P							X	X
*	Lithuania	P	P	P	CS	P	P	P	P	P	S	S	P	X	X
*	Luxembourg	Pr		Pr		P	P		P	P				X	X
*	Madagascar			P									P		
*	Malawi														
*	Malaysia					Pr	Pr						P		
	Maldives														
*	Mali			P	CS	P	P		P				P		
*	Malta			P					P				P	X	X
*	Marshall Islands			P											
*	Mauritania			P	CS								P		
*	Mauritius	P				Pr	Pr						P		
*	Mexico	Pr	P	P		P	P		P				P	X	
	Micronesia														
*	Monaco			P		Pr	Pr		S					X	X
*	Mongolia	P		P		P	P						P		
*	Montenegro	P	P	P		P	P			P			P		
*	Morocco	Pr	S	P		P	P	S	S	P	P	CS	P	X	
*	Mozambique			Pr		P	P								
*	Myanmar					Pr							P	X	X
*	Namibia			P									P		
	Nauru			P	CS										
*	Nepal														
*	Netherlands	P		Pr		Pr	Pr	P	P	P				X	X
*	New Zealand	P		P		P	Pr								

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Nicaragua	P		P		Pr	Pr		S				P		
*	Niger	P	P	P	CS	S	S						P		
*	Nigeria	P	P	P	CS	P	P		P	P			P		
	Niue			P											
*	Norway	P		Pr	CS	P	Pr	P	P	P					
*	Oman	Pr		Pr		Pr	Pr						P		
*	Pakistan	Pr		Pr		Pr	Pr		P				P	X	X
*	Palau			P											
*	Panama			P		P	P						P	X	
	Papua New Guinea														
*	Paraguay			P		S	S						P		
*	Peru		P	Pr		Pr	Pr		P	S	S	S	P	X	X
*	Philippines	P	P	P		P	P	S	S	S	S	S	P		
*	Poland	P	P	P	CS	P	P	P	P	P	P		P	X	X
*	Portugal	Pr		Pr	CS	P	P	S	P	P			P		
*	Qatar			Pr		P	P						P		
*	Rep. of Moldova	Pr	P	P	CS	P	P		P	Pr			P		
*	Romania	Pr	P	Pr	CS	Pr	Pr	P	P	P	P	CS	P	X	X
*	Russian Federation	Pr	P	P	CS	Pr	Pr		P	P					
	Rwanda			P											
	St Kitts Nevis			P											
	Saint Lucia														
	St Vinct Grn.		P			P	P	P							
	Samoa														
	San Marino														
	Sao Tome Príncipe														
*	Saudi Arabia			Pr		Pr	Pr		P				P		
*	Senegal	P	P	P		P	P		P	P			P		
*	Serbia	P	P	P		P	P						P		
*	Seychelles			P	CS								P		
*	Sierra Leone					S	S						P		

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Singapore	Pr				P	P		P				P		
*	Slovakia	P	P	P		Pr	Pr	P	P	P			P	X	X
*	Slovenia	P		P	CS	P	P	P	P	P			P	X	X
	Solomon Islands														
	Somalia														
*	South Africa	Pr		Pr		Pr	Pr		P	P			P		
*	Spain	P	S	Pr	CS	Pr	Pr	S	P	P			P	X	X
*	Sri Lanka					Pr	Pr		P				P		
*	Sudan			P		S	S		S				P		
	Suriname														
	Swaziland			P											
*	Sweden	P		Pr		P	Pr	P	P	P				X	X
*	Switzerland	Pr		Pr	CS	P	P	S	P	P				X	X
*	Syrian Arab Rep.	P				S	S		S				P		X
*	Tajikistan	P		P						P			P		
*	Thailand	Pr				Pr	Pr						P		
*	TFYR Macedonia		P	P		P	P		P	P			P		
	Timor Leste														
	Togo			P											
	Tonga			P											
	Trinidad Tobago		P	P											
*	Tunisia	P		P	CS	P	P		P				P	X	X
*	Turkey	Pr		Pr		Pr	Pr	P	P				P	X	X
	Turkmenistan			P	CS										
	Tuvalu														
*	Uganda			P									P		
*	Ukraine	Pr	P	P	CS	Pr	Pr	P	Pr	P	S	S	P	X	X
*	Utd Arab Emirates			P	CS	Pr	Pr		P	P			P		
*	United Kingdom	P	S	Pr	CS	Pr	Pr	S	P	P				X	X
*	Utd Rep. Tanzania			P		P	P						P		
*	USA			P		Pr	Pr		P	P		CSr			

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.a of the Agency's Statute (status as of 31 December 2010) (cont.)

