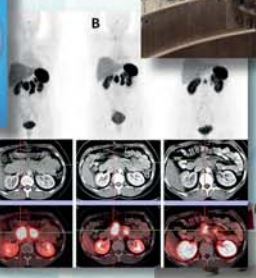
IAEA ANNUAL REPORT 2012












IAEA
International Atomic Energy Agency

IAEA Annual Report 2012

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 2012.

GC(57)/3

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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 2012)

158 Member States.

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

55 years of international service.

2474 professional and support staff.

€327 million total regular budget for 2012.[1] Extrabudgetary expenditures in 2012 totalled **€82.8 million** (including open purchase orders from previous years).

€62.3 million target in 2012 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **3250** expert and lecturer assignments, **4880** national experts, meeting participants and other project personnel, **3117** participants in training courses and **1675** 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) and research centres.

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

4 regional agreements relating to nuclear science and technology.

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

114 active CRPs involving **1547** approved research, technical and doctoral contracts and research agreements. In addition, **76** Research Coordination Meetings were held.

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

179 States in which safeguards agreements were being implemented[2,3], of which **119** States had additional protocols in force, with **1965** safeguards inspections performed in 2012. Safeguards expenditures in 2012 amounted to **€121.2 million** in regular budget and **€25.5 million** in extrabudgetary resources.

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

2.7 million people read more than **17 million** pages on the Agency's *iaea.org* site, and viewed stories on the Agency's *Facebook* site over **12.7 million** times.

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

1 million documents, technical reports, standards, conference proceedings, journals and books in the IAEA Library and **15 540** visitors to the Library in 2012.

211 publications, brochures, leaflets, newsletters and other promotional material issued in 2012 (in print and electronic formats).

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1 At the UN average rate of exchange of $1.2858 to €1.00. The total budget was € 341.5 million at the $1.00 to €1.00 rate.

2 The 179 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 And Taiwan, China.

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 2012*.

In the area of safety and security, the Board kept implementation of the IAEA Action Plan on Nuclear Safety, approved in 2011, under review throughout the year. The Board discussed the *Nuclear Safety Review for the Year 2012* and also debated the *Nuclear Security Report 2012*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2011*. 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 2011* and approved the Agency's technical cooperation programme for 2013.

Composition of the Board of Governors (2012–2013)

Chairperson:

HE Mr John BARRETT
Ambassador
Governor from Canada

Vice-Chairpersons:

HE Mr Pál KOVÁCS
Minister of State for Climate Change and Energy
Governor from Hungary

HE Mr Xolisa Mfundiso MABHONGO
Ambassador
Governor from South Africa

Algeria
Argentina
Australia
Belgium
Brazil
Bulgaria
Canada
China
Costa Rica
Cuba
Egypt
France
Germany
Greece
Hungary
India
Indonesia
Italy
Japan
Korea, Republic of
Libya
Mexico
Nigeria
Norway
Pakistan
Poland
Russian Federation
Saudi Arabia
South Africa
Sweden
Thailand
United Kingdom of Great Britain and Northern Ireland
United Republic of Tanzania
United States of America
Uruguay

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 and the Agency's activities during the previous year, approves the Agency's financial statements 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 2012, the Conference — upon the recommendation of the Board — approved Fiji, San Marino and Trinidad and Tobago for membership of the Agency. At the end of 2012, the Agency's membership was 158.

Notes

- The *IAEA Annual Report 2012* 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 2012–2013* (GC(55)/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 for 2012 and Background to the Safeguards Statement*.

- Additional information covering various aspects of the Agency's programme is available, in electronic form only, on *iaea.org*, along with the *Annual Report*.

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

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

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

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

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
Abdus Salam ICTP	Abdus Salam International Centre for Theoretical Physics
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
BWR	Boiling water reactor
CRP	Coordinated research project
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ESTRO	European Society for Radiotherapy and Oncology
Euratom	European Atomic Energy Community
Europol	European Police Office
FAO	Food and Agriculture Organization of the United Nations
FORATOM	European Atomic Forum
GEF	Global Environment Facility
HEU	High enriched uranium
ICAO	International Civil Aviation Organization
ICPO–INTERPOL	International Criminal Police Organization–INTERPOL
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
IEA	International Energy Agency (OECD)
ILO	International Labour Organization
INFCIRC	Information Circular (IAEA)
INIS	International Nuclear Information System
INPRO	International Project on Innovative Nuclear Reactors and Fuel Cycles
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IRPA	International Radiation Protection Association
ISO	International Organization for Standardization
LEU	Low enriched uranium

LMFR	Liquid metal fast reactor
LWR	Light water reactor
NATO	North Atlantic Treaty Organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OECD	Organisation for Economic Co-operation and Development
OECD/NEA	OECD Nuclear Energy Agency
OPEC	Organization of the Petroleum Exporting Countries
OSCE	Organization for Security and Co-operation in Europe
PAHO	Pan American Health Organization
PHWR	Pressurized heavy water reactor
PWR	Pressurized water reactor
RBMK	High-power channel-type reactor
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SAL	Safeguards Analytical Laboratory (IAEA)
SQ	Significant quantity
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNOPS	United Nations Office for Project Services
UNSC	United Nations Security Council
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization
WMO	World Meteorological Organization
WNA	World Nuclear Association
WWER	Water cooled water moderated energy reactor

OVERVIEW

The International Atomic Energy Agency continued to play an important role in 2012. Consistent with its statutory mandate "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world", the Agency focused on: developing and transferring nuclear technologies for peaceful purposes to its Member States; contributing to the strengthening of the global nuclear safety framework and strengthening the security of nuclear material and facilities; and guarding against the proliferation of nuclear weapons. This overview surveys the state of the 'nuclear world' in 2012 from the perspective of the Agency.

NUCLEAR TECHNOLOGY

Nuclear Power

Status and trends

At the end of 2012, there were 437 nuclear power reactors in operation worldwide, with a total capacity of 372.1 gigawatts-electric (GW(e)), 1% more than at the beginning of the year. Only three reactors were permanently shut down. This compares with 13 permanent shutdowns in 2011 (12 of which were shut down in the aftermath of the accident at the Fukushima Daiichi nuclear power plant (the Fukushima Daiichi accident)).

Sixty-seven new reactors were under construction around the world at the end of the year. There were three new connections to the grid: Ningde-1 in China, and Shin-Wolsong-1 and Shin-Kori-2 in the Republic of Korea. In addition, two laid-up units, Bruce 1 and 2, were reconnected in Canada. Seven construction starts were recorded in 2012: Fuqing-4, Shidaowan-1, Tianwan-3 and Yangjiang-4 in China, Shin-Ulchin-1 in the Republic of Korea, Baltiisk-1 in the Russian Federation, and Barakah-1 in the United Arab Emirates (UAE).

The impact of the Fukushima Daiichi accident continued to be felt in 2012, slowing the expansion of nuclear power. However, Agency projections indicate significant growth in the use of nuclear energy worldwide — between 23 and 100% by 2030 — although its projections for 2030 are up to 9% lower than those made in 2011. Capacity is now expected to grow to 456 GW(e) in 2030 in the Agency's low projection and 740 GW(e) in the high projection. Growth is still centred in Asia, where 47 of the 67 reactors under construction are located, and in countries that already have operating nuclear power plants.

Rio+20 and the extension of the Kyoto Protocol

The United Nations Conference on Sustainable Development (also referred to as 'Rio+20'), was held in June in Rio de Janeiro, Brazil, to review the progress made in sustainable development. The Rio+20 outcome document, *The Future We Want*, addresses several priority issues, including access to clean energy for everyone and ensuring that the energy produced does not contribute to climate change. The presentations on nuclear energy emphasized its low carbon source, which minimizes the greenhouse gases (GHGs) emitted in energy generation and mitigates the negative impact of climatic disruption on development.

"...Agency projections indicate significant growth in the use of nuclear energy worldwide — between 23 and 100% by 2030..."

In November–December, the 18th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-18) took place in Doha, Qatar, together with the 8th session of the Conference of the Parties to the Kyoto Protocol. The Parties to the Kyoto Protocol agreed to a second commitment period from 2013 to 2020. Without this commitment, the world would have had no international agreement limiting GHG emissions and nuclear power's very low emissions would have less economic value.

Support to existing nuclear power programmes

There is continuing interest around the world in the long term operation of existing nuclear power plants. Thus, the trends of uprating the power

of these plants and of renewing or extending the licences of operating reactors continued in many countries. For example, the French Nuclear Safety Authority granted a ten year renewal of the operating licence for unit 2 of the Bugey nuclear power plant. In the United Kingdom, the Nuclear Decommissioning Authority was given permission to continue operating Wylfa-1 until September 2014 by transferring partially used fuel from unit 2. In the USA, six uprate applications were approved by the Nuclear Regulatory Commission (NRC).

The Agency organized the third International Conference on Nuclear Power Plant Life Management in Salt Lake City, Utah, USA, in May, with the sponsorship of the US Department of Energy and the NRC. The participants discussed ways to extend the life of operating nuclear power plants safely and cost effectively in a 'post-Fukushima world'.

"...the Agency has been helping interested Member States increase their capabilities in analysing and planning national energy systems."

In September, at the second meeting of the Nuclear Operating Organizations Cooperation Forum, an initiative launched by the Agency in 2011, the participants shared operating experience and management strategies to help strengthen the effectiveness of nuclear operating organizations.

Launching nuclear power programmes

Countries with growing energy requirements continue to retain nuclear power as an important option to increase electricity production. Important steps taken by countries planning to introduce nuclear power included those of the UAE, which became the first country in 27 years to start construction of a first nuclear power plant. The Emirates Nuclear Energy Corporation poured the first concrete for the Barakah-1 unit after receiving a construction licence from the Federal Authority for Nuclear Regulation. This plant is scheduled to become operational in 2017, with three additional units planned for operation by 2020.

Several other countries took steps in 2012 towards constructing their first nuclear power plant. In June, Belarus hosted an Agency Integrated Nuclear Infrastructure Review (INIR) mission. In July, Belarus signed a general contract for two WWER units from the Russian Federation. Turkey is also moving forward with its programme: after having signed a contract in 2010 to build four WWER-1200 units at the Akkuyu site, it announced plans to build a second nuclear power plant at Sinop. Other countries have confirmed their intention to proceed with the development of a national nuclear power programme; they have continued building infrastructure and are considering possible contractual arrangements. Some other Member States are actively preparing for a nuclear power programme, but have not taken a final decision.

Two other INIR missions were conducted in 2012, to Jordan and Vietnam. The INIR mission to Jordan in January was a follow-up visit to review the country's plans, developed in response to the recommendations from the first INIR mission in 2009. The mission noted that progress had been made since 2009, especially in activities related to the nuclear power plant project. The INIR mission to Vietnam was conducted in December. The mission found that the programme for introducing nuclear power enjoyed strong government support and recognized the progress achieved, including preparations for the construction of the Ninh Thuan Nuclear Power Project.

Energy assessment services

Designing appropriate national energy strategies to meet development needs and to provide sustainable modern energy services is becoming increasingly complex owing to the growing number of factors influencing energy choices. A comprehensive evaluation of all possible energy supply and demand options in terms of social, economic and environmental impacts is required. Since many Member States, particularly developing countries, lack the expertise and experience to undertake such a task, the Agency has been helping interested Member States increase their capabilities in analysing and planning national energy systems. For those with operating or planned nuclear power programmes, the Agency provides technical support for long term strategic planning of nuclear energy systems.

In 2012, the Agency's tools for analysing and planning national energy systems were used in more than 125 Member States. Over 650 energy analysts and planners from 69 countries were trained in the use of Agency tools for analysing and planning national

energy systems. For long term strategic planning of nuclear energy systems, the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) provides a methodology, training and assistance in conducting Nuclear Energy System Assessments (NESAs). In 2012, Belarus completed such an assessment, while NESAs for Indonesia and Ukraine are continuing. A 'NESA Support Package' for Member State assessments included an e-learning course on the INPRO methodology.

In 2012, INPRO launched SYNERGIES (Synergetic Nuclear Energy Regional Group Interactions Evaluated for Sustainability). The goal of this project is to identify and evaluate frameworks for globally sustainable nuclear energy systems.

Capacity building

Recruiting a high calibre nuclear workforce for the operation of nuclear power plants is a growing challenge, even for existing nuclear power programmes, because of retirements combined with increasing global demand for qualified staff. Planning the nuclear workforce of the future begins up to ten years before the trained personnel are needed. Also, continuous education and succession planning to take account of turnover is essential. In 2012, the Agency launched a self-assessment methodology to assist Member States in reviewing the adequacy of their existing national capacity building arrangements, and in strengthening them as necessary.

The preservation and management of nuclear knowledge is also a high priority for many Member States. In 2012, the Agency conducted Knowledge Management Assist Visits and workshops in Belarus, Estonia, the UAE and the United Republic of Tanzania. The goal was to increase awareness of the importance of knowledge management in the daily operations of nuclear organizations and to help managers to identify, using methods developed by the Agency, the staff positions most critical in terms of knowledge. Nuclear Energy Management Schools for young professionals from the nuclear sector were held at the Abdus Salam ICTP in Trieste, Italy, in Japan and in the UAE. Additionally, Nuclear Knowledge Management Schools were conducted in Trieste, the Russian Federation and Ukraine to share best practices.

Assurance of supply

In December 2010, the Board of Governors approved the establishment of the IAEA LEU bank. During 2012, the Secretariat continued work on the financial, legal and technical arrangements and site assessments for establishing the fuel bank, which will be located at the Ulba Metallurgical Plant in Kazakhstan. Pledges in excess of $150 million have been made by Member States, the European Union and the Nuclear Threat Initiative (NTI) for the establishment of the LEU bank. By the end of 2012, pledges had ben fully paid by Kuwait ($10 million), Norway ($5 million), the USA (approximately $50 million) and the NTI ($50 million). The European Union had paid €20 million of its pledged €25 million, and arrangements were being finalized with the UAE for its pledge ($10 million).

"In 2012, the Agency launched a self-assessment methodology to assist Member States in reviewing the adequacy of their existing national capacity building arrangements, and in strengthening them as necessary."

Uranium resources

The uranium production cycle, involving exploration, mining and processing technology, and appropriate closure, is an important element in the sustainability of nuclear energy. In addition, the environmental and social impacts have to be minimized through good practices at all stages of the cycle. The 2011 edition of the 'Red Book', *Uranium 2011: Resources, Production and Demand*, issued jointly by the OECD/Nuclear Energy Agency and the Agency, identified conventional uranium resources recoverable at a cost of less than $130/kg U at 5.3 million tonnes of uranium (Mt U). Uranium production worldwide rose significantly, largely as a result of increased production in Kazakhstan. At the beginning of 2012, uranium spot prices were at $135/kg U, but finished the year at around $115/kg U. However, long term prices for uranium remained steady at around $158/kg U.

Small and medium sized reactors

Although the nuclear industry has historically pursued economies of scale, there is growing interest in small and medium sized reactors (SMRs)[1], partly because they require smaller investments and thus offer lower financial investment risks. Currently, approximately 45 innovative SMR concepts are at some stage of research and development. Two INPRO Dialogue Forums in 2012 brought together technology holders, users and other stakeholders to discuss how innovation in nuclear infrastructure and technology could contribute to the sustainability of nuclear energy.

Research reactors

Research reactors provide a neutron source for research and various other applications, including education and training, for the production of isotopes and for the irradiation of materials. They are small in comparison with power reactors since they do not produce electricity. As of the end of 2012, there were 247 operational research reactor facilities in the world. In addition, there were 15 research reactors in temporary shutdown mode and 150 in long term shutdown.

"The Agency continued to support efforts to minimize the civilian use of HEU ..."

As older research reactors are decommissioned and replaced by fewer, multipurpose, reactors, the number of operational research reactors is expected to continue to decrease. In 2012, existing research reactor regional networks or coalitions, facilitated by the Agency[2], helped foster greater international cooperation and assisted research reactors in expanding their stakeholder base.

The Agency continued to support efforts to minimize the civilian use of HEU, including the conversion of the Maria research reactor in Poland, and the conversion and fuel repatriation of the TRIGA research reactors operated in Austria and Mexico. The efforts in Austria and Mexico marked the removal of all TRIGA HEU fuel from civilian nuclear applications worldwide. Repatriation shipments of all Russian origin research reactor fuel were also completed from Poland, Ukraine and Uzbekistan.

A new Agency service, the Operation and Maintenance Assessments for Research Reactors (OMARR) service, was launched to: conduct peer reviews of research reactor facilities; verify compliance with existing plant procedures; suggest areas of improvement; and facilitate mutual transfer of knowledge and experience between mission experts and reactor personnel. The first OMARR mission was completed in December at the reactor of the US National Institute of Standards and Technology (NIST) Center for Neutron Research.

Molybdenum-99

During 2012, the supply shortages of the past several years finally abated and production levels returned to normal, although questions remain regarding medium to long term supply. The conversion of medical isotope production processes from HEU to LEU continued with a renewed focus during this period. Australia announced the expansion of its LEU molybdenum-99 production capability, to meet approximately 25% of global demand. South Africa continued its commercial production of molybdenum-99 made from LEU targets as well as the conversion of its processes to the exclusive use of LEU, while two major medical isotope producers (Belgium and the Netherlands) also started implementation of plans to convert their commercial scale production processes from HEU to LEU.

Applications of Nuclear Technology

The application of nuclear technologies in the areas of food security, disease prevention and control, water resources and environmental management has increasing importance in the world today. In 2012, the Agency strengthened its partnerships, responding to the world's food, environmental and cancer challenges by enhancing State and regional capacities to use relevant technologies for sustainable solutions.

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1 'Small' refers to reactors less than 300 MW(e). 'Medium sized' refers to reactors between 300 and 700 MW(e).

2 The Agency has set up research reactor coalitions in the following regions: the Baltic, the Caribbean (which includes participation from Latin America), Central Africa, Central Asia, Eastern Europe and the Mediterranean.

Status

The use of e-learning technology is becoming an important part of the Agency's capacity building activities, with almost all areas of nuclear applications making training materials available remotely to professionals in developing countries. This cost effective approach has been very well received. In addition, the IAEA Collaborating Centres scheme — currently numbering 20 centres — continued to be utilized effectively in 2012, and laboratory networks continued to enhance the contribution of nuclear applications to sustainable development. At the end of the year, there were 114 active CRPs in various nuclear fields, comprising more than 1500 research, technical or doctoral contracts, and research agreements with institutions in more than 100 Member States.

The 50th anniversary of the Agency's nuclear applications laboratories at Seibersdorf was marked with an interactive exhibit highlighting the work of the eight laboratories. A side event was also organized during the 56th General Conference.

In order to build on the achievements over the past half-century, a modernization plan is under way to ensure that the Agency's nuclear applications laboratories in Seibersdorf continue to provide optimum services to Member States.

Food and agriculture

Trypanosomosis, a disease that sickens and kills both livestock and people, is transmitted by the tsetse fly. The disease makes it particularly difficult to raise productive cattle in tsetse infested regions. Through a technical cooperation project, the Agency supports the Southern Rift Valley Tsetse Eradication Project (STEP) in Ethiopia's Rift Valley. Tsetse suppression activities have significantly reduced the prevalence of trypanosomosis in livestock in communities with about 116 000 farmers and 2.5 million cattle. The goal of STEP is to create a zone free of tsetse and trypanosomosis in an area covering 25 000 km^2 in the Southern Rift Valley to allow the introduction of mixed farming according to a land use plan being developed by the Ethiopian Government. In addition, this large project has developed the local infrastructure and capacity to mass rear sterile flies for the subsequent application of the sterile insect technique against two major tsetse species.

Determination of the genetic background (i.e. the DNA makeup) based on phenotypic characteristics of farm animals (i.e. those characteristics that can be seen) is a powerful tool for the improvement of productive performance and disease resistance. A 'Goat Radiation Hybrid Panel', which provides a resource for rapid and large scale physical mapping of the goat genome, was developed by the Agency. Now being distributed, the panel facilitates the phenotypic and genetic characterization of indigenous sheep and goat breeds in 16 Member States in Africa, Asia and Latin America. The panel also identifies molecular markers of economic interest, such as those related to improved productive performance, and markers related to improved resistance to infectious and metabolic diseases.

SCIENTIFIC FORUM 2012: FOOD FOR THE FUTURE

For nearly fifty years, applications of nuclear technology have been helping the world's farmers, contributing new varieties of crops, controlling pests, diagnosing livestock disease, improving soil and water management and increasing food safety. The Agency, working closely with FAO, has made these techniques available to farmers and food producers in developing countries.

The topic of the Scientific Forum at the 56th regular session of the General Conference in September addressed Agency activities in the fields of food production, food protection and food safety. The two day event on 'Food for the Future: Meeting the Challenges with Nuclear Applications' brought together experts and policy makers to consider how best to use nuclear techniques to increase food production, to control animal and plant diseases that threaten food supplies and to guard against food contamination.

The Forum was opened by the Agency's Director General and ministers from Indonesia, Kenya and Vietnam. The FAO Director-General, Mr. Graziano da Silva, delivered a video address. Each session featured a panel of experts who presented and discussed the benefits of nuclear techniques in food and agriculture.

Human health

In 2012, the Agency continued to improve and refine its educational resources in radiation medicine. The Human Health Campus, an educational web site for health professionals in radiation medicine, continues to receive great attention from practitioners in all Member States, including developed countries. Web based seminars (webinars) were tested as a new type of educational resource to provide Member States with regular material for strengthening and improving standards of practice. They will be conducted in partnership with major international scientific societies such as the Society of Nuclear Medicine and Molecular Imaging and the American Society of Nuclear Cardiology. Two webinars were conducted in 2012 with the attendance of 283 and 385 participants, respectively.

"An initiative called the 'Nuclear Medicine Global Initiative' was launched in 2012 to combat non-communicable diseases (NCDs) as a joint effort of the Agency and various scientific societies."

An initiative called the 'Nuclear Medicine Global Initiative' was launched in 2012 to combat non-communicable diseases (NCDs) as a joint effort of the Agency and various scientific societies. This initiative aims to promote health and better management of NCDs, such as cardiac diseases and cancers, by: promoting the use of nuclear medicine techniques, including molecular imaging; encouraging global collaboration in education and harmonization of procedures and guidelines; and improving quality and safety in the use of nuclear medicine.

Programme of Action for Cancer Therapy (PACT)

The Agency set up the Programme of Action for Cancer Therapy in 2004 to leverage the impact of global partnerships in cancer control and technology transfer in radiation medicine. For the first time, representatives of the eight PACT Model Demonstration Sites (PMDS) — Albania, Ghana, Mongolia, Nicaragua, Sri Lanka, United Republic of Tanzania, Vietnam and Yemen — met in Vienna in November with the Agency and its main partners in cancer control, including WHO, the International Agency for Research on Cancer and the Union for International Cancer Control, to review lessons learned and plan for the future.

The provision of the integrated missions of PACT (imPACT) as an Agency service to address Member State demand for comprehensive cancer control capacity and needs assessment continued to remain a priority. Thirteen Member States received imPACT missions in 2012, bringing the total number to 47 since PACT's inception.

The pilot project for Africa of the Virtual University for Cancer Control and Regional Training Network (VUCCnet) entered a new phase in 2012 with the adoption of a policy harmonization framework by the six participating Member States. The adoption of the framework illustrates the commitment of the Member States to establishing, operating and sustaining VUCCnet in the region, a major step towards addressing the critical shortage of cancer professionals in Africa.

Water resources

The water resources programme assists Member States in the use of nuclear and isotope techniques to accurately assess water resources in order to better manage them. In collaboration with counterparts from Argentina, Brazil and Argonne National Laboratory in the USA, the first measurements of the long lived radionuclide krypton-81 were conducted in 2012 in the Guarani transboundary aquifer, where water ages above 500 000 years were found in deep ground waters. The information gathered in this study has important implications for understanding and modelling water flow and transport in large sedimentary basins and for the management of water resources in similar systems.

The Agency released a new software package to facilitate isotope data processing and standardization in isotope hydrology laboratories in 2012. Additionally, a new, low cost and compact tritium enrichment system for measuring low levels of environmental tritium in water samples was built and is being evaluated for potential transfer to Member States.

Environment

Nuclear techniques have an important role to play in the management of the environment. Activities in capacity building and training in 2012 by the

IAEA Environment Laboratories in Monaco and Seibersdorf included the production of new Certified Reference Materials according to ISO Guides 34 and 35, running inter-comparison exercises and proficiency tests, preparing methodologies and manuals, organizing training courses, and backstopping national, regional and interregional technical cooperation projects.

In response to the global challenges of ocean acidification, the Agency launched a project to support the Ocean Acidification International Coordination Centre (OA-ICC) at the IAEA Environment Laboratories in Monaco. Announced at Rio+20 in June 2012, the OA-ICC project brings together stakeholders concerned with ocean acidification, including scientists and researchers, policy makers and academics, the media and the general public. Supported by the Peaceful Uses Initiative, a funding vehicle to support the Agency's work in the peaceful application of nuclear technology, the goal of the project is to coordinate international efforts that aim at developing response strategies to the growing threat of ocean acidification.

NUCLEAR SAFETY AND SECURITY

Nuclear Safety

Status and trends

The world nuclear community made noteworthy progress in strengthening nuclear safety in 2012. For example, an overwhelming majority of Member States with operating nuclear power plants have undertaken and essentially completed comprehensive safety reassessments ('stress tests') with the aim of evaluating the design and safety aspects of plant robustness to protect against extreme events. As a result, many have introduced additional safety measures including mitigation of station blackouts and construction of higher protective walls. As of the end of 2012, safety performance indicator data on the 437 operating nuclear power plants showed that the operational safety level remained high. Of these plants, 162 have been in operation for more than 30 years, and 22 have been in operation for more than 40 years. Thus, long term operation and ageing are ongoing challenges for regulators, operators and utilities. Additionally, there are growing expectations that older nuclear reactors should meet enhanced safety objectives that are closer to those of recent reactor designs. The Fukushima Daiichi accident has shown the importance of applying new safety knowledge to existing nuclear power plants throughout their lifetimes.

IAEA Action Plan on Nuclear Safety

The IAEA Action Plan on Nuclear Safety (the 'Action Plan') was adopted by all Member States at the 55th session of the General Conference in September 2011. Since its adoption, significant progress has been made in several key areas, such as assessments of safety vulnerabilities of nuclear power plants, strengthening of the Agency's peer review services, improvements in emergency preparedness and response capabilities, strengthening and maintaining capacity building, and widening the scope and enhancing communication and information sharing with Member States, international organizations and the public.

Significant progress has also been made in reviewing the Agency's safety standards, which have been widely applied by regulators, operators and the nuclear industry in general. The Agency has devoted greater attention to certain critical areas such as accident prevention, in particular severe accidents, and emergency preparedness and response. In addition, progress has been made in improving public information and enhancing transparency and communication during emergency situations.

"As of the end of 2012, safety performance indicator data on the 437 operating nuclear power plants showed that the operational safety level remained high."

The Agency also continued to share lessons learned from the Fukushima Daiichi accident with the nuclear community. Most notably, it convened three international experts meetings, on reactor and spent fuel safety, on communication in the event of a nuclear or radiological emergency, and on protection against extreme earthquakes and tsunamis.

In December 2012, the Fukushima Ministerial Conference on Nuclear Safety, organized by the Government of Japan in co-sponsorship with the Agency, was held in Fukushima Prefecture, Japan. The principal objective of the conference was to contribute to strengthening nuclear safety worldwide by providing another opportunity to share with the

international community, at the ministerial and expert levels, further knowledge and lessons learned from the Fukushima Daiichi accident, and to further enhance transparency, including the implementation of the Action Plan. The Conference provided yet another opportunity for the international community to reconfirm the importance of nuclear safety and to maintain and enhance the momentum towards strengthening nuclear safety worldwide. The conference was attended by over 700 delegates from 117 countries and 13 international organizations. Forty-six of these delegates attended at the level of minister or equivalent high rank, or as a head of organization.

"The [Fukushima Ministerial Conference on Nuclear Safety] was attended by over 700 delegates from 117 countries and 13 international organizations."

Improving regulatory effectiveness

Four Integrated Regulatory Review Service (IRRS) missions took place in 2012, bringing the total number of such missions since 2006 to 44. These missions seek to improve the effectiveness of a Member State's regulatory structure. To meet the requirements set by the Action Plan, the Agency has developed and evaluated the efficiency and effectiveness of IRRS performance indicators. A series of nine meetings were held in 2012 with 28 international experts to review thematic modules and to enhance IRRS programme efficiency.

Operation of nuclear power plants and research reactors

Eight Operational Safety Review Team missions were conducted with the aim of improving operational safety of nuclear power plants. The focus of these missions continued to be on safety culture enhancement, severe accident management and long term operational management. With respect to safety culture, the Agency prepared a training course for self-assessment.

Given that 37% of the world's nuclear power plants and 70% of research reactors have been in operation for more than 30 years, ageing management continues to be an important issue. The Agency conducted three missions through its Safety Aspects of Long Term Operation of Water Moderated Reactors Peer Review Service.

Protection of patients from high radiation doses

Protecting people and the environment from the harmful effects of ionizing radiation and providing for high levels of safety are an integral part of the Agency's activities. On the whole, the exposure of the global population has risen rapidly, almost wholly due to the medical uses of radiation. There is thus an urgent need to protect patients and medical staff from unnecessary and unintended exposure to high radiation doses. In 2012, the Agency organized an international conference, co-sponsored by WHO and held in Bonn, Germany, on 'Radiation Protection in Medicine — Setting the Scene for the Next Decade'. The conference issued the 'Bonn Call for Action', which urged international bodies to support the goal of "the highest benefit with the least possible risk to all patients and appropriate use of ionizing radiation for diagnosis and treatment".

Code of conduct on radioactive material

Radioactive material that has been inadvertently incorporated into scrap metal and semi-finished metal products may have potentially severe health, environmental and financial consequences. In 2012, the Agency further developed and sent for Member State comments a draft Code of Conduct on the Transboundary Movement of Radioactive Material Inadvertently Incorporated into Scrap Metal and Semi-Finished Products of the Metal Recycling Industries. The goal is to facilitate an international consensus that will harmonize Member State approaches regarding this issue.

Incident and emergency preparedness and response

To support building emergency preparedness in Member States, the Agency published four publications and training materials, and made significant progress in the process to revise the Safety Requirements publication *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2). In assisting Member States in applying its standards and guides, the

Agency also held training courses and workshops, and conducted Emergency Preparedness Review (EPREV) missions. Under the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear Accident, the Agency also organized various levels of exercises, referred to as 'Convention Exercises' (ConvEx).

The EPREV service assists Member States in appraising their preparedness for nuclear and/or radiological emergencies, irrespective of the causes. EPREV missions can cover all aspects of the emergency preparedness arrangements at a specific installation to a full appraisal of all arrangements in a requesting Member State, including on-site, off-site and national arrangements. In 2012, EPREV missions were conducted in Armenia, Bosnia and Herzegovina, Croatia, Kazakhstan, Lithuania, Serbia, Uruguay and Vietnam, while the regulatory aspects of national radiation emergency preparedness systems were assessed in Finland, Greece, Slovakia and Sweden within the framework of IRRS missions.

The Response and Assistance Network expanded in 2012, with three new members registering their National Assistance Capabilities and existing members adding new capabilities to their registrations. The Agency also published an *Operations Manual for Incident and Emergency Communications*. All of these activities supported the response to a number of radiological emergencies, some of which required assistance missions organized by the Agency.

The Agency continued to build its own, as well as inter-agency, emergency preparedness capabilities. This included training for staff members in the Incident and Emergency System, and cooperation with international organizations through exercises to strengthen the inter-agency framework for preparedness for and response to radiation emergencies.

Conventions: A status report

In August 2012, the Contracting Parties to the Convention on Nuclear Safety (CNS) met in Vienna for their Second Extraordinary Meeting to discuss, inter alia, the lessons learned from, and the actions taken in response to, the Fukushima Daiichi accident, reviewed the effectiveness of the CNS, and considered a set of future actions for strengthening nuclear safety. An organizational meeting for the Sixth Review Meeting, to be held in 2014, was also convened.

The Fourth Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management was held in May with the participation of 54 Contracting Parties. The meeting discussed proposals to increase the effectiveness of the Convention, including several amendments to the guidelines regarding the review process, and agreed to continue discussions at inter-sessional meetings.

The Sixth Meeting of the Representatives of Competent Authorities Identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency took place in Vienna in April. Discussions were held on, inter alia, the effectiveness of the conventions. In addition, there was agreement to explore proposals to enhance the implementation of notification and information sharing arrangements.

"The Response and Assistance Network expanded in 2012, with three new members registering their National Assistance Capabilities and existing members adding new capabilities to their registrations."

Civil liability for nuclear damage

The International Expert Group on Nuclear Liability (INLEX) continues to serve as the Agency's main forum for questions related to nuclear liability. At its 12th regular meeting in May, INLEX finalized its "recommendations on how to facilitate achievement of a global nuclear liability regime", as requested by the Action Plan.

Five IAEA–INLEX missions aimed at informing national policy makers about the relevant international legal instruments for achieving a global nuclear liability regime were dispatched to Jordan, Republic of Korea, South Africa, Ukraine and Vietnam. Informal discussions continue to be held with other Member States interested in hosting an IAEA–INLEX mission. A workshop on civil liability for nuclear damage was held in May at Headquarters and provided participants with an introduction to the subject.

Nuclear Security

Strengthening the nuclear security infrastructure

During the year, the Agency continued to assist States in strengthening and supporting nuclear security through guidance, education and training, advisory services and peer reviews. Increased emphasis was given to assisting States in their development of the requisite nuclear security infrastructure, including cyber security and nuclear forensics. The Agency's important role in nuclear security was reflected in a number of different forums, including the Second Nuclear Security Summit (in March), the 16th Summit of the Non-Aligned Movement (in August) and the High-Level Meeting on Countering Nuclear Terrorism (in September).

In 2012, States reported two incidents involving HEU in unauthorized activities to the Incident and Trafficking Database. There were also three incidents involving IAEA Category 1–3 radioactive sources (i.e. sources posing a very high risk to human health if not managed safely and securely), two of which were thefts. Such incidents underline the need for continued efforts to improve nuclear security globally.

"Increased emphasis was given to assisting States in their development of the requisite nuclear security infrastructure, including cyber security and nuclear forensics."

Implementing the Nuclear Security Plan

The Agency continued to encourage Member State involvement in the development and review of IAEA Nuclear Security Series publications. To this end, it established the Nuclear Security Guidance Committee (NSGC). At its first meeting, the NSGC approved the *Nuclear Security Fundamentals*, which include the essential elements for a State's national nuclear security framework, and which was subsequently endorsed by the Board of Governors and the General Conference.

The Amendment to the Convention on the Physical Protection of Nuclear Material has yet to enter into force. Given the importance of the entry into force of the Amendment, the Agency, in the course of the year, organized three regional workshops and other national workshops to make States aware of the importance of this instrument. It also encouraged States to make full use of the assistance available for this purpose through active participation in its nuclear security programme.

The Agency started preparations for the International Conference on Nuclear Security, to be held in Vienna in July 2013. It was decided that the Conference will be at the ministerial level and will provide a global forum for ministers, policy makers and experts from all areas of nuclear security. The aim is to review experience and achievements to date, enhance understanding of current approaches and formulate views on future priorities.

NUCLEAR VERIFICATION

Implementation of Safeguards in 2012

At the end of each year, based upon an evaluation of all safeguards relevant information available to it for that year, the Agency draws a safeguards conclusion for each State for which safeguards are applied. In 2012, safeguards were applied for 179 States[3] with safeguards agreements in force with the Agency.[4, 5]

For the Agency to be able to conclude that all nuclear material in a State remained in peaceful activities, both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) should be in force, and the Agency must have been able to conduct all necessary verification and evaluation activities. By the end of 2012, of the 114 States with both a CSA and AP in force, the Agency was able to draw such a conclusion for 60.[6] For the other 54 States, the Agency was only able to conclude that *declared* nuclear material remained in peaceful activities, as all the necessary evaluations had yet to be completed.

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[3] The 179 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.

[4] And Taiwan, China.

[5] The status with regard to the conclusion of safeguards agreements, additional protocols and small quantities protocols is given in the Annex to this report.

[6] And Taiwan, China.

For the 57 States with a CSA, but with no AP in force, the Agency was only able to conclude that *declared* nuclear material remained in peaceful activities, as the Agency did not have sufficient tools to provide credible assurances regarding the absence of *undeclared* nuclear material and 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 and APs. For these States, the Secretariat concluded that nuclear material to which safeguards had been applied in selected facilities remained in peaceful activities or had been withdrawn from safeguards as provided for in the agreements.

For the three States in which the Agency implemented safeguards pursuant to safeguards agreements 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.

The Secretariat could not draw any safeguards conclusions for the 13 NPT non-nuclear-weapon States without safeguards agreements in force.

During 2012, the Director General submitted four reports to the Board of Governors on the implementation of the NPT Safeguards Agreement and relevant provisions of United Nations Security Council resolutions in the Islamic Republic of Iran (Iran). While the Agency continued throughout 2012 to verify the non-diversion of declared nuclear material at the nuclear facilities and locations outside facilities declared by Iran under its Safeguards Agreement, as Iran did not provide the necessary cooperation, including by not implementing its Additional Protocol, as required in the binding resolutions of the Board of Governors and the United Nations Security Council, the Agency was unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran and, therefore, was unable to conclude that all nuclear material in Iran was in peaceful activities. In light of the Board of Governors' November 2011 resolution, during 2012 the Agency and Iranian officials held seven rounds of talks in Vienna and Tehran aimed at reaching agreement on a structured approach for the clarification of all outstanding issues related to Iran's nuclear programme. On 13 September 2012, the Board, in resolution GOV/2012/50 (adopted by a vote), stressed that it was essential for Iran to immediately conclude and implement such an approach. Nevertheless, no agreement was reached and substantive work on the outstanding issues did not begin.

In August 2012, the Director General submitted a report to the Board of Governors on the Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic (Syria). The Director General informed the Board that the Agency had not received any new information from Syria or other Member States that would have an impact on the Agency's assessment that it was very likely that a building destroyed at the Dair Alzour site was a nuclear reactor which should have been declared to the Agency by Syria. In February 2012, in response to an Agency proposal to hold further discussions to address all the outstanding questions, Syria indicated that it would provide a detailed response at a later time, noting the difficult prevailing security situation in the country. The Agency has taken note of Syria's position and has reiterated its request to Syria to hold further discussions to address all the outstanding questions. For 2012, the Agency was able to conclude for Syria that declared nuclear material remained in peaceful activities.

"By the end of 2012, of the 114 States with both a CSA and AP in force, the Agency was able to draw such a conclusion for 60.... For the other 54 States, the Agency was only able to conclude that declared *nuclear material remained in peaceful activities, as all the necessary evaluations had yet to be completed."*

In August 2012, the Director General submitted a report to the Board of Governors and General Conference on the application of safeguards in the Democratic People's Republic of Korea (DPRK), which provided an update of developments since the Director General's report of September 2011. As the Agency has not been able to implement any verification measures in the DPRK since April 2009, it could not draw any safeguards conclusion regarding the DPRK. Statements by the DPRK about uranium enrichment activities and the construction of a light water reactor in the DPRK continue to be deeply troubling. The Agency continued to monitor the DPRK's nuclear activities by using open source information, satellite imagery and trade information, and 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 DPRK.

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 2012. Outreach events in 2012 included a briefing on the Agency's safeguards for States in the Pacific region (held in Fiji in June 2012), and a regional seminar on safeguards for States in the greater Caribbean region with limited nuclear material and activities (held in Mexico City in June 2012).

"In the Clean Laboratory Extension building, the Agency's first multi-collector inductively coupled plasma mass spectrometer was brought into service to further improve the precision of analysis of uranium and plutonium particles collected through environmental sampling."

In 2012, CSAs entered into force for one State and APs for five States. Small quantities protocols that reflect the revised text were brought into force in four States.

Other Developments

To address near term development objectives and to support the implementation of its verification activities, the Agency continued to rely on Member State Support Programmes (MSSPs) in implementing its *Research and Development Programme for Nuclear Verification 2012–2013*. At the end of 2012, 21 States had formal support programmes with the Agency, supporting over 300 tasks, valued at over €20 million per annum. During 2012, the Secretariat finalized the review of its R&D activities implemented in 2010–2011 and published the *Biennial Report on the Research and Development Programme for Nuclear Verification 2010–2011*.

During the year, the Agency conducted 117 safeguards training courses for safeguards staff, including its revised 'Introductory Course on Agency Safeguards', and its long-standing, ten month Safeguards Traineeship Programme graduated six participants — from Central African Republic, Chile, Malaysia, Namibia, South Africa and Sudan.

The project entitled 'Enhancing Capabilities of the Safeguards Analytical Services (ECAS)' achieved significant progress. Construction of the Nuclear Material Laboratory (NML) building at Seibersdorf progressed on schedule and within budget, reaching 70% completion in 2012. The building is expected to be ready for commissioning in mid-2013, with a year long transfer of scientific functions from the old laboratory to follow. In the Clean Laboratory Extension building, the Agency's first multi-collector inductively coupled plasma mass spectrometer was brought into service to further improve the precision of analysis of uranium and plutonium particles collected through environmental sampling.

MANAGEMENT OF TECHNICAL COOPERATION FOR DEVELOPMENT

The Global Development Context

The technical cooperation programme is the primary vehicle for the delivery of Agency capacity building services to Member States, through which it contributes to the achievement of the UN Millennium Development Goals (MDGs). In 2012, the global development context for the Agency's technical cooperation programme included the initiation of United Nations system-wide deliberations on the post-2015 development agenda — the target date for the attainment of the MDGs. Global discussions were informed by the preliminary assessment of advances towards the achievement of the MDGs, as well as by the findings and resolutions passed at Rio+20. Science, technology and innovation — significant Agency strengths — have played an important role and are expected to play a larger role in development initiatives after 2015.

In many areas of the Agency's technical cooperation programme, nuclear technology offers important advantages and complementarities. As a large part of this programme addresses areas where the Agency does not have the lead mandate in the United Nations system, partnerships with relevant actors are crucial for the Agency to meet its strategic goal of promoting tangible socioeconomic impact in Member States. Over the past five years, the Agency has made a particular effort to participate in the United Nations Development Assistance

Framework (UNDAF) processes and to build on complementarities with the activities of UN country teams in support of national development priorities, including the achievement of the MDGs.

In addition to the Agency's established partnership with the FAO through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, and the WHO–IAEA Joint Programme on Cancer Prevention and Control, cooperation with UNIDO was established in 2012 in the field of cleaner industrial production processes, and further collaboration is expected in energy planning. In the field of nutrition, collaboration was established with UNICEF and WHO. In the fight against desertification, land degradation and drought, cooperation was established with UNDP, the United Nations Convention to Combat Desertification, the World Overview of Conservation Approaches and Technologies, and the Global Soil Partnership. Furthermore, collaboration with WHO and the Pan American Health Organization was expanded in the areas of cancer, medical physics, NCDs and nutrition.

The Technical Cooperation Programme in 2012

In 2012, health and nutrition accounted for the highest proportion of 'actuals', or disbursements, in the technical cooperation programme, at 26.2%. This was followed by safety and security at 22.6%, and by food and agriculture at 14.8%. By the end of the year, financial implementation of the Technical Cooperation Fund (TCF) stood at 76.5% (Fig. 1).

At the regional level, in Africa, Agency assistance focused on meeting basic human needs through the safe utilization of nuclear technology, and on supporting human and institutional capacity building. Continued efforts were made to align Agency support with Member State national development plans and the AFRA Regional Strategic Cooperative Framework, concentrating mainly on food and agriculture, human health, water resources management, industrial applications, environment, energy and safety. The application of nuclear techniques in these areas contributed to increased food and water security, improved health care and environmental management, and enhanced productive capacity in the region. In addition, the Agency also prioritized building and strengthening partnerships with, for example, the Organization of Islamic Cooperation and the Islamic Development Bank on cancer control in Africa, and mobilized initial resources to begin a large scale water project in the Sahel region. Special attention was also given to helping African Member States strengthen their nuclear safety and national regulatory infrastructure.