	STATE	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Uruguay		P	P		P	P	P	P	P			P		
*	Uzbekistan			P						P			P		
	Vanuatu														
*	Venezuela												P		
*	Vietnam	P				Pr	Pr		P				P		
*	Yemen			P											
*	Zambia												P		
*	Zimbabwe					S	S						P		
	Euratom			Pr		Pr	Pr		Pr	P					
	FAO					Pr	Pr								
	WHO					Pr	Pr								
	WMO					Pr	Pr								

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

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

Agreement on the Privileges and Immunities of the IAEA (reproduced in INFCIRC/9/Rev. 2). In 2010, one State became Party to the Agreement. By the end of the year, there were 82 Parties.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2010, the status remained unchanged with 36 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2010, the status remained unchanged with two Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2010, three States became Party to the Convention. By the end of the year, there were 145 Parties.

Amendment to the Convention on the Physical Protection of Nuclear Material. Adopted on 8 July 2005. In 2010, 12 States adhered to the Amendment, bringing the total to 45 States.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2010, three States became Party to the Convention. By the end of the year, there were 109 Parties.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (reproduced in INFCIRC/336). Entered into force on 26 February 1987. In 2010, one State became Party to the Convention. By the end of the year, there were 105 Parties.

Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (reproduced in INFCIRC/402). Entered into force on 27 April 1992. In 2010, the status remained unchanged with 26 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2010, five States became Party to the Convention. By the end of the year, there were 71 Parties.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (reproduced in INFCIRC/546). Entered into force on 18 June 2001. In 2010, six States became Party to the Convention. By the end of the year, there were 57 Parties.

Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/566). Entered into force on 4 October 2003. In 2010, one State became Party to the Protocol. By the end of the year, there were six Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Opened for signature on 29 September 1997. In 2010, one State signed the Convention. By the end of the year, there were four Contracting States and 14 Signatories.

Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA). In 2010, three States concluded an RSA. By the end of the year, there were 114 States party to an RSA.

Fourth Agreement to Extend the 1987 Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) (reproduced in INFCIRC/167/Add.22). Entered into force on 26 February 2007 with effect from 12 June 2007. In 2010, the status remained unchanged with 15 Parties.

African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (Fourth Extension) (reproduced in INFCIRC/377). Entered into force on 4 April 2010. In 2010, 21 States became Party to the Agreement. By the end of the year, there were 21 Parties.

Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) (reproduced in INFCIRC/582). Entered into force on 5 September 2005. In 2010, two States became Party to the Agreement. By the end of the year, there were 20 Parties.

Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) (First Extension) (reproduced in INFCIRC/613/Add.2). Entered into force on 29 July 2008. In 2010, two States became Party to the Agreement. By the end of the year, there were nine Parties.

Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/702). Entered into force on 24 October 2007. In 2010, the status remained unchanged with seven Parties.

Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/703). Entered into force on 24 October 2007. In 2010, the status remained unchanged with six Parties.

Table A9. Nuclear power reactors in operation and under construction in the world (as of 31 December 2010)[a]

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2009		Total operating experience through 2010	
	No. of units	Total MW(e)	No. of Units	Total MW(e)	Terawatt-hours (TW·h)	% of total	Years	Months
Argentina	2	935	1	692	7.6	7.0	64	7
Armenia	1	375			2.3	45.0	36	8
Belgium	7	5 934			45.0	51.7	240	7
Brazil	2	1 884	1	1 245	12.2	2.9	39	3
Bulgaria	2	1 906	2	1 906	14.2	35.9	149	3
Canada	18	12 569			85.3	14.8	600	2
China	13	10 048	27	27 230	65.7	1.9	111	2
Czech Republic	6	3 678			25.7	33.8	116	10
Finland	4	2 716	1	1 600	22.6	32.9	127	4
France	58	63 130	1	1 600	391.8	75.2	1 758	4
Germany	17	20 490			127.7	26.1	768	5
Hungary	4	1 889			14.3	43.0	102	2
India	19	4 189	6	3766	14.8	2.2	337	3
Iran, Islamic Republic of			1	915				
Japan	54	46 823	2	2 650	263.1	29.2	1 494	8
Korea, Republic of	21	18 665	5	5 560	141.1	34.8	360	1
Mexico	2	1 300			10.1	4.8	37	11
Netherlands	1	487			4.0	3.7	66	0
Pakistan	2	425	1	300	2.6	2.7	49	10
Romania	2	1 300			10.8	20.6	17	11
Russian Federation	32	22 693	11	9 153	152.8	17.8	1026	5
Slovakia	4	1 762	2	782	13.1	53.5	136	7
Slovenia	1	666			5.5	37.8	29	3
South Africa	2	1 800			11.6	4.8	52	3
Spain	8	7 514			50.6	17.5	277	6
Sweden	10	9 303			50.0	37.4	382	6
Switzerland	5	3 238			26.3	39.5	179	11
Ukraine	15	13 107	2	1900	78.0	48.6	383	6
United Kingdom	19	10 137			62.9	17.9	1 476	8
United States of America	104	100 747	1	1 165	796.9	20.2	3 603	11
Total[b, c]	**441**	**374 682**	**66**	**63 064**	**2 558.3**	**NA**	**14 353**	**4**