" Over the past five years, the Agency has made a particular effort to participate in the United Nations Development Assistance Framework (UNDAF) processes and to build on complementarities with the activities of UN country teams in support of national development priorities, including the achievement of the MDGs."

In Asia and the Pacific, the technical cooperation programme continued to focus on the most prevalent development needs of individual countries and on addressing global and emerging issues of regional significance. Some ten countries are currently taking steps towards building nuclear power infrastructure in preparation for launching nuclear power programmes in the future. Support to countries embarking on this path, and for the assessment of energy options, continued to be one of the main priorities for the region. Member States are re-emphasizing human health related applications, for example, upgrading the use of nuclear technologies in the diagnosis and treatment of diseases, focusing on the safe use of ionizing sources, and adopting quality assurance practices. In this respect, the programme promoted strong regional cooperation to enhance capacities in Asia and the Pacific, seeking to further strengthen the existing centres of excellence and regional resource centres, and to enable South–South cooperation and complementarity in knowledge, expertise, products and services.

In Europe, technical cooperation activities covered the development of nuclear power, applications in health care and industry, and environmental protection and remediation. Major emphasis was placed on maintaining appropriate levels of safety and security in all aspects of the peaceful use of nuclear technology.

In Latin America the key thematic areas for the region continue to be safety, food and agriculture, environmental management and human health. During 2012, management focused on enhancing

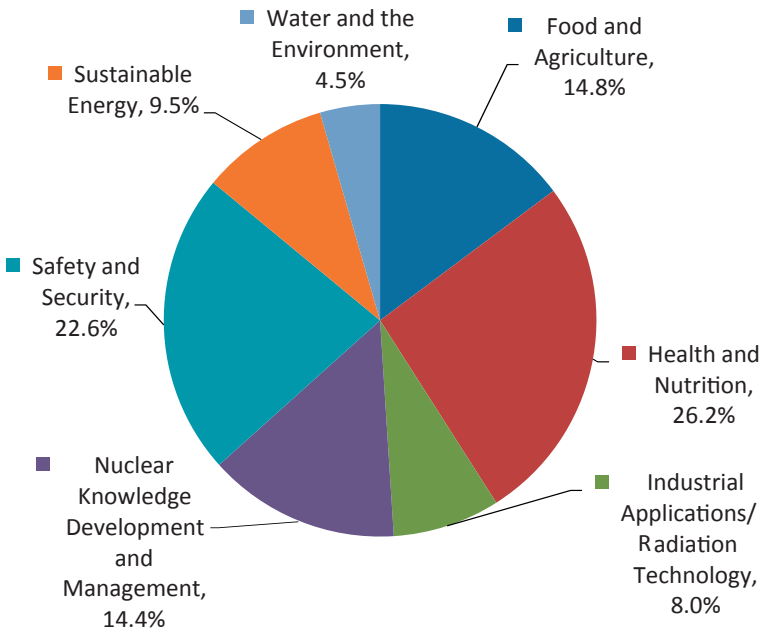


FIG. 1. Actuals by grouped fields of activity in 2012 (percentages in charts may not add up to 100% due to rounding). Nuclear safety includes transport safety and the safe management of radioactive waste. Nuclear fuel cycle includes predisposal and disposal of nuclear fuel waste.

"Cooperative arrangements in all regions continue to be key strategic mechanisms to expand cooperation, collaboration and coordination with other partners at the regional and international levels."

accountability for results, improving work planning and management capabilities, and programme integration. For instance, the project formulation process for the 2014–2015 technical cooperation programme cycle began in close association with the priorities reflected in the 2007–2013 ARCAL Regional Strategic Profile for Latin America and the Caribbean, and with the ARCAL management committee. Stakeholder participation in the project preparation process was also a management priority. The application of quality criteria continued to guide planning and design, as did new approaches to results based budgeting, minimum technical criteria for regional projects and a more strategic approach to procurement. The management strategy in the Latin America region is emphasizing synergy between national and regional programmes, and highlighting the regional programme as a means to promote long term technical collaboration between institutes, as well as technical self-reliance and leadership within the region.

Cooperative arrangements in all regions continue to be key strategic mechanisms to expand cooperation, collaboration and coordination with other partners at the regional and international levels.

Programme Quality

The Agency continued to focus on further improving programme quality and transparency, responding to Member State requests for better programme monitoring and efficiency. Training for programme management officers, national liaison officers and technical officers was provided to ensure that all project proposals submitted to the technical cooperation programme for consideration would be of high quality in terms of consistency, clarity and logic, with specific, measurable, attainable, realistic and timely objectives. Special efforts were made to ensure that Member States received systematic feedback and information in a timely fashion. Further efforts to improve monitoring of the implementation of technical cooperation projects will be put into practice

in 2013, including 'project progress assessment reports', a field monitoring mission and a project self-evaluation methodology.

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 €70.7 million in 2012, with approximately €58.1 million for the TCF (including assessed programme costs (APCs), national participation costs[7] (NPCs) and miscellaneous income), €11.4 million in extrabudgetary resources, and about €1.2 million representing in-kind contributions.

The rate of attainment[8] for the TCF stood at 89.3% on pledges and at 88.3% on payments at the end of 2012, while payment of NPCs totalled €2.8 million (Fig. 2).

Actuals

In 2012, approximately €68.8 million was disbursed to 125 countries or territories, of which 31 were least developed countries, reflecting the Agency's ongoing effort to address the development needs of those States.

MANAGEMENT ISSUES

The Agency's Draft Programme and Budget 2014–2015

In developing the proposals for the Agency's draft Programme and Budget 2014–2015, the Secretariat focused in 2012 on maximizing efficiency, prioritizing tasks and finding an appropriate balance among the Agency's activities. At the same time, due consideration was given to meeting the continuing demand from Member States for the Agency's services.

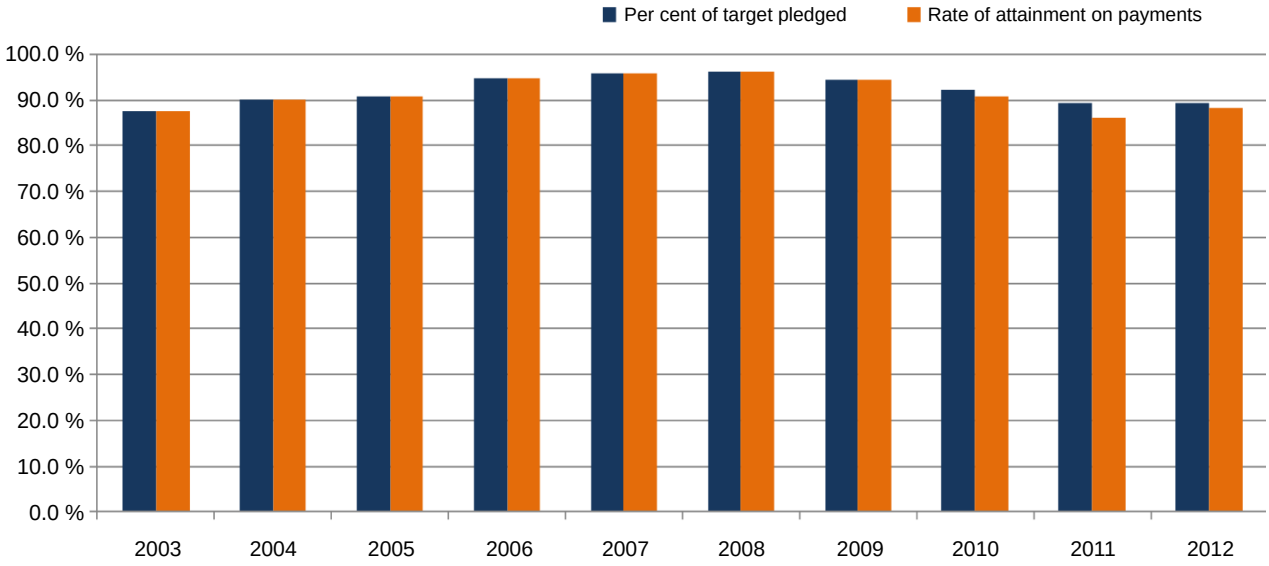


FIG. 2. Trends in the rate of attainment, 2003–2012.

AIPS

The Agency-Wide System for Programme Support (AIPS), an enterprise resource planning system that is being used to re-engineer the Secretariat's business processes, is now half-way through its implementation cycle. The new system fully implements the results based

[7] *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.

[8] 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.

management approach, integrating the Agency's goals, as contained in its *Medium Term Strategy 2012–2017*, with the planning and execution of programmes and projects and the assessment of their effectiveness. In 2012, the project concluded its second phase with the introduction of a new system for planning the Agency's budgets, expenditure forecasting, assessment and registering of risk. For the first time, the Agency's draft Programme and Budget 2014–2015 was prepared using the 'Oracle Hyperion Planning' tool. Under the second phase of the project, information relating to contacts such as suppliers, customers and meeting participants will be centrally controlled using sophisticated management tools.

The Agency's Financial Statements

For the first time, *The Agency's Financial Statements for 2011* were in compliance with International Public Sector Accounting Standards, known as IPSAS. The External Auditor released an unqualified opinion on the Financial Statements. The successful introduction of IPSAS represents a milestone in the Agency's management reform efforts.

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 nuclear power programmes 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 to develop evolutionary and innovative nuclear technology for electricity generation, for actinide utilization and transmutation and for non-electric applications, consistent with sustainability goals.

Launching Nuclear Power Programmes

Nuclear power remains an important option to increase electricity production for countries with growing energy requirements. Although a few countries have delayed decisions to start nuclear power programmes, significant steps were taken in 2012 by several countries planning to introduce nuclear power. In July, the United Arab Emirates (UAE) became the first country in 27 years to start the construction of a first nuclear power plant (Barakah-1), when the Emirates Nuclear Energy Corporation (ENEC) poured the first concrete after receiving a construction licence from the Federal Authority for Nuclear Regulation (Fig. 1). Belarus and Turkey, which had previously signed contracts, continued their preparation for licensing construction in 2012. Table 1 compares Member States at different stages of decision making and planning for nuclear power at the end of 2011 and 2012, according to their official statements.

FIG. 1. Construction at Barakah-1 in the UAE (photograph courtesy of ENEC).

Table 1. Number of Member States at different stages of decision making and planning for nuclear power in 2011 and 2012

	2011	2012
First nuclear power plant started construction	0	1
First nuclear power plant ordered	3	2
Decided and started preparing infrastructure	6	6
Active preparation with no final decision	6	6
Considering a nuclear power programme	14	13

The Agency continued to cooperate with States that have taken a decision on starting a nuclear power programme ('newcomer' countries) and that are actively building infrastructure. As an example, during the General Conference, the Member State delegations of all advanced newcomers met with Agency experts on nuclear infrastructure development.

Integrated Nuclear Infrastructure Review (INIR) missions were conducted in Belarus, Jordan and Vietnam in 2012. An updated INIR evaluation methodology was used for the first time in December 2012 during the mission to Vietnam. To better assist Member States in completing Phase 3 of the 'Milestones' approach[1] — i.e. activities to commission a first nuclear power plant — the concept for INIR missions to Member States at this phase was developed.

[1] For further information on the phases, see INTERNATIONAL ATOMIC ENERGY AGENCY, *Milestones in the Development of a National Infrastructure for Nuclear Power*, IAEA Nuclear Energy Series No. NG- G-3.1, IAEA, Vienna (2007).

Engineering Support for Operation, Maintenance and Plant Life Management

There is continuing interest around the world in the long term operation of existing plants. The Agency organized the third International Conference on Nuclear Power Plant Life Management, held in Salt Lake City, USA, in May. Over 350 participants representing 38 Member States and 3 international organizations attended the conference. Among the issues discussed were ways to safely and efficiently extend the life of many of the world's operating nuclear power plants, as well as ways for existing reactors to effectively deal with the increased expectations for safety in a 'post-Fukushima world'.

At the second meeting of the Nuclear Operating Organizations Forum in September, more than 70 delegates and other participants from Member States met to share operating experience and management strategies to help strengthen the effectiveness of operating organizations. The important role of operating organizations and other stakeholders in the development of safe and sustainable nuclear power plants was recognized and recommendations were made to increase the Agency's interactions and strengthen its cooperation with nuclear power plant operators and other stakeholders in the nuclear industry.

"There is continuing interest around the world in the long term operation of existing plants."

The instrumentation and control (I&C) system of a nuclear power plant serves as its 'central nervous system', ensuring efficient and safe power production. An Independent Engineering Review of I&C Systems mission was conducted at the All-Russia Scientific Research Institute for Nuclear Power Plant Operation, Russian Federation, in December to review the computerized process control system of the AES-2006 nuclear power plant. The mission concluded that extensive engineering work of high quality had been performed to develop the advanced I&C system and that, in general, the reviewed areas met the requirements of the relevant sections of IAEA Safety Standards Series No. NS-G-1.3, *Instrumentation and Control Systems Important to Safety in Nuclear Power Plants*.

The Agency also supports Member States in enhancing the operational safety of existing nuclear power plants. In October and December, Agency experts participated in an international engineering review of reactor pressure vessel material at the Doel-3 and Tihange-2 plants in Belgium (Fig. 2). It was recommended that the licence holder, Electrabel, carry out a confirmatory test programme before the next refuelling outage, as well as an ultrasonic testing inspection, enabling validation of the overall safety case.

The long-standing cooperation of more than 30 years between FORATOM and the Agency in the area of management systems was formalized in March with the signing of a 'Practical Arrangement Agreement'. This agreement is intended to broaden cooperation to cover such areas as energy planning, human resources, and knowledge and waste management.

Human Resource Development

Developing human resources for nuclear power programmes in Member States has specific challenges that require innovative methods and approaches. Mentorship programmes have been established in the

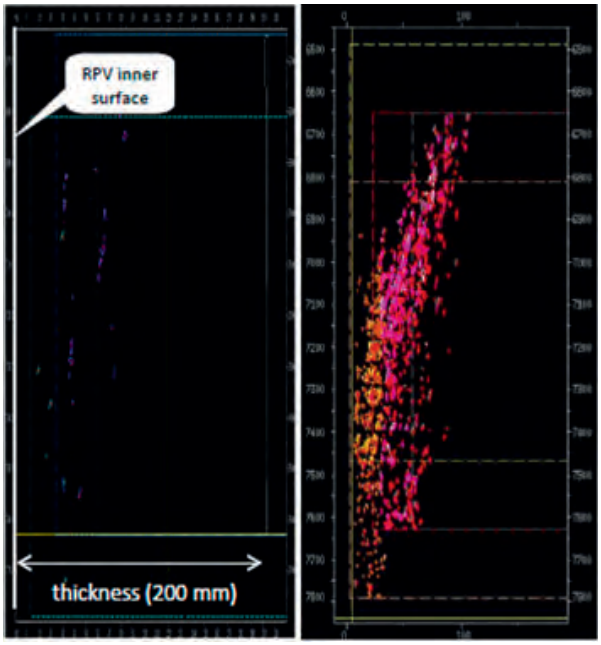


FIG. 2. Typical example of data recorded in the lower core shell of a reactor pressure vessel. The photograph on the left shows an axial section, with indications appearing as colour spots. The photograph on the right shows the accumulation of indications, all detected in a 20° sector of the shell (photograph courtesy of Electrabel).

Asia–Pacific region, in collaboration with experienced countries such as China, Japan and the Republic of Korea, for senior managers and decision makers from countries starting nuclear power programmes. In July, the Agency signed an arrangement with the Korea Electric Power Corporation International Nuclear Graduate School, covering international student recruitment, curriculum development, and seminar and outreach programmes.

One of the Agency's main areas of focus for newcomer States is to help them review the adequacy of their existing national capacity building arrangements and to strengthen them as necessary. A technical meeting in October on 'Capacity Building and Human Resource Development for New and Expanding Nuclear Power Programmes' developed a self-assessment methodology for this purpose, training the 29 participants from 25 Member States.

The Agency's Nuclear Power Human Resources (NPHR) modelling tool supports Member States in analysing their national workforce planning process. Bangladesh, Indonesia, Malaysia, Thailand and Vietnam were trained in the use of this tool, which can be adapted to reflect a country's national needs (Fig. 3).

The increasing cost effectiveness and efficiency of distance learning for training and capacity building in Member States led the Agency to establish a 'Framework Agreement' for the coordinated procurement of e-learning materials. Implementation continued of the 'Milestones' e-learning project to create content for non-experts considering nuclear power. In addition, modules on the 'Milestones' approach for human resource development, stakeholder involvement, project management and construction management were being developed.

In October, the Agency organized a technical meeting focusing, for the first time, on stakeholder involvement in nuclear power. The goal of the meeting, jointly organized with FORATOM, was to exchange information and develop sustainable relationships. The more than 50 participants from 29 countries shared experience, and identified activities and areas that the Agency could support to assist Member States embarking on nuclear power programmes or those with existing programmes.

Nuclear Reactor Technology Development

In the area of advanced water cooled reactors, a course reviewing the science and engineering of supercritical water cooled reactor (SCWR) concepts was held at McMaster University in Mississauga, Canada, in July, under a CRP on 'Heat Transfer Behaviour and Thermo-hydraulics Code Testing for SCWRs'. Sixteen collaborating institutes from nine Member States and two international organizations, including the OECD/NEA, participated in this CRP, which was completed in September. Results included the establishment of a database on heat transfer and pressure drop in supercritical fluid at the OECD/NEA.

"The Agency's Nuclear Power Human Resources (NPHR) modelling tool supports Member States in analysing their national workforce planning process. "

In the area of small and medium sized reactors, Agency activities focused on addressing cross-cutting technology and institutional issues in the light of the accident at the Fukushima Daiichi nuclear power plant. A booklet on the *Status of Small and Medium-sized Reactor Designs*, a supplement to the Agency's Advanced Reactors Information System, was published in September, providing information on advanced reactor designs and concepts.

Gas cooled reactor activities in 2012 concentrated on closing technology development gaps by providing a platform for information exchange and international collaboration. A publication on *Advances in High Temperature Gas Cooled Reactor Fuel Technology* (IAEA-TECDOC-CD-1674) was published in 2012 summarizing the results of a CRP on 'Advances

FIG. 3. Training course on the Agency's NPHR model.

in HTGR Fuel Technology'. Efforts to preserve knowledge in this area led to the development of a training course on HTGR technology in October in Beijing, which was attended by 35 scientists and engineers from ten States.

The co-generation option for nuclear power plants (i.e. electricity and water production) is becoming more suitable for many countries, as was recognized in a technical meeting on 'Advances in Seawater Desalination Using Nuclear Power'. In addition, a new tool on water management in nuclear power plants, the 'Water Management Program' (WAMP), was released in November. WAMP provides a quick reference for the estimation of water requirements and helps in the evaluation of water needs during the siting evaluation and selection process of nuclear power plants, especially for newcomer countries.

"A two track revision of the INPRO methodology and an expansion of NESA to enable a comparison of nuclear energy systems with innovative technologies were also under way in 2012."

Enhancing Global Nuclear Energy Sustainability through Innovation

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) supports Member States in developing and deploying sustainable nuclear energy systems. In 2012, three States joined INPRO: Malaysia, Romania and Vietnam. This brought the number of members to 38[2].

In 2012, a nuclear energy system assessment (NESA) using the INPRO methodology was completed for Belarus, confirming in general the long term sustainability of the nuclear energy system planned for that country. Two more NESAs were under way, in Indonesia (Fig. 4) and Ukraine.

A two track revision of the INPRO methodology, based on feedback from concluded assessments, and an expansion of NESA to enable a comparison of nuclear energy systems with innovative technologies were also under way in 2012.

A number of reports on the results of completed collaborative projects, such as GAINS (Global Architecture of Innovative Nuclear Energy Systems Based on Thermal and Fast Reactors Including a Closed Fuel Cycle), were published. These include the *Role of Thorium to Supplement Fuel Cycles in Future Nuclear Energy Systems* (IAEA Nuclear Energy Series No. NF-T-2.4), *Proliferation Resistance: Acquisition/Diversion Pathway Analysis (PRADA)* (IAEA-TECDOC-1684) and *Assessment of Nuclear Energy Systems based on a Closed Nuclear Fuel Cycle with Fast Reactors* (IAEA-TECDOC-1639/Rev. 1).

Strategic discussions between nuclear technology holders, users and other stakeholders were promoted through the fourth and fifth INPRO Dialogue Forums, the former on 'Drivers and Impediments for Regional Cooperation on the Way to Sustainable Nuclear Energy Systems', held in July, and the latter on 'Long-term Prospects for Nuclear Energy in the Post-Fukushima Era', held in August. At the fourth Dialogue Forum, collaboration among States was confirmed as a necessary condition for making a transition to future sustainable nuclear energy systems (Fig. 5).

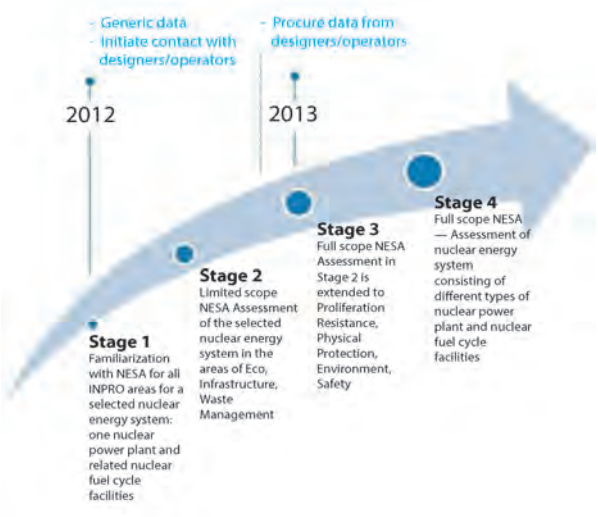


FIG. 4. A graded approach for the NESA for Indonesia.

[2] The members of INPRO at the end of 2012 were Algeria, Argentina, Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, Egypt, France, Germany, India, Indonesia, Israel, Italy, Japan, Jordan, Kazakhstan, Republic of Korea, Malaysia, Morocco, Netherlands, Pakistan, Poland, Romania, Russian Federation, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, United States of America, Vietnam and the European Commission.

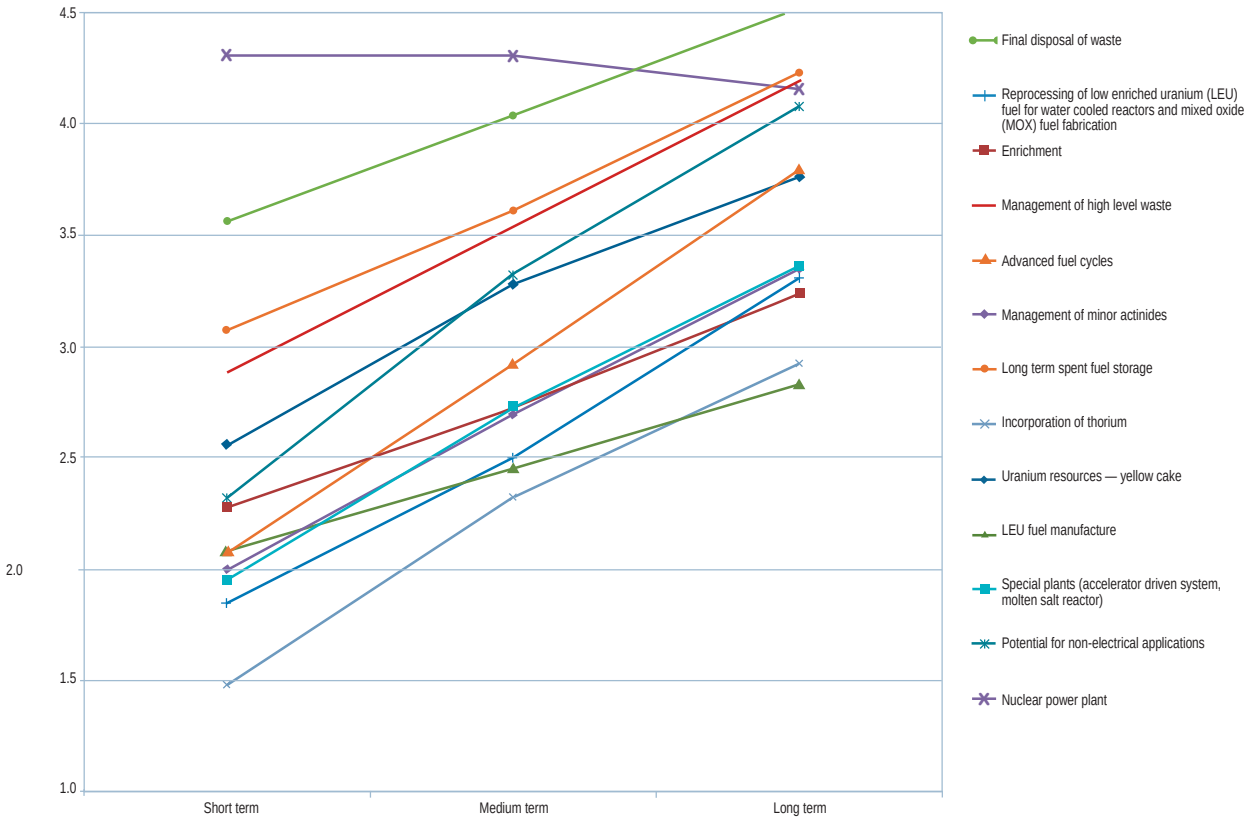


FIG. 5. Importance of collaboration with other States on issues relevant to the transition to sustainable nuclear energy systems.

Nuclear Fuel Cycle and Materials Technologies

Objective

To advance the development and implementation of an increasingly safe, reliable, economically efficient, proliferation resistant and environmentally sustainable nuclear fuel cycle, providing the maximum benefit to Member States.

Uranium Production Cycle and the Environment

Accurate knowledge of uranium resources, production and demand in Member States is essential for planning the supply of uranium fuel for nuclear power plants. This is particularly important since the projected growth in nuclear power is expected to increase uranium requirements for power reactors from 63 875 tonnes of uranium per year (t U/a) in 2010 to between 97 645 and 136 385 t U/a by 2035. The latest update of the joint IAEA–OECD/NEA publication *Uranium 2011: Resources, Production and Demand* (the 'Red Book'), published in 2012, estimated that the total amount of identified conventional uranium resources recoverable at a cost of less than $130/kg U was 5.3 million tonnes of uranium (Mt U), demonstrating a slight decrease from 2010. Uranium production worldwide rose significantly, largely as a result of increased production in Kazakhstan. Uranium production worldwide in 2010, the most recent year reported in the Red Book, was 54 670 t U. According to the report, three countries account for 62% of this production: Australia, Canada and Kazakhstan. These countries, together with Namibia, Niger, the Russian Federation, the USA and Uzbekistan, account for 92% of global production. Reflecting recent increases in exploration efforts, other countries, including China and India, are emerging as increasingly important uranium resource areas. Exploration activities have also increased in a number of South American and African countries, where uranium exploration and production have been either non-existent or long dormant.

"Accurate knowledge of uranium resources, production and demand in Member States is essential for planning the supply of uranium fuel for nuclear power plants. "

Identifying and extracting uranium resources are challenges that need to be addressed, especially in areas that have not been previously investigated. To assist Member States in this area, the Agency organized a series of meetings and training courses during the year. For example, almost 200 experts from 30 countries were trained in interregional and regional courses on uranium geology and exploration held in China, Madagascar, Nepal, the United Republic of Tanzania and Venezuela. Additionally, at a meeting in Vienna on the origin of sandstone uranium deposits, experts from 35 Member States discussed recent advances in understanding the origin of sandstone uranium deposits to assist efforts in exploration, production optimization and the safe management of mine wastes and remediation. The effective regulatory and environmental management of uranium production was discussed by experts from 12 countries at a training course in Darwin, Australia, in August (Fig. 1). Finally, the Uranium Production Network for Education and Training (UPNET) met in Vienna in October to share international experience in addressing education and workforce training for new or expanding uranium projects and operations.

FIG. 1. The Ranger uranium mine in Australia.

The availability of unconventional uranium resources should also be assessed when estimating total resources. These unconventional resources include uranium in seawater and resources from which uranium is recoverable as a by-product of other extraction processes. Past estimates of potentially recoverable uranium associated with phosphates, non-ferrous ores, carbonatite, black schist/shales and lignite are of the order of 10 Mt U.

Continued Member State interest in uranium extraction from phosphates led to two Agency training activities. The first was a regional workshop on uranium resources assessment and recovery from phosphate and rare earth element ores, held in Cairo, Egypt, to build capacity in the African region. The second was an interregional training course held in Amman, Jordan, on uranium production from phosphate rocks, which focused on the basic requirements to advance projects from laboratory to commercial scale (Fig. 2).

Thorium has been used as a nuclear fuel on a demonstration basis. However, its broader use depends on the commercial deployment of thorium fuelled reactors. Known world thorium resources are estimated to be about 6–7 Mt. Advances in the evaluation of thorium and uranium deposits were discussed in October at an interregional workshop, held in Lisbon, Portugal, on the evaluation of uranium and thorium resources. Organized jointly by the Agency, the Ibero-American Programme of Science and Technology for Development and the United Nations Economic Commission for Europe, experts from 30 countries and two international organizations discussed initial experience in using the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 for uranium and thorium resource reporting and for mapping the full life cycle of uranium and thorium mining, from exploration to end of mine life remediation.

FIG. 2. Participants at an Agency training course on the extraction of uranium from phosphates, at the Jordan Phosphate Mining Company, Aqaba, Jordan.

"Demand for fuel fabrication services is expected to continue to increase for the foreseeable future as nuclear programmes are developed or expanded..."

Nuclear Power Reactor Fuel Engineering

Through its nuclear fuel cycle programme, the Agency provides assistance to Member States in collecting information and facilitates research on the development, design, manufacture and performance of nuclear fuel. In 2012, worldwide LWR fuel fabrication capacity considerably exceeded the annual demand for LWR fuel fabrication services, which remained at about 7000 tonnes of enriched uranium in fuel assemblies. Demand for fuel fabrication services is expected to continue to increase for the foreseeable future as nuclear programmes are developed or expanded, but a longer term forecast of fuel demand depends on many factors that are still unclear. Fuel demand for PHWRs accounted for about 3000 t U/a.

The Agency published the results of two technical meetings held in Hyderabad, India, and Obninsk, Russian Federation, in a report entitled *Structural Materials for Liquid Metal Cooled Fast Reactor Fuel Assemblies — Operational Behaviour* (IAEA Nuclear Energy Series No. NF-T-4.3). The report collects the experience of Member States that operate, or have operated, fast reactors and presents results and perspectives of the development of advanced radiation resistant materials for fast reactor cladding, including oxide dispersion strengthened alloys, which are considered by the majority of experts as the most promising for high dose applications. However, further R&D is required to address issues such as welding or mechanical anisotropy.

Reports on two CRPs, 'Modelling of Transport of Radioactive Substances in the Primary Circuit of Water-Cooled Reactors' and 'Fuel Modelling at Extended Burnup (FUMEX-2)' were published as IAEA-TECDOC-1672 and IAEA-TECDOC-1687, respectively. These publications address the analysis of in-core radioactivity transport and prediction of fuel behaviour by computer simulation, with the aim of improving and verifying computer codes developed in different Member States. Both CRPs are part of a series of Agency projects on fuel modelling, with a focus on the safety aspects of the behaviour of in-core fuel and structural materials in accident conditions.

"...most of the storage facilities necessary for extended storage [of spent fuel] have not yet been designed or built, though experience so far has shown that storage periods are likely to be longer than anticipated."

Spent Fuel Management

About 10 000 tonnes of heavy metal (t HM) were discharged in 2012 as spent fuel from all nuclear power reactors. However, the total cumulative amount of spent fuel that has been discharged globally up to December 2012 is approximately 360 500 t HM. Currently, less than a third of discharged fuel has been reprocessed, and the construction of disposal facilities for spent fuel or high level waste has been delayed in most Member States. Consequently, although in recent years there has been a slight decrease in the amount of spent fuel being generated, the trend of growing inventories of spent nuclear fuel is expected to continue. The Agency's spent fuel management activities focused mainly on addressing technical and operational issues associated with long term storage (up to about 100 years), facilitating the sharing of results and assisting Member States in their R&D programmes in support of continued spent fuel storage and retrieval.

The Irradiated Fuel Management Advisory Programme (IFMAP), implemented by the Agency in 1991, was the framework for the first IFMAP Peer Review Mission, conducted in March to the Spent Fuel Dry Storage Project of the Atucha I Nuclear Power Plant in Lima, Argentina. An international team of experts reviewed the project's technical and planning documentation, suggested improvements to the conceptual engineering, and issued a report covering technical and organizational issues. The report included recommendations for interaction with the regulator, and technical improvements such as an enhanced drying procedure. Backup options in case of delays, including the temporary use of the spent fuel pools at the adjacent Atucha II nuclear power plant, which is expected to start operation in 2013, were also discussed.

In May, 17 participants from 10 States and the European Commission attended the second Research Coordination Meeting of a CRP on 'Spent Fuel Performance Assessment and Research (SPAR-III)', held in Charlotte, USA. In addition to exchanging information and experience on a range of activities in support of spent fuel storage, the participants focused on the effect of long term storage and handling of fuel during spent fuel retrieval (Fig. 3). The effects of the reorientation of hydrides on the properties of Zircaloy cladding were discussed in detail.

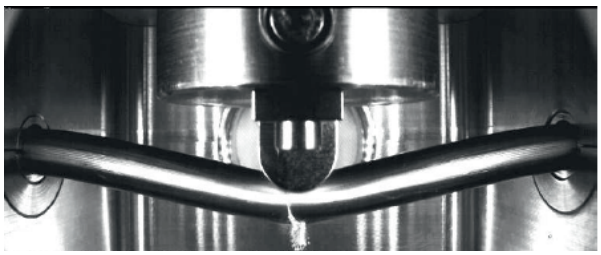


FIG. 3. High speed photograph showing impact testing of a fuel rod.

Another meeting, related to this CRP, examining issues associated with extending spent fuel storage beyond the long term, was organized in October. With input from almost 60 participants from 30 States and the European Commission, the meeting concluded that most of the storage facilities necessary for extended storage have not yet been designed or built, though experience so far has shown that storage periods are likely to be longer than anticipated.

Topical Issues of Advanced Fuel Cycles

The search for long term sustainability in the nuclear fuel cycle is a major trend in nuclear

energy research, addressing issues such as the efficient utilization of resources, the management of radioactive waste and proliferation resistance. Partitioning, which involves the chemical separation of various constituents of spent nuclear fuel, could facilitate the reuse of separated fissile material to obtain extra energy and reduce the radiotoxicity of nuclear waste, and thus the size of geological repositories. The Agency continues to encourage and support research in this promising area.

A compilation of updated information on experience with the manufacturing technology of nuclear fuels for power reactors and research reactors was published as IAEA-TECDOC-1686 in 2012.

In order to assess the inherent safety margins in PHWR fuel design and to plan for the mitigation of the consequences of accidents, a technical meeting on 'Fuel Integrity during Normal Operation and Accident Conditions in PHWRs' was held in September in Bucharest, Romania. The participants discussed fuel and cladding behaviour under normal reactor operating conditions, severe transients and accident conditions in PHWRs. They also assessed inherent safety margins in the fuel design and recommended a number of design changes to improve the safety margins of fuels intended to reach higher values of burnup.

Increased interest among some Member States, including China and India, in the use of thorium as a fuel led to a new CRP on 'Near Term and Promising Long Term Options for Deployment of Thorium Based Nuclear Energy'. The first Research Coordination Meeting, held in June in Vienna, enabled the eight participating national laboratories and research institutes from seven States to share the results of R&D on thorium energy systems in thermal and fast reactors, and to review recent developments.

"[The] Integrated Nuclear Fuel Cycle Information System (iNFCIS)...makes it possible to analyse the different stages, facilities, capacities, interlinkages and synergies related to various fuel cycle options and approaches."

Integrated Nuclear Fuel Cycle Information System

The Agency provides comprehensive technical and statistical information on nuclear fuel cycle activities around the world, as reported to it, through its Integrated Nuclear Fuel Cycle Information System (iNFCIS) *(http://infcis.iaea.org)*. This system makes it possible to analyse the different stages, facilities, capacities, interlinkages and synergies related to various fuel cycle options and approaches. It attracts about 600 000 visits every year and includes the Nuclear Fuel Cycle Information System (NFCIS), World Distribution of Uranium Deposits (UDEPO), World Distribution of Thorium Deposits and Resources (ThDEPO), Post-Irradiation Examination Facilities Database (PIE), and the Minor Actinide Property Database (MADB).

Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development

Objective

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

Energy Modelling, Databanks and Capacity Building

The Agency publishes annually two updated projections for the global growth in nuclear power: a low projection and a high projection. The 2012 updates for both the low and high projections show growth in nuclear power capacity, by 23% by 2030 in the low projection and by 100% by 2030 in the high projection. However, the growth rate is slower than what was projected in 2011, particularly in the low projection. Most new nuclear power reactors planned or under construction are in Asia, particularly in China and India. Additionally, the Republic of Korea and the Russian Federation plan significant expansion.

"Demand for the Agency's assistance in capacity building for energy system analysis and planning continued to increase."

The low and high projections are not intended to identify extremes, but to cover a plausible range. They are developed by an international group of experts assembled by the Agency and are based on a country by country assessment, bottom-up approach reflecting both announced plans by governments and electric utilities, and the judgement of the experts.

Demand for the Agency's assistance in capacity building for energy system analysis and planning continued to increase. The Agency's analytical tools for conducting national and regional studies on future energy strategies and the role of nuclear power are now used in more than 125 Member States. During 2012, over 650 energy analysts and planners from 69 countries were trained in the use of these tools. Conventional face to face training was complemented by web based e-learning courses, and the share of e-learning events has steadily increased. More than 200 people (over 30% of those trained in classrooms) were trained using e-learning (Fig. 1). The use of the Agency's e-learning tools for energy planning also avoided an estimated 1000 tonnes of carbon dioxide (CO_2) emissions due to the reduced need for air travel.

In Africa, a regional technical cooperation project on 'Planning for Sustainable Energy Development' provided comprehensive training to facilitate the preparation of subregional energy plans that are compatible with national development goals. Planning was extended beyond the modellers to government departments that are responsible for the implementation of energy plans. To address the lack of expertise in the region, the project gives priority to a train the trainers programme focusing on the Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) analytical tool.

In Latin America, the Agency contributed to the preparation of a comprehensive, region-wide analysis of energy demand under a technical cooperation project, which was concluded in 2012. At the national level, the Agency provided advice on energy planning and consumption through technical cooperation projects to Member States in the region. For example, the Agency worked with the Cuban national authorities through a technical cooperation project to assess the environmental impact of the atmospheric pollution generated by energy facilities, using nuclear measuring techniques and modelling/statistical tools, for supporting energy policy decisions. This assessment will be completed in 2013.[1]

[1] A web link was created for information purposes: *http://cub7007.cubaenergia.cu.*

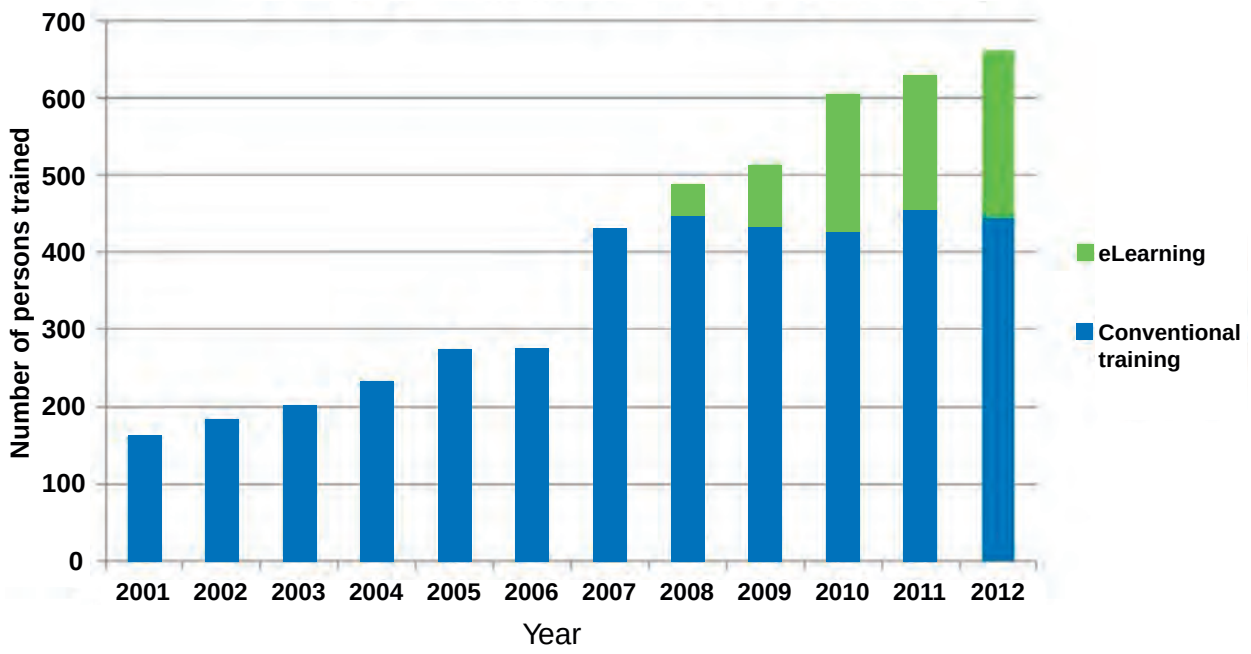


FIG. 1. Growing demand for capacity building in energy system analysis and planning, and increased use of e-learning.

Energy–Economy–Environment (3E) Analysis

In preparation for the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro, Brazil, in June, the Agency published *Energy for Development: Resources, Technologies, Environment*. The publication emphasizes the importance of providing modern, safe and efficient energy services for poverty alleviation, sustainable development, climate change mitigation and energy security. The Agency also published a brochure, *Nuclear Technology for a Sustainable Future,* for Rio+20, which describes the reasons for the continuing interest in nuclear power, including increasing global demands for energy, concerns about climate change, volatile fossil fuel prices and security of energy supply. The Agency also organized three side events as well as a learning event on energy planning. An information centre was maintained that presented the Agency's work to government and non-government delegates.

For the 18th Session of the Conference of the Parties (COP-18) to the United Nations Framework Convention on Climate Change, held in Doha, Qatar, in November and December, the Agency published *Climate Change and Nuclear Power 2012*, which emphasizes the importance of nuclear power, in conjunction with hydropower and other renewables, in reducing CO_2 emissions in the electricity sector and summarizes the latest relevant data and information. The main conclusion is that it will be difficult for the world to achieve the twin goals of ensuring sustainable energy supplies and curbing greenhouse gases without nuclear power. The Agency contributed to the work of the UN High-Level Committee on Programmes Working Group on Climate Change and reported about its work on climate change mitigation and capacity building for energy planning at two UN system side events at COP-18 in Doha. The Agency also maintained an information centre at COP-18 that provided information on the linkages between climate change and nuclear power. Nuclear power continues to be of major interest to delegations from developing countries as they assess their climate change mitigation options.

> *"Nuclear power continues to be of major interest to delegations from developing countries as they assess their climate change mitigation options."*

The Agency initiated a CRP on financing nuclear investments and began preparation of a publication on managing the financial risks associated with new nuclear plant construction. The objective of both projects is to clarify for those considering new nuclear plants the key concepts of financial risk, the current relationship between financial risk

and financing costs, and potential approaches to minimizing such costs.

The Agency also began a CRP on the impacts of climate change and extreme weather events on nuclear energy installations and the energy sector at large. The CRP will use as source material papers prepared for a special issue of the journal *Climatic Change* about the different ways in which climate change is expected to affect different energy technologies and about possible adaptation options. It will cover impacts due both to gradual changes in climate attributes such as temperature, precipitation, windiness and cloudiness, and to changes in the frequency and intensity of extreme weather events.

"The Agency also began a CRP on the impacts of climate change and extreme weather events on nuclear energy installations and the energy sector at large."