NA: not applicable.

[a] Data are from the Agency's Power Reactor Information System (*http://www.iaea.org/pris*).

[b] The total includes the following data from Lithuania and Taiwan, China:
Lithuania: 100 TW·h of nuclear electricity generation, representing 76.2% of the total electricity generated;
Taiwan, China: 6 units, 4980 MW in operation; 2 units, 2600 MW under construction; 39.9 TW·h of nuclear electricity generation, representing 20.7% of the total electricity generated.

[c] The total operating experience also includes shutdown plants in Italy (81 years), Kazakhstan (25 years, 10 months), Lithuania (43 years, 6 months), and Taiwan, China (170 years, 1 month).

Table A10. Integrated Regulatory Review Service (IRRS) missions in 2010	
Type	**Country**
IRRS	China
IRRS	Islamic Republic of Iran
IRRS	United States of America
IRRS Follow-up	Ukraine

Table A11. Advisory Missions on the Regulatory Infrastructure for the Control of Radioactive Sources in 2010	
Type	**Country**
Advisory Mission	Brunei Darussalam
Advisory Mission	Cambodia
Advisory Mission	Democratic Republic of the Congo
Advisory Mission	Lao People's Democratic Republic
Advisory Mission	Lesotho
Advisory Mission	Malawi
Advisory Mission	Mauritania
Advisory Mission	South Africa

Table A12. Operational Safety Review Team (OSART) missions in 2010		
Type	**Nuclear power plant**	**Country**
OSART	Doel	Belgium
OSART	St. Alban	France
OSART	Bohunice	Slovakia
OSART	Ringhals	Sweden
OSART Follow-up	Cruas	France
OSART Follow-up	Mihama	Japan
OSART Follow-up	Balakovo	Russian Federation
OSART Follow-up	Oskarshamn	Sweden
OSART Follow-up	Rovno Units 3 and 4	Ukraine
OSART Follow-up	Arkansas	United States of America

Table A13. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2010		
Type	**Organization/Nuclear power plant**	**Country**
PROSPER Follow-up	Sizewell A	United Kingdom

Table A14. Safe Long Term Operation (SALTO) missions in 2010		
Type	**Organization/Nuclear power plant**	**Country**
SALTO	Atucha 1	Argentina
SALTO Follow-up	Kori 1	Republic of Korea

Table A15. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2010

Type	Location	Country
INSARR	ETTR-1	Egypt
INSARR	ETTR-2, AEA	Egypt
INSARR	JAEC	Jordan
INSARR	HFR, NRG	Netherlands
INSARR	KACST	Saudi Arabia
INSARR	SAEC	Sudan
INSARR Follow-up	Halden RR	Norway

Table A16. Emergency Preparedness Review (EPREV) missions in 2010

Type	Country
EPREV	Azerbaijan
EPREV	Belarus
EPREV	Philippines
EPREV	Romania
EPREV	Thailand
EPREV Follow-up	Qatar

Table A17. International Nuclear Security Advisory Service (INSServ) missions in 2010

Type	Country
INSServ	Bolivia
INSServ	Burkina Faso
INSServ Follow-up	Uruguay

Table A18. International Physical Protection Advisory Service (IPPAS) missions in 2010