Nuclear Knowledge Management

Through its technical cooperation programme, the Agency conducted a number of knowledge management assist visits and informational seminars in 2012. In Belarus, the Agency helped develop and install a computer based training system and an education laboratory for physics studies in nuclear power plants. In Estonia, it helped review that country's new programme to educate specialists in nuclear energy and nuclear safety. In Nigeria, it reviewed nuclear education curriculums against international standards and provided advice about the first postgraduate programme in nuclear science and nuclear engineering. In the United Republic of Tanzania, it helped conduct a needs assessment for a national institute of nuclear science and technology. An assistance visit to the Federal Authority for Nuclear Regulation (FANR) in the United Arab Emirates (UAE) analysed the nuclear knowledge management system FANR had developed to capture and localize relevant knowledge and helped identify key achievements as well as gaps. And in Ukraine, the Agency helped install a computer based simulator complex for nuclear engineering education.

The Agency published *Knowledge Management for Nuclear Research and Development Organizations* (IAEA-TECDOC-1675), which highlights techniques for transferring and preserving knowledge, exchanging information, establishing and supporting cooperative networks, and training the next generation of nuclear experts. It also describes basic concepts, trends and key drivers for nuclear knowledge management relevant to nuclear R&D organizations.

To support sustainable and high quality nuclear education, the Agency continued to facilitate three important regional educational networks, the Asian Network for Education in Nuclear Technology, the AFRA Network for Education in Nuclear Science and Technology, and the Latin American Network for Education in Nuclear Technology. It also completed *Nuclear Engineering Education: A Competence-based Approach in Curricula Development*.

A central element of the Agency's support for the three regional networks is a 'Cyber Learning Platform for Nuclear Education and Training' (CLP4NET). CLP4NET helps Member States to ensure high standards for nuclear education and training and to establish a framework for e-learning. In addition to the existing installations at the Agency, in the Republic of Korea and the UAE, pilot versions of CLP4NET were installed in 2012 in Argentina and Ghana.

Nuclear Energy Management Schools were held at the Abdus Salam ICTP in Trieste, Italy, and in Japan and the UAE (Figs 2 and 3). Intended for young professionals from the nuclear sector, the schools covered the world energy balance, nuclear power and nuclear power economics, materials and research reactors, climate change, Agency activities in nuclear power, the nuclear fuel cycle and waste management, nuclear safety and security, nuclear law, nuclear safeguards, nuclear leadership and management, human resource development and nuclear knowledge management.

FIG. 2. The 2012 Nuclear Energy Management School in Japan.

FIG. 3. Visit to the full scope simulator at the Krško nuclear power plant in Slovenia by participants of the Nuclear Energy Management School at the Abdus Salam ICTP in Trieste.

Nuclear Knowledge Management Schools were conducted in Italy, the Russian Federation and Ukraine. Each provided a forum to share experience and best practices in addition to specialized training on implementing knowledge management programmes in nuclear organizations and on knowledge loss risk management to support innovative developments in the nuclear industry.

In cooperation with the Karlsruhe Institute of Technology in Germany, the Agency trained 14 university teachers from 13 Member States on implementing standardized curriculums for nuclear knowledge management in their universities. The training is part of the Agency's multi-year initiative in cooperation with universities in Member States to address future workforce demands by providing appropriate nuclear curriculums and fostering improvements in nuclear education.

Collecting and Disseminating Nuclear Information

The Agency's International Nuclear Information System (INIS) is operated with the collaboration of 128 States and 24 international organizations. It comprises almost 3.5 million bibliographic records and more than 314 000 full-text non-conventional publications, making it the Agency's largest document database. It is fully indexed and searchable on the Internet using the INIS Collection Search (ICS), a Google based web application developed originally by the Agency in 2011. A new version of ICS that integrates the various INIS databases was implemented in 2012. Users are now able to use ICS in one of eight languages: Arabic, Chinese, English, French, German, Japanese, Russian and Spanish. Using advanced search, users can also obtain the results from other languages, irrespective of the language used to perform the search. Over 90 000 bibliographic records from the IAEA Library catalogue were incorporated into the INIS collection in 2012, making the ICS a single access point for both the IAEA Library catalogue and the INIS collection.

In 2012, an average of 47 000 INIS searches and 2700 downloads were performed each month. Assistance and on the job training were provided to a number of national INIS centres, improving all aspects of their INIS operational capabilities. The INIS/ETDE Thesaurus is available cost free through the INIS web site (*www.iaea.org/inis*) in eight languages — Arabic, Chinese, English, French, German, Japanese, Russian and Spanish.

"In 2012, an average of 47 000 INIS searches and 2700 downloads were performed each month."

The IAEA Library has continued to ensure that information resources and services are timely, cost effective and easily accessible. The number of electronic journals available through the Library increased from 7724 in 2011 to over 16 000 in 2012. Visitors to the Library grew to 15 540, and loans rose from 20 000 to 25 241. Responding to customer demands for tailored packaging of products and services, personalized user profiles increased from 511 to 1018, and 58 987 information packages were delivered in 2012 compared with 41 379 in 2011. Fulfilling the Agency's mandate of fostering information exchange, membership in the International Nuclear Library Network, coordinated by the Agency, grew from 35 partners in 2011 to 42 in 2012.

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

Accurate and reliable nuclear, atomic and molecular data for nuclear technologies are maintained through on-line databases by the Agency for use by its Member States. In 2012, the more than 20 databases received approximately 22 600 hits per month, an increase of about 25% over 2011. In addition, more than 20 000 reports, manuals and technical documents were downloaded during the year.

"Accurate and reliable nuclear, atomic and molecular data for nuclear technologies are maintained through on-line databases by the Agency for use by its Member States."

The International Networks of the Nuclear Reaction Data Centres (NRDC) and the Nuclear Structure and Decay Data Evaluators (NSDD) continued to play a vital role in coordinating the development and maintenance of the databases for, respectively, the Experimental Nuclear Reaction Data (EXFOR) and the Evaluated Nuclear Structure Data File (ENSDF). One major software improvement to the EXFOR database allows more user-friendly retrieval and display of data by renormalizing old measurements using newly evaluated values. Figure 1 shows both old and updated data for the ^{64}Zn(n, p)^{64}Cu reaction. Such updates can be applied automatically, with an additional option to input user specified changes.

To compile and evaluate existing data on beta-delayed neutron emission, as well as to undertake new measurements and develop models based on theory and systematics, a new CRP was launched in August. In May, a preliminary workshop was conducted at McMaster University, in Canada, in support of the CRP.

The publication *Nuclear Data for the Production of Therapeutic Radionuclides* (Technical Reports Series No. 473) was issued in 2012 following the completion of a CRP on the subject. The report provides standardized data for the production of radionuclides for therapeutic purposes.

A technical meeting on 'Data Evaluation for Atomic, Molecular and Plasma–Material Interaction Processes in Fusion' was organized in September jointly by the Agency and the National Fusion Research Institute in Daejeon, Republic of Korea. The papers from this meeting, which were published

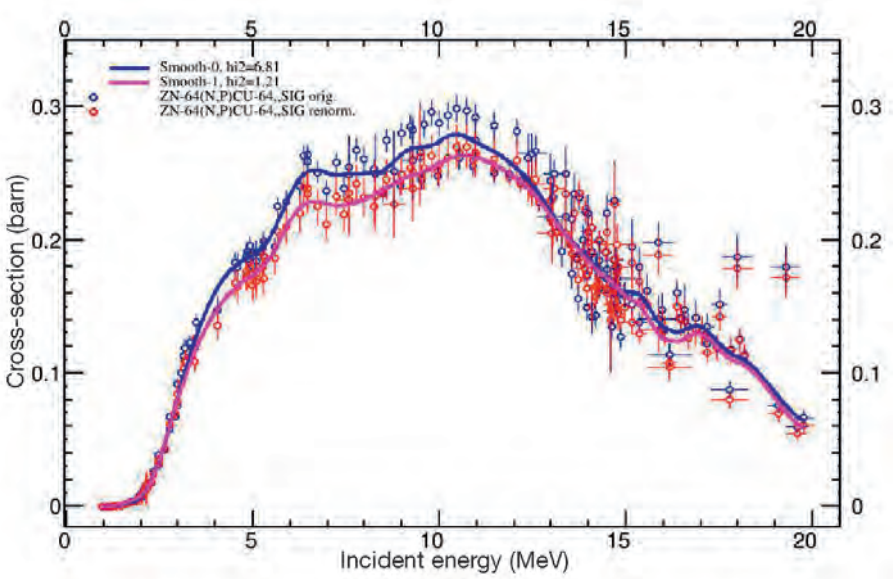


FIG. 1. Original (blue) and renormalized (magenta) experimental data for the ^{64}Zn(n, p)^{64}Cu reaction from EXFOR illustrating improved fitting.

in a special issue of *Fusion Science and Technology*, describe the current status of evaluated databases and improvements to data evaluation methods.

Two key challenges for fusion energy production are wall erosion and tritium retention in wall materials. The Agency is encouraging collaboration on plasma–wall interaction studies for beryllium, tungsten (including irradiated tungsten) and various steels, all of which are regarded as the most important fusion materials. A related CRP on 'Data for Erosion and Tritium Retention in Beryllium Plasma-Facing Materials' was launched in 2012. Owing to the toxicity of beryllium, there has been little experimental work, and materials modelling has an important role to play.

About 45 participants were trained in fusion plasma modelling and nuclear structure and decay data evaluation, at joint Agency–Abdus Salam ICTP workshops in 2012. The workshops covered fusion plasma modelling using atomic and molecular data and nuclear structure and decay data.

Research Reactors

Improving the utilization of research reactors

The Research Reactor Benchmarking Database: Facility Description and Experiments brings together information for carrying out computational code validation exercises across a wide range of research reactor types. It was completed in 2012 through a CRP, which concluded in December.

A manual on *Neutron Transmutation Doping of Silicon at Research Reactors* (IAEA-TECDOC-1681) was published in 2012. The publication also includes a database on experience in Member States and on using neutron irradiation of silicon for the semiconductor industry.

"The Agency is encouraging collaboration on plasma–wall interaction studies for beryllium, tungsten (including irradiated tungsten) and various steels, all of which are regarded as the most important fusion materials."

In October, the Agency cooperated with the Egyptian Atomic Energy Authority in convening the 7th AFRA Conference on Research Reactor Utilization and Safety, held in Cairo, Egypt (Fig. 2). The event provided a forum for managers, operators, users and safety specialists from 17 AFRA Member States to discuss topics related to research reactor utilization, operation and safety. Emphasis was given to the importance of cooperation among States through the sharing of available infrastructure and expertise, enhancing regional networking, promoting national and regional self-reliance, and

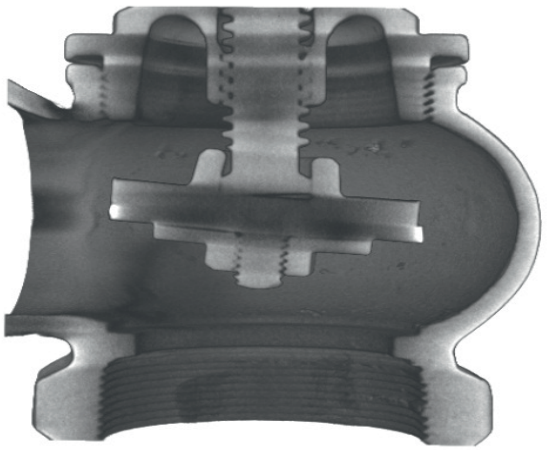


FIG. 2. A digital neutron imaging facility (left) licensed at the ETRR-2 reactor in Egypt. This state of the art installation will provide 2-D and 3-D non-destructive testing capabilities for various applications. On the right is a reconstructed image of a defective valve.

enabling the sustainable utilization and enhanced safety of research reactors.

Research reactors in education and training

A training course to assist Member States interested in initiating new research reactor projects or improving the utilization of existing research reactors was held in 2012. The six week course, organized by the Eastern European Research Reactor Initiative and supported by the Agency, was conducted at research reactors in Austria, the Czech Republic and Slovenia. Since this course was established in 2009, 44 students from Africa, Asia, Europe and Latin America have been trained.

As in previous years, the use and applications of research reactors were addressed in the programme of the School of Nuclear Energy Management. In 2012, two schools were conducted: in January in Abu Dhabi, United Arab Emirates, and in November at the Abdus Salam ICTP, in Trieste, Italy, which also included a technical tour of the TRIGA research reactor in Ljubljana, Slovenia.

"The safe repatriation of the Austrian fuel marks the removal of all TRIGA HEU fuel from civilian nuclear applications worldwide."

Research reactor infrastructure

A guidance publication stressing the importance of a sound justification for a research reactor based on national or regional needs, *Specific Considerations and Milestones for a Research Reactor Project* (IAEA Nuclear Energy Series No. NP-T-5.1), was issued in 2012.

As part of its activities to assist Member States in the aftermath of the accident at the Fukushima Daiichi nuclear power plant, the Agency developed guidance on performing safety reassessments for research reactors. One of the steps recommended was to carry out a graded approach commensurate with potential hazards.

The Agency's Research Reactor Database (RRDB) continued to be updated during the year. Data for 226 facilities were updated.

Research reactor fuel

The TRIGA MARK III research reactor in Mexico was converted from HEU to LEU fuel, and its final HEU fuel shipped back to the USA in March 2012. In September, conversion of the Maria research reactor in Poland to LEU fuel was also completed using specially designed LEU fuel. In December 2012, the final removal of all HEU from Austria took place following the complete conversion of the Vienna TRIGA reactor to LEU fuel. The safe repatriation of the Austrian fuel marks the removal of all TRIGA HEU fuel from civilian nuclear applications worldwide.

As part of the Russian Research Reactor Fuel Return programme, the Agency assisted in the repatriation to the Russian Federation of fresh HEU fuel and HEU spent fuel from Ukraine. In August and September 2012, HEU spent fuel was shipped from Uzbekistan and Poland. One additional shipment to remove fresh HEU fuel from Poland was also completed.

The Miniature Neutron Source Reactors (MNSRs) Working Group (which coordinates the conversion of MNSRs to LEU and the shipping of HEU spent fuel to China) held a series of meetings to plan the modification of the Skoda VPVR/M spent research reactor fuel casks, purchased in 2006 for the Russian Research Reactor Fuel Return programme, for the project. In China, construction of a test facility to demonstrate LEU fuel design progressed.

In order to facilitate the transition away from reliance on HEU for global molybdenum-99 (^{99}Mo) supply, the Agency organized a meeting in Vienna in November focused on specific issues confronting major HEU based producers and on opportunities for multilateral cooperation. Support to Member States is to continue until all major producers have converted to LEU by the end of 2015.

Research reactor operation and maintenance

To provide a peer review service on research reactor operational performance complementing Integrated Safety Assessments of Research Reactors (INSARR) missions, the Agency established the Operation and Maintenance Assessment for Research Reactors (OMARR) service in 2012. The first OMARR review mission was concluded in December to the National Institute of Standards and Technology in Maryland, USA. A pre-OMARR review mission to the TRIGA research reactor at

the University of Pavia, Italy, was conducted in October for the OMARR review mission scheduled for March 2013.

Accelerators for Materials Science and Analytical Applications

A CRP on improving the reliability and accuracy of heavy ion beam nuclear analytical techniques, expanding the existing high velocity dataset (Fig. 3), was completed in 2012.

In August, 39 trainees reviewed the status of ion induced radiation effects in semiconductors and insulators in a joint Agency workshop in Trieste, on the physics of radiation effect and its simulation for non-metallic condensed matter.

A technical meeting organized jointly by the Agency, the Support of Public and Industrial Research Using Ion Beam Technology (SPIRIT) and Japan was held in Croatia. The meeting focused on the development and utilization of MeV secondary ion mass spectrometry, and participants examined future R&D needs for molecular surface analysis and imaging.

to accelerator applications to make use of highly specialized applications to monitor, diagnose and remediate environmental and human health related problems (Fig. 4).

The Agency ion beam line at the Ruđer Bošković Institute (RBI) in Zagreb, Croatia, was upgraded to expand the analytical range of its particle induced X ray emission mode and to significantly improve detection limits for trace elements. With Agency support, researchers from Member States conducted a series of joint measurements at RBI in July using the upgraded ion beam line.

"A CRP on improving the reliability and accuracy of heavy ion beam nuclear analytical techniques, expanding the existing high velocity dataset ..., was completed in 2012."

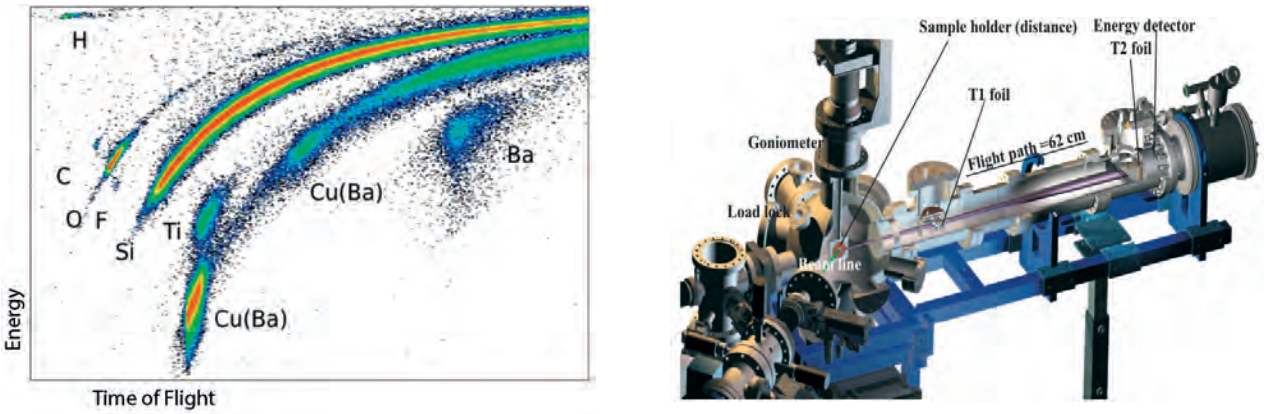


FIG. 3. Time of flight–energy histogram from a thin barium titanate film on silicon measured as part of the CRP on heavy ion beam nuclear analytical techniques (left), and the experimental setup (right).

Nuclear Instrumentation and Spectrometry

The construction of the ultra-high vacuum chamber (UHVC) continued in 2012, with most key phases of the project implementation completed. The UHVC, which is to be installed at the Elettra IAEA Collaborating Centre in Trieste, is being developed in collaboration with the Federal Institute of Physics and Technology, Berlin, and the Technical University of Berlin. The UHVC will enable Member States working on a variety of Agency projects related

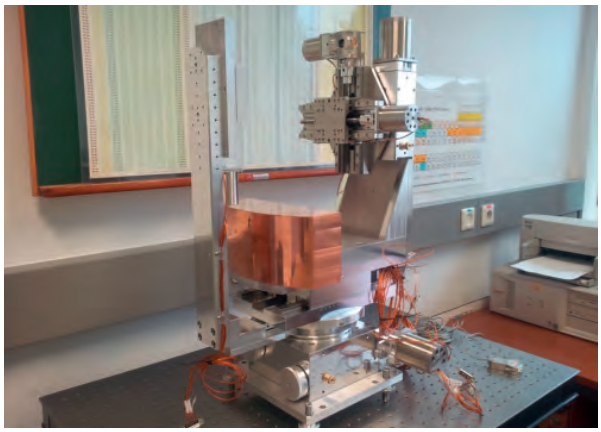


FIG. 4. The seven axis motorized UHVC sample manipulator test setup at the Agency's Nuclear Spectrometry and Applications Laboratory.

Nuclear Fusion

The 24th IAEA Fusion Energy Conference, held in October in San Diego, USA, attracted nearly 850 participants from 37 Member States and 5 international organizations. Approximately 700 papers were presented, including results of the ITER like wall experiment (Fig. 5) on the Joint European Torus (JET) fusion device in the United Kingdom. The conference provided encouraging news of advances in fusion research, including the steady progress in the construction of ITER, and numerous advances at different laboratories in the physics basis for runaway electron control and the mitigation of disruptive instabilities in ITER.

With ITER under construction and many countries initiating R&D activities as part of the Demonstration Power Plant (DEMO), which envisions the use of fusion energy on an industrial, power plant scale, the Agency established an annual series of DEMO Programme Workshops to facilitate international cooperation and define and coordinate DEMO activities. Approximately 70 participants attended the first of such workshops, held in October at the University of California, Los Angeles, USA. Discussions highlighted the importance of ITER as a critical element of the DEMO programme. Although countries are developing their own strategies independently, given the breadth of expertise and the scale of facilities and activities required to develop fusion, international collaboration will remain an essential component for advancing in this area.

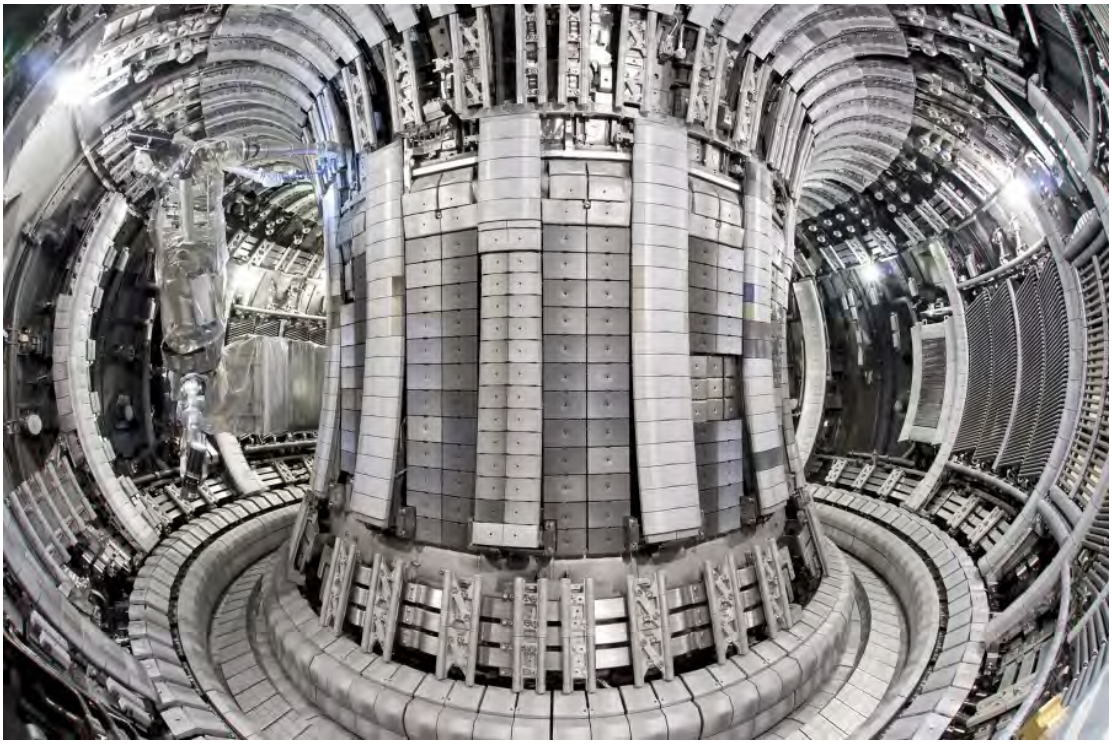


FIG. 5. The inside of the JET vacuum vessel with the installation of the ITER-like wall completed.

Food and Agriculture

Objective

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

Animal Production and Health

Development of early and rapid diagnostic technologies for 'on the spot diagnosis' of animal diseases plays a crucial role in limiting the spread of disease and in applying timely disease control measures. With this in mind, the Agency developed a prototype of a mobile laboratory device that brings the laboratory to the field. The device, aimed at the early and rapid diagnosis of various infectious diseases such as peste des petits ruminants (PPR), Newcastle disease, avian influenza H5N1, and foot-and-mouth disease (FMD), was successfully evaluated in Cameroon. This new technology is being disseminated to Member States through regional training courses. The device supports scientifically advanced diagnostic chemistries packed in simplified reagent kits and using equipment capable of being connected to car batteries (Fig. 1).

FIG. 1. The Agency's mobile laboratory device for rapid disease diagnosis in the field, shown in Cameroon.

Animal diseases, including those with zoonotic impact, are still a major threat to animal and human health in developing countries. The Agency enhanced support to numerous Member States in the diagnosis and control of animal diseases such as FMD (Argentina, Bolivia, Botswana, China, Democratic Republic of the Congo, Mongolia and Nigeria); PPR (Angola, Botswana, Democratic Republic of the Congo, Mozambique, Namibia, United Republic of Tanzania and Zambia); Rift Valley fever (Botswana, Kenya, Islamic Republic of Mauritania, South Africa and Zimbabwe); trypanosomosis (Ethiopia, Kenya, United Republic of Tanzania and Zambia); African swine fever (Angola, Democratic Republic of the Congo and Zambia); and brucellosis (Algeria, Bosnia and Herzegovina, and Zimbabwe).

"...the Agency developed a prototype of a mobile laboratory device that brings the laboratory to the field."

Artificial insemination of domesticated animals is a well known technique that improves the productive performance of farm animals by using the semen of carefully selected, certified males. In 2012, artificial insemination centres for cattle and small ruminants were established in Angola, Cambodia, Central African Republic, Chad, Iraq, Jordan, Nepal, Oman, Sierra Leone, Syrian Arab Republic and Yemen, enabling wider use of genetically superior animals which can improve livestock productivity (Fig. 2).

FIG. 2. Cross-bred cattle are more resistant to diseases.

Emergency Preparedness and Response

An interactive database used to monitor the radiological contamination of foodstuffs for human consumption after the accident at the Fukushima Daiichi nuclear power plant has been developed by the Agency through the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture. This database, which is awaiting release, includes information provided since March 2011 by the Japanese Ministry of Health, Labour and Welfare through the FAO/WHO International Food Safety Authorities Network (INFOSAN) and facilitates standardized data entry and evaluation by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) of exposure and assessment of dose to the public and the environment. Additionally, the database allows interactive communication with independent external databases, enabling comprehensive, multi-layer analysis of accidents.

Approximately 126 000 records on radionuclide concentrations in over 500 types of foodstuff collected from 1076 locations in all 47 prefectures of Japan, have been compiled in the database. The database was made available to the Expert Groups for the UNSCEAR Fukushima study during September 2012 and is now being used for the assessment of radiation doses to the public and the environment. This assessment is on the agenda of UNSCEAR's 60th session, in May 2013, at which it is expected to finalize its evaluation for the United Nations General Assembly.

"...the use of irradiation as a treatment against harmful insect pests is expanding with Agency assistance in countries...which trade irradiated fruit to meet quarantine requirements for international trade."

Food Safety and Food Control

To facilitate the training of developing country scientists, five train the trainers workshops on food quality and safety were held in 2012, the first year of a three year project funded by the Peaceful Uses Initiative. Approximately 90 developing country scientists were trained in the use and deployment of liquid and gas chromatography coupled to mass spectrometry, advanced analytical methodologies, laboratory quality systems, food safety monitoring and contaminant control programmes, sampling, radiotracer techniques for food contaminant control, and integrated analytical approaches for food traceability. The workshops were held in Austria, Belize, Panama and Uruguay. Special emphasis was given to the central role played by analytical laboratories in the 'farm-to-fork' food safety chain.

Irradiation prevents insects from reproducing without leaving residues or altering product temperature, and avoids detrimental effects on food quality by eliminating harmful pre-shipment chemical treatments. Consequently, the use of irradiation as a treatment against harmful insect pests is expanding with Agency assistance in countries such as Australia, India, Mexico, New Zealand, Pakistan, Thailand, the USA and Vietnam, which trade irradiated fruit to meet quarantine requirements for international trade.

Through the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, the Agency has supported research into phytosanitary irradiation treatments since 2007, resulting in 13 treatments against specific insects and one generic fruit fly treatment being adopted as the International Plant Protection Convention (IPPC) standard. Important gaps remain, however, and generic treatments need to be developed against broad pest categories to provide countries with safe new options for protecting their produce and strengthening international trade (Fig. 3).

FIG. 3. Irradiation prevents loss of fresh produce.

Sustainable Management of Major Insect Pests

The combination of pre-harvest pest suppression measures and post-harvest quarantine treatments can help countries to export their produce by eliminating the risk of introducing new pests into importing countries and by improving food quality. The FAO/IAEA Insect Pest Control Laboratory in Seibersdorf is currently rearing 14 species of invasive tephritid fruit flies, with some 30 different strains. This offers the opportunity, not possible in any other facility in the world, to develop, in collaboration with the United States Department of Agriculture, phytosanitary treatments for several important pest species. A cold treatment for *Bactrocera zonata* on oranges was completed, which has led to the development of a new internationally recognized treatment schedule for this pest species on citrus. Studies on the relative cold tolerance of other species are continuing. Validation of hot water treatment for three fruit fly species (*B. invadens*, *B. zonata* and *Ceratitis capitata*) in mango is in progress. Also, work on *Anastrepha grandis* is continuing with the successful development of infestation techniques for this tephritid in zucchini and pumpkin.

In addition to the studies mentioned above, and to provide the required regulatory framework, an international standard on 'Systems approach for pest risk management of fruit flies (Tephritidae)', developed by the Agency in support of the IPPC, was ratified by the Commission of Phytosanitary Measures in 2012. Its application allows a level of quarantine security that guarantees that the fruit fly pest cannot establish itself in the importing country, thereby overcoming phytosanitary trade barriers and supporting the exports of fruit and vegetable crops by Member States.

A CRP on 'Improving SIT for Tsetse Flies through Research on Their Symbionts and Pathogens' was completed in 2012, resulting in a better understanding of the dynamics and interaction between bacterial symbionts and viral and other pathogens, as well as the development of strategies based on symbionts or entomopathogenic fungi to control tsetse flies. In conjunction with this CRP, the Agency developed effective tsetse virus management protocols that have significantly reduced the virus load in fly colonies, thereby removing some of the constraints to mass rearing systems in Africa and the implementation of the sterile insect technique (SIT) for tsetse.

Crop Improvement through Mutation Breeding

The introduction of mutant varieties contributes not only to food security, but also to adaptation to climate change. The High Level Panel of Experts on Food Security and Nutrition that supports the United Nations Committee on World Food Security emphasized the importance of developing strategies for climate resilient agriculture and food security.

"In 2012, six new mutant varieties were officially released by Member States, and another three pre-released, to farmers."

In 2012, six new mutant varieties were officially released by Member States, and another three pre-released, to farmers. These varieties were produced with the support of the Agency through its technical cooperation programme and CRPs. They include two tomato varieties from Sudan that are resistant to tomato yellow leaf curl virus (TYLCV) (Fig. 4). Both had higher fruit yields, earlier harvesting, better fruit quality in terms of size and firmness, and higher tolerance to TYLCV and powdery mildew in comparison not only to their parent variety, but also to the most commonly grown commercial tomato cultivars.

Agency support in building capacity in the area of mutation breeding in the former Yugoslav Republic of Macedonia resulted in the first national yield trials of

FIG. 4. Mutant tomato lines in Sudan.

mutant wheat varieties. These are expected to be the first mutant varieties officially released in this country.

Further applications of mutant varieties contribute to both food security and to adaptation to climate change. In this context, an Agency CRP included a Chinese research contract on a cropping technique that allows the production of two crops from one planting. The crop involved should have a well developed root system, earlier maturity, and a perennial nature. The technique involves cutting the crop in such a way as to allow a shoot to sprout from the root of the cropped plant (rationing), reducing the need to prepare and clear the land for agriculture. The technique's main economic benefit is to rapidly expand the area of cultivation, thereby contributing to food security.

"Under a technical cooperation project ... scientists in Zambia used nitrogen-15 isotopes to evaluate and apply the most effective fertilizer, resulting in the yield increasing from 1.2 to 5 t/ha with a urea application of 100 kg N/ha."

Sorghum, a crop introduced in Indonesia, has a narrow genetic base which has been improved through mutation breeding. In 2012, mutant sorghum varieties with high yield and drought tolerance increased crop productivity in Indonesian drylands. This promoted food diversification and sustainable agricultural development, while providing employment and improving the welfare of farmers through a range of healthful food products high in protein and calcium. In Peru, a high altitude mutant amaranth variety adapted to harsh climatic conditions was certified as an organic produce. This variety is in demand for export due to its high quality grain, and because it is cultivated under good agronomic practices with little or no chemically maintained weed, pest or disease management interventions. Its export has generated additional income for farmers.

Soil and Water Management and Crop Nutrition

The Agency organized an FAO/IAEA international symposium on 'Managing Soils for Food Security and Climate Change Adaptation and Mitigation' in July 2012, which covered a wide range of topics, including soil management for crop production, climate change adaptation and mitigation, ecosystem services, preservation and protection of soil resources, water conservation for agricultural production and pollution control. Recent advances in nuclear techniques and applications in soil and water management for agricultural production were also discussed. In addition, the FAO Global Soil Partnership was highlighted, and various soil and water sampling and measurement devices were displayed.

Maize is a staple food crop in Zambia and is grown by 70% of smallholder farmers. Yield is low (1.2 tonnes/hectare (t/ha)), compared with the global average of 4 t/ha). One of the major challenges limiting high maize yield is poor soil fertility and inadequate nutrients due to the high cost of fertilizer. With a price of around $41 per 50 kg bag of urea, many farmers cannot afford to pay for the fertilizer to maximize yield. There is thus an urgent need to improve maize yield while keeping the input costs to a minimum. Under a technical cooperation project on 'Developing Maize Genotypes for Drought and Low Soil Fertility Tolerance', scientists in Zambia used nitrogen-15 isotopes to evaluate and apply the most effective fertilizer, resulting in the yield increasing from 1.2 to 5 t/ha with a urea application of 100 kg N/ha. The project results showed that the controlled or slow release of urea coated with nitrification and urease inhibitors decreases the rate at which urea is converted to ammonia and nitrate. This decreases the amount of urea required for maize crops by 50% while maintaining yield. The potential impact in terms of saving fertilizer and increasing production over 500 000 ha is significant. The results of this study are likely to shape the policy on the type of fertilizer to be used and fertilizer imports in Zambia (Fig. 5).

FIG. 5. Farmers applying urea fertilizer to a maize crop.

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.

Stable Isotope Techniques in Nutrition for Improved Health

One of the Agency's priorities is to build capacity in Member States in the use of stable isotope techniques for the evaluation of nutrition interventions. For example, through Agency support, the Kuwait Institute for Scientific Research acquired a highly trained body of staff and a laboratory equipped with an isotope ratio mass spectrometer and the ability to perform dual energy X ray absorptiometry. The laboratory is the only one in the Gulf Cooperation Council region with the capability to use stable isotope techniques, and the only one in the country that can perform assessments to evaluate the effectiveness of national intervention programmes aimed at reducing childhood obesity.

A United Nations task force was created in 2012 to help fulfil the commitments that form part of the 2011 Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases (NCDs). The Declaration calls on relevant United Nations system programmes, funds and agencies to work together in a coordinated manner to support national efforts against NCDs and to mitigate their impact. The Agency participated in the third meeting and hosted the fourth meeting of the UN Funds, Programmes and Agencies on the Implementation of the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of NCDs. It also contributed comments on the Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020 to ensure that Agency support to health ministries in strengthening their capacities to use nuclear techniques in evaluating interventions on physical activity and healthy lifestyle is reflected fully in the final Global Action Plan (Fig. 1).

A publication issued in 2012 on the *Assessment of Iron Bioavailability in Humans Using Stable Iron Isotope Techniques* is an important part of the Agency's efforts to transfer technology and to address micronutrient deficiency issues in Member States. It provides guidelines on how to use stable isotope techniques to assess the bioavailability of iron compounds as an important step in the development of food based strategies such as food fortification and food biofortification to combat iron deficiency anaemia.

FIG. 1. Children participating in an Agency supported regional project using stable isotope techniques to evaluate nutrition interventions against childhood obesity.

"One of the Agency's priorities is to build capacity in Member States in the use of stable isotope techniques for the evaluation of nutrition interventions."

Nuclear Medicine and Diagnostic Imaging

As part of the QUANUM (Quality Assurance in Nuclear Medicine) programme, an interregional project was started in 2012 to offer auditing missions to all regions covered by the Agency's technical cooperation programme. The objective is to conduct quality assessments of nuclear medicine services, in accordance with the Agency's QUANUM guidelines. A quality management self-assessment questionnaire

was completed by the selected institutes and submitted before the visit by the external audit team.

Quality Assurance and Metrology in Radiation Medicine

The role of computed tomography (CT) in modern medicine is well established as a means of diagnosis and also as an essential precursor to radiotherapy treatment. The complexity of this technology continues to increase, as does its potential to deliver substantial doses to patients. Consequently, the need for quality assurance to acquire the maximum clinical information at acceptable radiation dose levels is critical. The Agency issued a publication — *Quality Assurance Programme for Computed Tomography: Diagnostic and Therapy Applications* (IAEA Human Health Series No. 19) — that contains advice on both diagnostic and therapeutic applications of CT in recognition of the fact that in many facilities a CT scanner is used for both applications.

To ensure consistency in radiation measurements, the Agency calibrated about 50 national dosimetry standards of Member States, harmonizing and linking radiation measurements to the International System of Units for radiotherapy, radiation protection and X ray diagnostic radiology. Since many Member States are in the process of establishing measurement and calibration capabilities in X ray diagnostic radiology, a technical meeting on 'Dosimetry and Comparisons in Diagnostic Radiology for Secondary Standards Dosimetry Laboratories (SSDLs)' was held at the Agency's Dosimetry Laboratory in Seibersdorf in November with the participation of several Member States. Comparison measurements were performed in the Agency's reference X ray diagnostic beams to verify the link of their national dosimetry standards to the international measurement system (Fig. 2).

"...the Agency calibrated about 50 national dosimetry standards of Member States, harmonizing and linking radiation measurements to the International System of Units for radiotherapy, radiation protection and X ray diagnostic radiology."

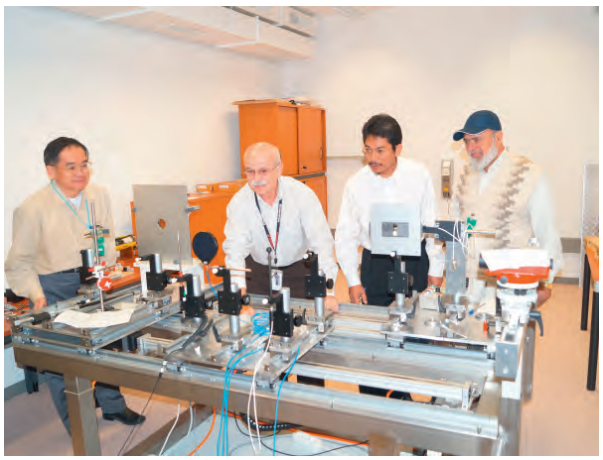


FIG. 2. Comparison measurements of national dosimetry standards in X ray beams during a technical meeting at the Agency's Dosimetry Laboratory in Seibersdorf.

Applied Radiation Biology and Radiotherapy

A network of radiotherapy departments in Anglophone countries in Africa was established in 2012. The aim is to provide a forum for the professionals in radiotherapy centres in those countries who otherwise would have little opportunity to discuss cases, attend international meetings, or present challenging or unusual patient cases and benefit from the opinion of outside experts. The forum is expected to improve the quality of clinical decision making, thus contributing to radiotherapy treatments which are safer and more in line with internationally accepted standards (Fig. 3). Eight on-line meetings have taken place, during which diagnostic images, pathology slides and radiotherapy plans have been shared.

Biological dosimetry is a set of tools and techniques for assessing the health risk to the general public as well as to individuals who as a result of their work are exposed to radiation caused

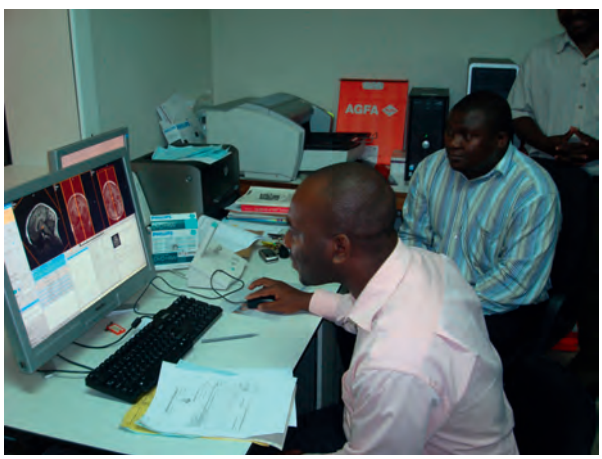


FIG. 3. Image acquisition for radiotherapy planning.

by nuclear or radiation accidents. A network of 24 laboratories from around the world was established in 2012 to conduct research on biological dosimetry techniques. The research results can be applied in the assessment of human populations exposed, or potentially exposed, to radiation as a consequence of radiation accidents or malicious acts. The network made progress in establishing four major methods of contemporary biodosimetry and derived an in vitro dose response curve for all four methods. Some of the groups are performing innovative research to develop new methods using biodosimetry for adaptive response studies and the adoption of advanced statistical methods to improve the resolution of dose reconstructions.

Programme of Action for Cancer Therapy (PACT)

With increasing demand for support from low and middle income (LMI) Member States, funding and resource mobilization continued to be a major focus for the Agency. In 2012, PACT received $1.8 million in contributions and pledges from partner organizations and Member States. In addition, agreements were signed for the implementation of cancer control projects through PACT Model Demonstration Sites in Mongolia, Nicaragua and Vietnam.

The integrated missions of PACT (imPACT) reviews to address Member State requests for comprehensive cancer control capacity and needs assessment require a high level of coordination with external partners such as WHO, the International Agency for Research on Cancer and the Union for International Cancer Control. The establishment of an internal PACT Working Group in December 2012 and completion of the imPACT process review are expected to strengthen imPACT reviews and ensure timely, efficient and comprehensive delivery of this important Agency service to Member States. By the end of 2012, 13 Member States had received imPACT missions. This brought to 47 the number of Member States who have received an imPACT mission since the creation of PACT.

The Advisory Group on Increasing Access to Radiotherapy Technology in LMI countries (AGaRT) entered its third year in 2012, and continued to bring together users in LMI countries and major radiotherapy equipment suppliers. During the annual AGaRT meeting in June 2012, discussions focused on the development of radiotherapy equipment packages for low resource settings. AGaRT members agreed to develop basic, intermediate and advanced level radiotherapy equipment based upon the specific conditions of the four geographical regions represented in AGaRT.

"During the annual AGaRT meeting in June 2012, discussions focused on the development of radiotherapy equipment packages for low resource settings."

The Virtual University for Cancer Control and Regional Training Network (VUCCnet) Africa initiative also entered its third year in 2012. The participating Member States include Egypt, Ghana, South Africa, Uganda, the United Republic of Tanzania and Zambia, as well as donors such as the Roche African Research Foundation and the USA, among others. In addition to courses on cervical cancer, two e-learning courses on palliative care and cancer care skills for community health workers are being developed.

Water Resources

Objective

To enable Member States to use isotope hydrology for the assessment, use and management of their water resources.

The IAEA Water Availability Enhancement Project

The IAEA Water Availability Enhancement (IWAVE) project assists Member States in increasing the availability and sustainability of fresh water using comprehensive, science based assessments of national water resources. Specifically, the project strengthens national capacities for collecting, managing and interpreting water resources data using advanced techniques. A side event on the progress made in this project was held during the Agency's 56th General Conference in September. Ministerial representatives from Costa Rica, Oman and the Philippines highlighted achievements and shared their experience.

"The IAEA Water Availability Enhancement (IWAVE) project...strengthens national capacities for collecting, managing and interpreting water resources data using advanced techniques."

For example, in Costa Rica, a new initiative by the Ministry of Environment, Energy and Telecommunications, known as the 'Agenda for Water', was initiated with the involvement of IWAVE and major national stakeholders. In Oman, work focused on completion of the third assessment of the national monitoring networks, involving substantial field work as well as upgrading of monitoring networks and national hydrological databases. And through the IWAVE project, the Agency assisted the Philippines in publishing a document identifying the main gaps in the data and scientific capacity required to provide a sound assessment of surface water and groundwater systems as well as the specific investments required to fill those gaps. Field studies to acquire hydrological data have been initiated in the three Member States (Fig. 1).