Type	Country
IPPAS	Cuba
IPPAS Follow-up	Slovenia

Table A19. IAEA SSAC Advisory Service (ISSAS) missions in 2010

Type	Country
ISSAS	Azerbaijan
ISSAS	Turkey

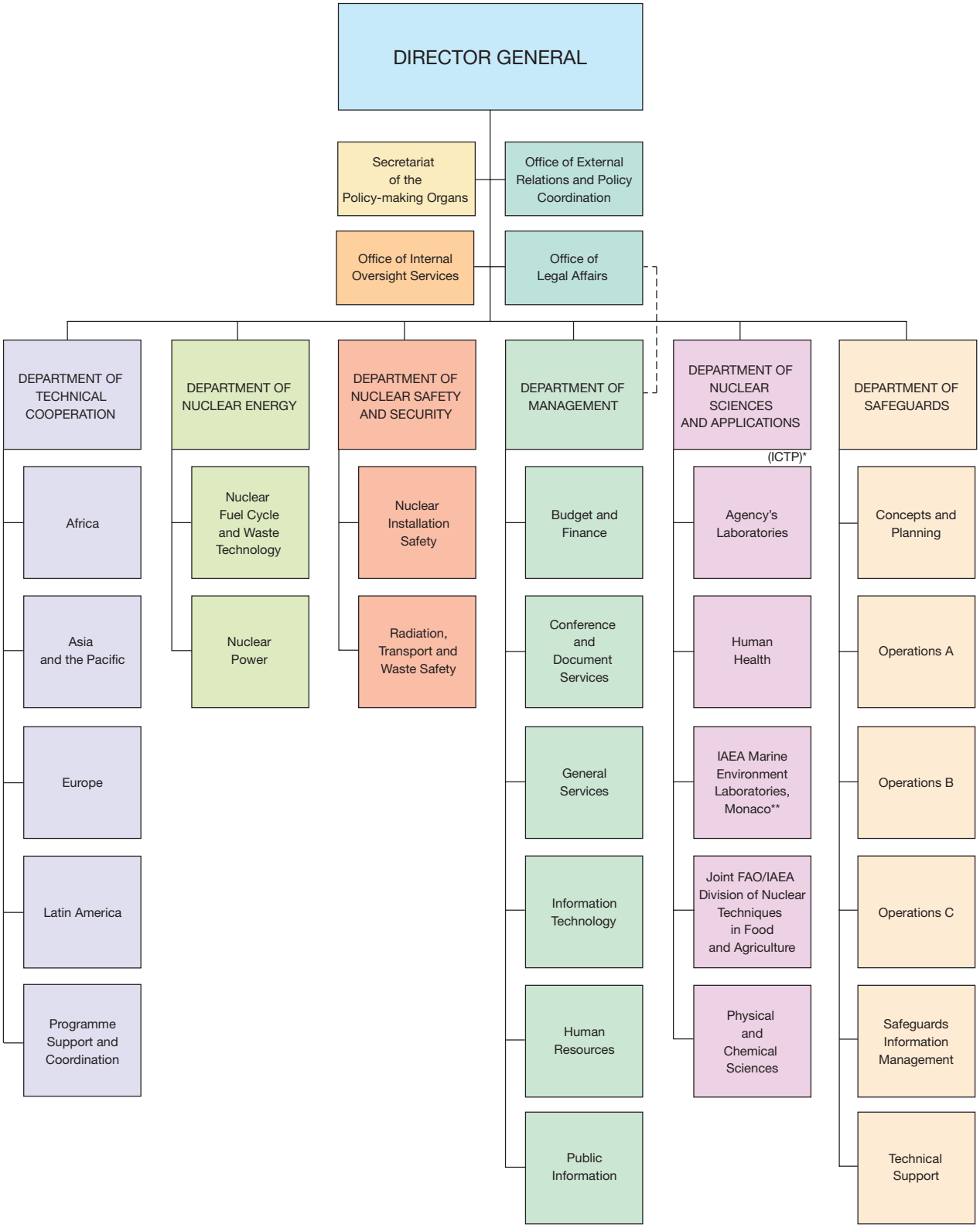
Table A20. International Probabilistic Safety Assessment Review Team (IPSART) missions in 2010

Type	Nuclear Power Plant	Country
IPSART	Borssele	Netherlands
IPSART Follow-up	Belene	Bulgaria

Table A21. International Team of Experts (ITE) missions in 2010	
Type	**Country**
ITE	Lesotho
ITE	Zambia

Organizational Chart

(as of 31 December 2010)



* The Abdus Salam International Centre for Theoretical Physics (Abdus Salam ICTP), legally referred to as the "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.

** 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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