FIG. 1. Water sampling in the Philippines as part of the IWAVE project.

Technical Publications in Isotope Hydrology

More than 20 scientific articles on different aspects of isotope hydrology were published describing new methods for isotope data collection and interpretation. These include a new interpretation of the factors controlling the isotope contents in precipitation at global and regional scales, overcoming the inconsistencies and limitations of previous approaches. Other work dealt with the development of a simplified graphical interpretation of carbon-14 data in groundwater, which will help the counterparts of Agency projects to better assess groundwater flow and transport. In addition, the tritium content of precipitation in Japan following the accident at the Fukushima Daiichi nuclear power plant was evaluated to assess the environmental impact of accidental releases of radioactivity.

Technical Cooperation Projects on the Assessment of Water Resources

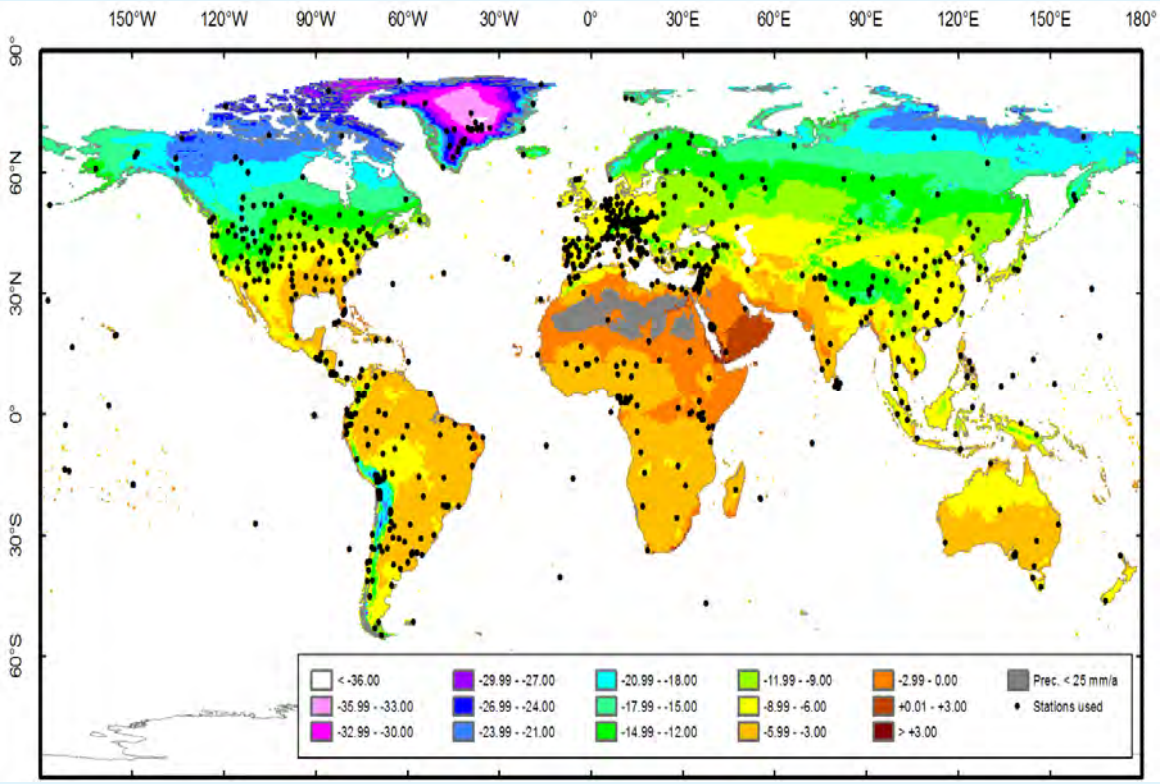
In Ghana, an Agency technical cooperation project focusing on the assessment of water quality issues in the coastal zone of the Central Region demonstrated, through the use of stable water isotopes, tritium and carbon-14, that seawater intrusion was not the main mechanism responsible for the high salinity observed in groundwater

near the coast. The study proved that there are at least two main types of aquifer in the area, one in fractured media, which is poorly replenished, and a shallower one, formed by fluvial sediments, which has a significantly higher rate of recharge and is more prone to water quality deterioration. The findings of this project have provided a sound basis for sustainable water resource development and management in the area. The Agency's technical cooperation projects in Ghana also contributed to developing the expertise required to interpret isotope data, as well as to building capabilities for

MORE ACCURATE ISOTOPE MAPS

The stable oxygen and hydrogen isotope compositions of meteoric waters (i.e. precipitation, rivers, lakes and shallow groundwater) are used to trace water sources and hydrological processes in a wide range of environmental disciplines, including hydrology, climate and palaeoclimate studies, atmospheric sciences, ecology and forensics. These applications use the isotopic composition of present-day precipitation for which the Agency's Global Network of Isotopes in Precipitation (GNIP), a programme operated since 1961 in cooperation with the World Meteorological Organization, is the primary source of global data. In recent years, there has been a growing demand in many environmental sciences for isotope maps covering different spatial and temporal scales. Because the data are provided by individual stations and GNIP is limited to point measurements, there are substantial gaps, in both time and space, requiring the estimation of isotope contents of meteoric waters at the global scale based on the observations provided by the GNIP data set.

To address this need, the Agency has developed a new method for the interpolation of isotope data. This method, based on the use of regionally defined climatic regression coefficients, resulted in the production of more accurate isotope maps than those previously available. In addition, the Agency's new method provides the ability to generate isotope maps at variable time and space intervals (for example, monthly or yearly at regional or local scales). Different isotope maps are being made accessible on-line to scientists and other users of environmental isotopes in many disciplines.



Distribution of long term oxygen-18 contents of precipitation obtained through the interpolation of data from GNIP.

FIG. 2. Sampling campaign for isotope and hydrochemical analysis of groundwater in southern Ghana.

the analysis of stable water isotopes and tritium (Fig. 2).

An Agency regional technical cooperation project in the Asia and Pacific area addressing the assessment of fresh water quality using environmental isotopes and chemical techniques was completed. Thirteen Member States showed marked progress in the acquisition and interpretation of isotope data to address key issues related to water resources assessment and management. These issues included the identification of groundwater recharge sources, and groundwater flow and transport, as well as inter-aquifer hydraulic connections, and characterization and assessment of the impact caused by natural and human-made pollution sources, such as arsenic, fluoride, iron or nitrate.

Environment

Objective

To enhance the capacity to understand marine, terrestrial and atmospheric environmental processes and identify problems caused by radioactive and non-radioactive pollutants and climate change using nuclear techniques and isotopes.

Strengthening Laboratory Analyses in Member States

The Agency provides about 100 reference materials in the fields of environmental radionuclides, stable isotopes, trace elements and organic pollutants according to ISO Guides 34 and 35. In 2012, new potential reference materials for radionuclides were characterized for environmental emergencies, for example, with regard to milk powder, soil and hay with slightly enhanced radionuclide levels. In order to assist Member States in strengthening the data quality assurance of their marine pollution monitoring programmes, three new reference materials were produced for trace elements and methyl mercury in marine sediments, and one reference material was produced for organic contaminants in marine biota (clams) (Fig. 1).

The Agency organizes annual proficiency tests to assess, on a voluntary basis, the quality and performance of analytical laboratories around the world. In 2012, a special proficiency test was organized, upon request, for 20 Japanese laboratories to evaluate and upgrade their analytical capabilities for environmental radionuclide analysis.

As part of the Agency's quality assurance scheme for laboratories in the ALMERA (Analytical Laboratories for the Measurement of Environmental Radioactivity) network, robust analytical procedures are developed and tested to improve the capabilities of these laboratories for reliable measurement of radionuclides in the environment. Three new procedures for improved measurement of radionuclides in the environment were finalized in 2012 and are ready to be issued. The first is a procedure for the rapid determination of radium isotopes in drinking water, while the other two procedures improve the analysis of radionuclides of plutonium, americium, strontium, polonium, lead, thorium, uranium and radium in environmental samples (Fig. 2).

"The Agency organizes annual proficiency tests to assess, on a voluntary basis, the quality and performance of analytical laboratories around the world."

FIG. 1. Marine reference materials for radionuclides to support Member State analytical capabilities for the determination of radionuclides in the marine environment.

FIG. 2. Cutting a sediment core collected in the Kara Sea into vertical layers in order to investigate the historical contamination of radionuclides near dumped nuclear waste.

A proficiency test for radionuclides was conducted with over 200 participants from environment laboratories all over the world. Another test involved 50 participants from laboratories in the ALMERA network. A steady improvement in the performance of the ALMERA laboratories was noted, as well as the fact that they significantly outperformed other similar laboratories in radioanalysis and in reporting results with higher precision.

In June, the Agency hosted the 13th international symposium on Biological and Environmental Reference Materials (BERM 13). About 200 representatives from leading Member State institutions that produce reference materials, as well as their recipients, discussed the provision of analytical tools to laboratories around the world. Individual sessions focused, inter alia, on safeguards, environmental emergency preparedness and stable isotope applications.

"Furthermore, 70 bottles of certified reference materials for trace elements and organic contaminants were distributed free of charge to Member State laboratories for the validation of analytical methods and to achieve traceability of the results."

In collaboration with regional seas organizations such as HELCOM, OSPAR, ROPME and MED POL,[1] the Agency conducted three proficiency tests for radionuclides, trace elements and organic contaminants for ROPME. In addition, two proficiency tests were organized for UNEP's Mediterranean Action Plan for the Barcelona Convention for organic contaminants and for trace elements in marine samples. These types of proficiency test are necessary to improve the quality of monitoring data in order to jointly assess the marine environmental status in the Arctic, Baltic, Mediterranean and North Seas, as well as areas of the Gulf.

Two worldwide interlaboratory comparisons for trace elements in sediments were conducted with the participation of 105 laboratories. Five hundred sediment samples certified for the mass fraction content of 16 trace elements were produced and sent to the Korea Ocean Research and Development Institute, in the Republic of Korea, to be used for local proficiency tests. Furthermore, 70 bottles of certified reference materials for trace elements and organic contaminants were distributed free of charge to Member State laboratories for the validation of analytical methods and to achieve traceability of the results.

A proficiency test exercise was organized in the framework of a technical cooperation project entitled 'Marine Benchmark Study on the Possible Impact of the Fukushima Radioactive Releases in the Asia–Pacific Region' to test the analytical performance of regional laboratories in the determination of radionuclides in sea water. The exercise was initiated to support Member States in the region in analysing sea water in relation to the Fukushima Daiichi nuclear accident. A total of 23 laboratories in 17 countries participated in the exercise, including seven laboratories from Europe. Based on the results submitted by the participating laboratories, their performance of the analyses was evaluated in relation to the target value and in relation to the other participants. The overall evaluation of the caesium-134 and caesium-137 results showed that the majority of the reported measurement results fulfilled the criteria of acceptability, although a significant number of measurements did not meet these criteria. Improvements in the analytical procedures are planned for future proficiency tests.

The annual meeting of the ALMERA laboratories was held in Ankara, Turkey, to define future activities of the network in relation to proficiency tests, training and methodological developments. Members expressed their interest in increasing the network's response capacity to emergency situations. This was followed by a training course on the estimation of the uncertainty of measurement results.

[1] HELCOM: Helsinki Commission, the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area; OSPAR: OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic; ROPME: Regional Organization for the Protection of the Marine Environment (comprising Bahrain, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates); MED POL: Programme for the Assessment and Control of Pollution in the Mediterranean Region.

Behaviour of Radionuclides and Non-radioactive Pollutants in the Environment

An update of a 20 year old manual on remediation strategies for radionuclides released into the terrestrial environment (originally prepared after the Chernobyl accident) was published in 2012. The manual compiles scientific advancements in the field over the last two decades. In addition, two reports on the behaviour of radium in the environment and on radon releases from naturally occurring uranium and thorium were completed and are ready to be published.

New analytical methods were developed to assist laboratories in the Mediterranean Sea region in accurately measuring hazardous substances and elements in the marine environment. One method in particular involves the determination of mercury and methyl mercury in marine biota using inductively coupled plasma–mass spectroscopy. Other methods focused on the selective extraction, separation and determination of organotin compounds in marine sediment and biota; determination of petroleum hydrocarbons in marine samples (biota and sediments); determination of total mercury in marine samples based on atomic absorption and solid sampling with an advanced mercury analyser (AMA); and selective extraction of organic mercury in biota followed by solid sampling analysis with AMA.

Building Capacity in Member States

Through its Environment Laboratories in Monaco, the Agency provides technical support to Member States in the form of: training courses; national, regional and interregional technical cooperation projects; and the preparation of methodologies and training manuals. For example, the radioligand receptor binding assay for harmful algal bloom toxins was accepted as an official method of AOAC International. Scientists from Bosnia and Herzegovina, Croatia, Egypt, Greece, Iraq, Israel, Jordan, Lebanon, Mali, Mongolia, Montenegro, Pakistan, Qatar, Saudi Arabia, the Syrian Arab Republic, Tunisia, Turkey and Yemen were trained at the Agency's Environment Laboratories on the application of suitable analytical techniques for the determination of radionuclide trace elements and organic contaminants in marine and terrestrial environmental samples (Fig. 3).

"New analytical methods were developed to assist laboratories in the Mediterranean Sea region in accurately measuring hazardous substances and elements in the marine environment."

FIG. 3. Participants in a training course on the determination of chlorinated pesticides, polychlorinated biphenyls and petroleum hydrocarbons in marine biota are shown dissecting fish muscle samples for analysis.

Radioisotope Production and Radiation Technology

Objective

To strengthen national capabilities for producing radioisotope products and utilizing radiation technology, and contribute to improved health care and safe and clean industrial development in Member States.

Radioisotopes and Radiopharmaceuticals

The Agency continued to strengthen its efforts to promote the development and availability of radiopharmaceuticals for diagnostic and therapeutic applications in Member States. A CRP entitled 'Development of Fluorine-18 (^{18}F) Labelled Radiopharmaceuticals for Use in Oncology and Neurosciences' led to the development of new ^{18}F radiopharmaceuticals. Fourteen Member States worked over a period of three years on eight radiopharmaceuticals of high value in tumour characterization and developed detailed protocols for their synthesis and quality control. The CRP facilitated the introduction of these radiopharmaceuticals in Member State institutions, as well as preparing guidelines and documentation on their production and use in nuclear medicine and diagnosis.

"In the area of capacity building, the Agency assisted Member States in the local production of radiopharmaceuticals."

In the area of capacity building, the Agency assisted Member States in the local production of radiopharmaceuticals. For example, the first technetium-99m (^{99m}Tc) generator production facility in the Philippines was put into operation (Fig. 1). This facility has the capacity to produce 25–50 molybdenum-99/technetium-99m sterile generators per week. Local availability of this important medical isotope is expected to result in the wider use of ^{99m}Tc based radiopharmaceuticals.

Another example of capacity building was the inauguration of a cyclotron facility for positron emission tomography (PET) radiopharmaceutical production in the Radiopharmaceuticals Production and Research Centre of the University of Warsaw, in Poland (Fig. 2). The facility is capable of producing large amounts of ^{18}F labelled radiopharmaceuticals, as well as other PET radiopharmaceuticals, for diagnostic use.

Two publications in the IAEA Radioisotopes and Radiopharmaceuticals Series — *Cyclotron Produced Radionuclides: Guidance on Facility Design and Production of [F-18]Fluorodeoxyglucose (FDG)* and *Cyclotron Produced Radionuclides: Operation and Maintenance of Gas and Liquid Targets* — were issued. These manuals provide guidelines on the production of radiopharmaceuticals.

Radiation Technology Applications

Applications in radiation technology continue to increase as new radiation processing modalities are introduced and existing radiation technologies are enhanced. When applied under well defined

FIG. 1. The molybdenum-99/technetium-99m generator production facility in the Philippines.

FIG. 2. The cyclotron facility for PET radiopharmaceutical production in Poland.

conditions, radiation degraded, low molecular weight alginate, carrageenan and chitosan — which are natural, non-toxic, non-polluting and biodegradable — can be used to promote plant growth, to protect against plant diseases, and as a natural antioxidant for the preservation of food and allied products. Using such products, instead of chemical fertilizers, yields significant environmental benefits.

A CRP on the 'Development of Radiation Processed Products of Natural Polymers for Applications in Agriculture, Health Care, Industry and Environment' was completed in 2012. Sixteen participating institutions developed guidelines to produce radiation degraded chitosan from shrimp/prawn and crab exoskeleton and squid pen. Research in Brazil showed that electron beam processing of sugarcane bagasse could be beneficial and economical for enhancing the enzymatic hydrolysis of cellulose when combined with thermal pre-treatment for the production of biofuel from non-food resources. Superabsorbents based on radiation cross-linked natural polymers developed under this CRP pointed to their suitability for producing transparent, flexible, mechanically strong, biocompatible, effective and economical hydrogel dressings. Certain other commodity products, such as tableware, heat shrinkable tubes and dummy lenses for eyeglasses were also developed from bio-based materials under this CRP.

Another CRP that concluded in 2012 aimed at using radiation techniques in creating biomaterials of enhanced specific functionalities, improved biocompatibility and minimal natural rejection, but with enhanced interfacial adhesion. Seventeen Member State institutions collaborated and developed methodologies for nanogel and nanoparticle synthesis, enabling precise control of the product structure, size and functionality. Products such as hydrogel–nanoparticle composites for anti-leishmania drug release and to treat 'dry eye' syndrome, a protective drug-eluting coating for medical implants, coatings with antimicrobial properties, biodegradable polymer/inorganic nanocomposites for bone fracture setting devices, amphiphilic chitosan nanoparticles for encapsulating anti-cancer drugs, and nanoparticles for sustained release of thymoquinone were among the results reported.

"In 2012, a new CRP was initiated with the aim of developing and integrating nuclear methods for the investigation of multiphase flow systems for efficient management of industrial processes."

Considerable R&D is being carried out in Bangladesh, Brazil, Canada, Egypt, India, Italy, Pakistan, Poland, Romania, Thailand, the United Kingdom and the USA to improve and develop new packaging materials and coatings for use in the food industry. In support of such efforts, a CRP on the 'Application of Radiation Technology in the Development of Advanced Packaging Materials for Food Products' was initiated in 2012. The CRP's objective is to develop new packaging materials based on natural and synthetic polymers using radiation techniques, and to assess the effects of ionizing radiation on commercial food packaging materials, especially for their use in pre-packaged foods intended for radiation processing. This research includes developing recyclable, biodegradable, bioactive and smart packaging and coatings.

Nuclear Malaysia, an IAEA Collaborating Centre, developed a radiation curable green nanocomposite coating, which is a solvent free formulation with essentially no emission of volatile organic compounds (Fig. 3). The coating is based on epoxidized palm oil acrylate. The cured coatings are non-toxic and

transparent, with high mechanical and abrasion and scratch resistant properties.

A CRP that ended in 2012 focused on the application of neutron activation analysis (NAA) in the areas of archaeology and geology. Fifteen Member States studied NAA application in archaeology, as well as geology, food and nutrition, material science and waste characterization. Large sample NAA facilities are now operational in all participating Member States.

Multiphase flow systems are widely used in large industrial and environmental processes such as chemical and mineral processing, oil production, wastewater treatment, and sediment and solids transport. Optimized design and scale-up of multiphase flow systems are important in ensuring enhanced performance, economic viability and environmental acceptability. In 2012, a new CRP was initiated with the aim of developing and integrating nuclear methods for the investigation of multiphase flow systems for efficient management of industrial processes. The CRP includes 18 institutes from 17 Member States.

FIG. 3. Radiation processing (cross-linking and sterilization) of nanocomposite, bio-based hydrogels for biomedical applications at Nuclear Malaysia.

Nuclear Safety and Security

Incident and Emergency Preparedness and Response

Objective

To maintain and enhance effective and compatible Agency, national, regional and international emergency response capabilities and arrangements for early warning and timely response to nuclear or radiological incidents and emergencies independent of whether they arise from an accident, negligence or nuclear security event. To improve the provision and sharing of information on radiation incidents and emergencies among States, international organizations and the public/media.

Safety Standards and Guidelines

In the area of emergency preparedness and response, three publications in the Emergency Preparedness and Response (EPR) series were issued: *Communication with the Public in a Nuclear or Radiological Emergency*; *Considerations in Emergency Preparedness and Response for a State Embarking on a Nuclear Power Programme;* and *Lessons Learned from the Response to Radiation Emergencies (1945–2010).* The Agency also released training material to accompany the publication on public communications.

The Agency is revising the Safety Requirements publication *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2). At a technical meeting, representatives of Member States and international organizations reviewed the revised draft.

Communication with Member States

The procedures described in the new EPR publication *Operations Manual for Incident and Emergency Communication* were put into operation on 1 June 2012. The manual, which describes the Agency's expectations regarding notification and reporting, the exchange of official information and the timely provision of assistance, reflects changes based on lessons identified from experience in exchanging information, and in responding to and providing assistance during incidents and emergencies over the past few years. It also, for the first time, specifies time expectations on the Agency and on Member States regarding notification and information exchange in the event of an emergency. The possibility that emergency situations can arise from criminal or other nuclear security acts is also addressed in the manual.

The Agency's Unified System for Information Exchange in Incidents and Emergencies (USIE) is designed to improve the communication and coordination systems that deliver information to emergency responders. In 2012, USIE was improved to provide more functionality and allow contact points to conduct routine tasks themselves, such as granting and removing access within their organizations and updating emergency contact details. Additionally, the Agency held a number of workshops for designated emergency contact points on incident and emergency communications and on USIE, which were attended by representatives of 47 countries. Training sessions were also held for national officers of the International Nuclear and Radiological Event Scale on the use of the scale and on USIE.

"...the Agency held a number of workshops for designated emergency contact points on incident and emergency communications and on USIE, which were attended by representatives of 47 countries."

Response to Events

In 2012, the Agency was directly informed, or indirectly became aware, of 219 events involving or suspected to involve ionizing radiation. The Agency took response actions in 34 events. The Agency offered its good offices in 17 events (11 of which were triggered by the occurrence of earthquakes and tsunamis) (Fig. 1).

Following requests from Member States, three field assistance missions were carried out to provide dose reconstruction, medical advice and help with source recovery (Figs 2 and 3). The missions were coordinated by the Agency through its Response and Assistance Network (RANET). The RANET

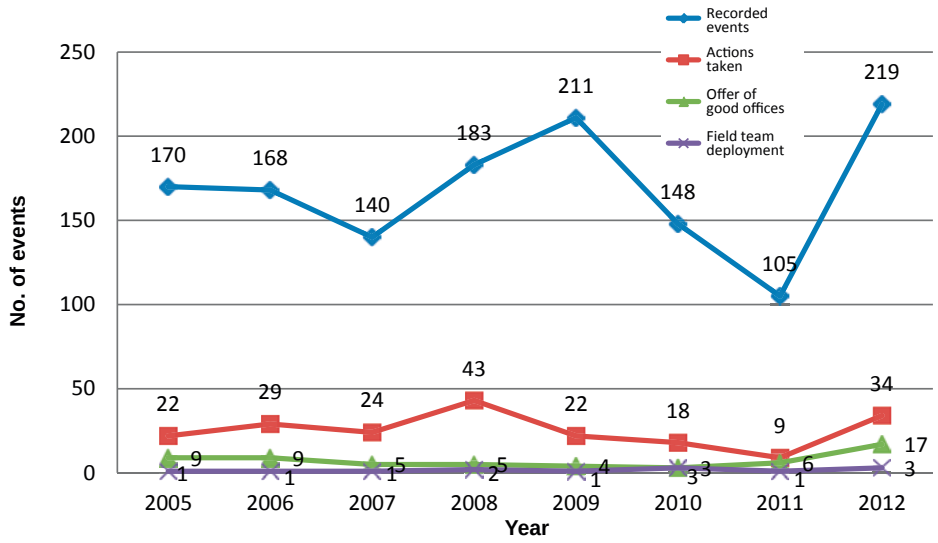


FIG. 1. Number of radiation events the Agency became aware of, and the Agency responses, since 2005.

assistance teams comprised experts from Australia, France and the USA. In one case involving an industrial radiography accident, in addition to the mission, medical treatment was provided in a specialized French hospital with financial support provided by the USA.

"At an Agency meeting, it was concluded that there was a need to expand RANET's scope..."

Response and Assistance Network

In 2012, Canada, Norway and the United Kingdom registered their national assistance capabilities in RANET, while Australia and the USA added new assistance capabilities to their current registrations. RANET membership now includes 22 Member States.

At an Agency meeting, it was concluded that there was a need to expand RANET's scope, mainly by including assessment and advice to competent authorities on on-site response activities to mitigate the impacts of emergencies at nuclear facilities. The Agency also hosted discussions with the aim of enhancing international assistance during the Sixth Meeting of the Representatives of Competent Authorities Identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Suggestions included investigating a mechanism for financing assistance missions, establishing minimum compatibility guidelines for the outputs generated during assistance missions, and developing coordination mechanisms between RANET and the European Union.

In-house Preparedness and Response

In implementing the IAEA Action Plan on Nuclear Safety (the Action Plan), which expanded the response mandate of the Agency, efforts continued in 2012 on

FIG. 2. Brachytherapy source recovery in a hospital in Cambodia in 2012.

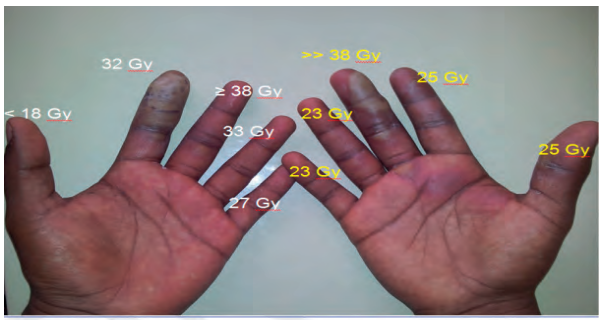


FIG. 3. Dose measured by electron paramagnetic resonance spectroscopy on fingernails of workers involved in an accident in Peru. (Photograph courtesy of IRSN, France.)

enhancing in-house capabilities, particularly staff participation, in the incident and emergency system (IES) to strengthen the Agency's preparedness to respond to radiation emergencies. A professional experience and skills survey was completed by 1076 Agency staff members, identifying competences and capabilities that could be essential when responding to radiation emergencies. All staff involved in the IES underwent intensive training in 2012: 35 training sessions and 34 drills and exercises were organized for all technical, managerial, liaison and logistical functions within the established response structure of the IES (Fig. 4).

FIG.4. The Director General (centre) and his senior staff at a full response IES exercise in 2012.

Compliance with Current Standards

The Action Plan called on Member States to conduct a prompt national review and thereafter regular reviews of their emergency preparedness and response arrangements and capabilities. The Agency provided support and assistance through Emergency Preparedness Review (EPREV) missions[1]. In 2012, EPREV missions were conducted in Armenia, Bosnia and Herzegovina, Croatia, Kazakhstan, Lithuania, Serbia, Uruguay and Vietnam, while the regulatory aspects of the national radiation emergency preparedness systems were assessed in Finland, Greece, Slovakia and Sweden within the framework of Integrated Regulatory Review Service missions. A number of conclusions arose from these missions. For example, national plans for nuclear and radiological emergencies at the local and national levels needed to be established or improved; stronger coordination was necessary between the various relevant governmental regulatory bodies with responsibilities in the area of EPR; and the infrastructure and capability of regulatory bodies in several Member States required strengthening. Good practices in the prompt application of the Agency's safety standards and guidance were also identified. The Agency also conducted 34 expert missions to assist Member States in developing and strengthening different aspects of national emergency preparedness and response systems, such as medical, public information and first response facets.

"...efforts continued in 2012 on enhancing in-house capabilities, particularly staff participation, in the incident and emergency system (IES) to strengthen the Agency's preparedness to respond to radiation emergencies."

Capacity Building in Member States

Training and exercises continued to be key elements of capacity building in Member States. The Agency organized 36 training events, including workshops and courses on various aspects of EPR such as medical, public information and first

[1] The EPREV service, offered to Member States since 1999, is an independent assessment of preparedness for responding to radiation incidents and emergencies, and of compliance with the Agency's Safety Requirements, *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GS-R-2), and relevant Safety Guides.

response capabilities (Fig. 5). The Agency also focused on supporting the establishment of EPR capacity building centres.

Inter-agency Coordination

Based on lessons identified in the response to the Fukushima Daiichi accident, the Agency, as the secretariat of the Inter-Agency Committee on Radiological and Nuclear Emergencies, initiated and coordinated preparation of the 2013 edition of the *Joint Radiation Emergency Management Plan of the International Organizations (JPLAN)*. It also initiated preparation of the ConvEx-3 (2013) exercise that will be hosted by Morocco and conducted in November 2013. The key objective of this full scale exercise is to evaluate the response in the case of a radiological emergency that is triggered by a nuclear security event(s).

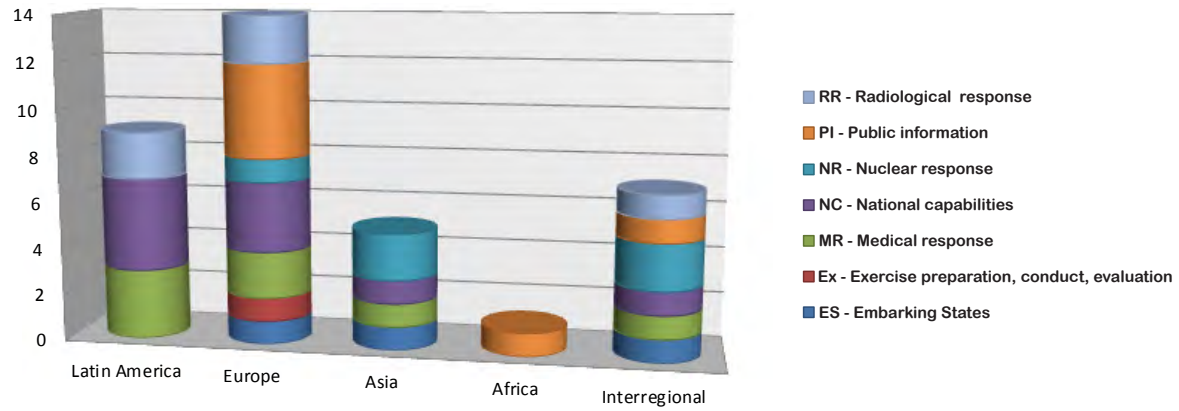


FIG. 5. Number of training events per region in 2012 and the event-specific EPR areas.

Safety of Nuclear Installations

Objective

To continuously improve the safety of nuclear installations during site evaluation, design, construction and operation through the availability of set safety standards and their application. To support Member States in developing appropriate safety infrastructure. To assist adherence to, and implementation of, the Convention on Nuclear Safety and the Code of Conduct on the Safety of Research Reactors, and to strengthen international cooperation.

Nuclear Safety Infrastructure

The Agency continued to support Member States in enhancing their governmental, legal and regulatory frameworks, which were evaluated through Integrated Regulatory Review Service (IRRS) missions. Four IRRS missions were conducted in 2012 — in Finland, Greece, Slovakia and Sweden. In addition, an IRRS scoping mission was conducted in Kazakhstan. The IRRS mission guidelines were reviewed through a series of consultancy meetings targeting methods to improve mission efficiency, consistent with the IAEA Action Plan on Nuclear Safety. Improvements were also made to the SARIS (Self-Assessment of Regulatory Infrastructure for Safety) methodology and software; this self-assessment is required of the host country prior to an IRRS mission.

Countries embarking on nuclear power have benefited from IAEA Safety Standards Series No. SSG-16, *Establishing the Safety Infrastructure for a Nuclear Power Programme*. Over 150 training courses, workshops and advisory missions were conducted to support national activities in countries considering or deciding to introduce nuclear power. These included Bangladesh, Belarus, Egypt, Indonesia, Jordan, Lithuania, Malaysia, Nigeria, the Philippines, Poland, Thailand, Turkey, the United Arab Emirates and Vietnam. Additionally, workshops on self-assessment of safety infrastructure were conducted for the Arab Network of Nuclear Regulators and the Asian Nuclear Safety Network, and at the national level (for example, in Egypt, Poland, Lithuania and the Philippines). Moreover, a technical meeting attended by 40 Member States in December highlighted the use of the Integrated Review of Infrastructure for Safety methodology and software, which are tailored to assess the progress made in developing safety infrastructure of embarking countries.

The Agency updated its guidance on infrastructure self-assessment, specifically the questionnaires for the Systematic Assessment of Regulatory Competence Needs service, and developed a safety report on the competences of human resources for regulatory bodies. Infrastructure development and capacity building for Member States were facilitated, mainly through international networks and forums such as the International Regulatory Network and the Regulatory Cooperation Forum, respectively (Fig. 1).

FIG 1. The Regulatory Cooperation Forum assists countries.

Convention on Nuclear Safety

The objectives of the 2nd Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS), facilitated by the Agency, were to review the lessons learned from the accident at the Fukushima Daiichi nuclear power plant and to evaluate the effectiveness of the provisions of the Convention. The Contracting Parties recognized that these objectives must be accomplished in addition to

"Over 150 training courses, workshops and advisory missions were conducted to support national activities in countries considering or deciding to introduce nuclear power."

meeting the ongoing safety obligations for currently operating facilities.

During the meeting, CNS guidance documents were revised to enhance the effectiveness of the review process and to make national reports more comprehensive. Each Contracting Party will incorporate the revisions in their national reports to the 6th Review Meeting, scheduled for 2014. Moreover, Contracting Parties agreed to establish an "effectiveness and transparency" working group, open to all Contracting Parties, with the task of reporting to the next review meeting on a list of actions to strengthen the CNS and on proposals to amend it, where necessary. The CNS working group will take account of the conclusions of this Extraordinary Meeting, including the initial proposals to amend the Convention submitted by Switzerland and by the Russian Federation.

"... the Global Safety Assessment Network (GSAN) ... provides registered users a means of sharing a wide range of information — webinars, streamed videos and presentations on nuclear safety."

Safety Assessment of Nuclear Installations

A technical meeting in July, attended by 16 Member States, investigated the application of Level 3 probabilistic safety assessment techniques to estimate potential off-site consequences of a severe nuclear accident. The participants identified emergent technical areas for further development (for example, long term accident scenarios, evaluation of land contamination and impact of filtered containment venting) and recommended an update of the existing guidance.

Collaboration among safety assessment experts is expected to be greatly enhanced through the Global Safety Assessment Network (GSAN), which provides registered users a means of sharing a wide range of information — webinars, streamed videos and presentations on nuclear safety. This conclusion was reached by 12 Member States at a technical meeting in December, which covered features of the GSAN platform and the safety assessment practices, experiences and needs of Member States.

Following a request from the Russian Federation and China to use the Generic Reactor Safety Review (GRSR) module of the Design and Safety Assessment Review Service for new reactor designs, the Agency established a programme of work in 2012 to review the reactor designs of these two Member States, and possibly extend the review to six designs in total. Japan made initial enquiries late in 2012 about updating an existing GRSR of one of its designs to take account of the latest Agency Safety Requirements for design.

Member States embarking on a nuclear power programme have been requesting safety assessment techniques to further enhance their capability to produce and review preliminary safety reports. In response, the Agency organized a 'Zwentendorf Plant Walkdown' workshop, which for the first time used this never commissioned nuclear power plant in Austria for training and demonstration purposes (Fig. 2). The workshop provided future safety analysts and regulators from Member States embarking on a nuclear power programme with hands-on training.

FIG. 2. Participants train using a boiling water reactor fuel assembly at the 'Zwentendorf Plant Walkdown' workshop.

Site Safety and Design against Internal and External Hazards

Prior to site selection and the subsequent construction of a nuclear power plant, newcomer Member States need assistance in systemically evaluating their resource needs, national capability and workforce for the development of a site licence application. The Agency provided such capacity building services to Indonesia, Turkey and Vietnam. As a result, Turkey provided the Agency with a list of services that can be provided through the Agency's

Site and External Events Design (SEED) service to support it in meeting its national objectives.

The SEED service, which added a new module for environmental impact assessment in 2012, is helpful not only for Member States requesting capacity building services, but also for specific hazard assessments. SEED review services were conducted in Hungary, Japan, Kazakhstan, Lebanon, Nigeria, Romania, South Africa, Turkey and Vietnam. The increasing demand from States with developed nuclear programmes demonstrated not only the service's universal appeal but also the legal commitment by all Contracting Parties to the CNS to ensure site safety for both new and existing nuclear power plants.

Multi-unit sites are exposed to more complex sets of interactions with multiple hazards. At a workshop held in Mumbai, India, in October, the results of the Agency's extrabudgetary programme to share knowledge and experience in this area were reviewed and development began on a framework addressing multi-site issues.

In July and August, the Agency undertook a mission to collect data on the possible effects of the earthquake and tsunami that struck Japan in March 2011 on structures, systems and components (SSCs) at the Onagawa nuclear power plant (Fig. 3). The findings of the mission will be added to the Agency's seismic experience database for use by Member States in developing earthquake preparedness and response plans.

FIG. 3. Experts collect data about the possible effects on SSCs at the Onagawa nuclear power plant in Japan as a result of the 2011 earthquake and tsunami.

Operational Safety and Experience Feedback

The Agency's Operational Safety Review Team (OSART) service, which comprises an internationally based team of experts reviewing operational safety performance, conducted eight missions and four follow-up missions in 2012 (Fig. 4). Three additional missions, including an expert mission to evaluate the station blackout event at the Kori nuclear power plant in the Republic of Korea and two pilot missions using a new OSART methodology, were conducted. Six of the eight OSART missions included a module for assessing severe accident management, which extends design, operational, technical and emergency preparedness and response measures to better manage accidents that occur beyond the scope of a reactor's design basis. An evaluation of this OSART module in the six missions found wide variation in the implementation scope and sufficiency of the Agency's severe accident management guidelines. Areas for improvement were identified and good practices were highlighted. Additionally, the Agency conducted a technical meeting in June in Vienna on 'Managing the Unexpected', which attracted experts and scientists from 22 Member States to discuss systemic improvements to the risk models in place.

"The SEED service...added a new module for environmental impact assessment in 2012..."

In the area of long term operation and ageing, the Agency carried out three missions as part of the Safety Aspects of Long Term Operation of Water Moderated Reactors Peer Review Service (SALTO) at nuclear power plants in Belgium, the Republic of Korea and the Netherlands.

The gap between awareness of a strong safety culture's fundamental components and identifying practical measures for its improvement was highlighted by the publication *Safety Culture in Pre-operational Phases of Nuclear Power Plant Projects* (Safety Reports Series No. 74). At a technical meeting in Cape Town, South Africa, the 144 participants used this publication as the basis for a discussion of the multinational components of safety culture and the complexity of 'new build' projects involving hundreds of vendors. A training course on

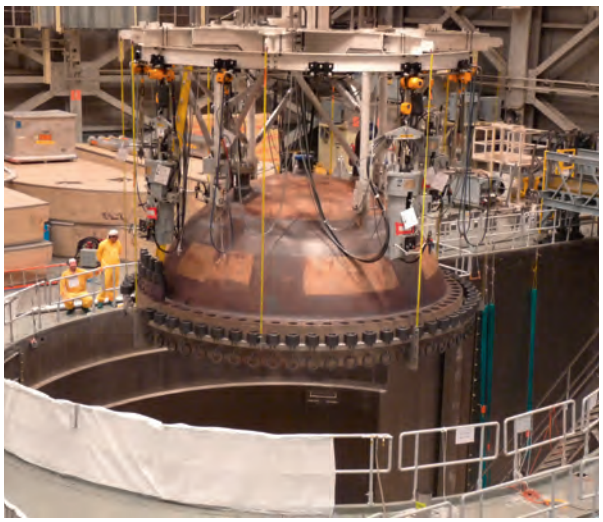


FIG. 4. A reactor vessel head being lifted at the Laguna Verde nuclear power plant in Mexico. An OSART mission visited this plant.

performing a safety culture self-assessment, held at a nuclear waste facility in Dessel, Belgium, and an on-line questionnaire whose results were analysed in collaboration with St. Mary's University in Canada, also addressed the issue of safety culture.

"Safety missions were undertaken to research reactors in Congo, Egypt, Ghana, Jordan, Kazakhstan, Malaysia, Slovenia, Thailand, Tunisia and Uzbekistan."

Safety of Research Reactor and Fuel Cycle Facilities

Agency support of efforts to enhance research reactor safety included two regional meetings in Algiers, Algeria, and Warsaw, Poland, on the application of the Code of Conduct on the Safety of Research Reactors. To improve networking, the Agency supported the first meetings of the Regional Advisory Safety Committees for Research Reactors in Africa and in Europe.

In addition, the Agency conducted two technical meetings, one on the safety of experiments and the other on the implications of the Fukushima Daiichi accident; two regional workshops on ageing management (in Accra, Ghana, and Bangkok, Thailand); one regional workshop on the development of human resources (ARASIA); and two regional workshops on the safe operation of research reactors (Africa and ARASIA). Six workshops were also conducted on regulatory supervision, use of a graded approach, human factors, training programmes, assessment of safety documents and the safety of reactors in extended shutdown. In total, more than 240 participants from 58 Member States operating or planning research reactors participated in these activities.

The Agency published three Safety Guides on research reactors covering: utilization and modification, use of a graded approach, and safety assessment and preparation of the safety analysis report. Additionally, a publication was issued on considerations and milestones for a new research reactor, which also provides guidance on the safety enhancement of research reactors.

Safety missions were undertaken to research reactors in Congo, Egypt, Ghana, Jordan, Kazakhstan, Malaysia, Slovenia, Thailand, Tunisia and Uzbekistan, which provided recommendations for safety improvements concerning safety analysis and documents, ageing, utilization, modifications, radiological safety and emergency planning.

To enhance the safety of fuel cycle facilities, the Agency finalized the development of Safety Requirements on research and development activities and reprocessing facilities, as well as a Safety Guide on criticality. These efforts included a meeting of the national coordinators of the Fuel Incident Notification and Analysis System, and workshops on the application of the Agency's safety standards and on the licensing process for such facilities.

Radiation and Transport Safety

Objective

To achieve global harmonization of the development and application of the Agency's radiation and transport safety standards. 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.

Radiation Protection Safety Standards

Radiation protection, sometimes referred to as radiological protection, applies to the protection of people and the environment from the harmful effects of ionizing radiation and to the safety of radiation sources. The radiation risks to people and the environment that may arise from the use of radiation and radioactive material must be assessed and controlled through the application of standards of safety. One of the most widely used radiation protection standards is the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS), a revised interim edition of which was recently published. In 2012, the co-sponsoring organizations, namely, the European Commission, FAO, the Agency, ILO, the OECD/NEA, PAHO, UNEP and WHO, formally confirmed their intention to jointly sponsor the revised BSS, which will be published in 2013.

The Agency continued to facilitate Member State implementation of the BSS by organizing three regional workshops, hosted by the Governments of Costa Rica, Malaysia and Ukraine. These regional workshops covered topics on new or strengthened safety requirements in the BSS and were attended by 83 representatives from 42 Member States. The workshops also provided opportunities for the Agency to discuss implementation issues and to receive valuable feedback on topics that required more detailed guidance.

In November, a 'Task Group on the Implementation of the International Basic Safety Standards' was established consisting of representatives of all of the co-sponsoring organizations. The Group, which is chaired by the Agency, will coordinate and monitor the implementation of the BSS in a consistent and coherent manner in United Nations system Member States in accordance with the respective roles and responsibilities of each co-sponsor.

Radiation Protection of Patients

'Appropriateness criteria' are the rationale used by a physician when deciding whether or not a particular imaging study is justified, taking into account risk and benefit, for answering the clinical questions about a patient who exhibits a specific set of conditions. These criteria have an important role in improving referral patterns in diagnostic imaging, and thereby reducing unnecessary exposure of patients. In March, the Agency organized a technical meeting in Vienna on 'Radiation Protection of Patients through the Development of Appropriateness Criteria in Diagnostic Imaging' where participants agreed on the key principles of a methodology for the development of appropriateness criteria in order to work towards harmonization of these guidelines.

"...the Agency hosted a side event on 'Event Reporting of Medical Exposures', reviewing the importance of learning lessons from radiation incidents in medicine with the aim of enhancing patient safety."

At the General Conference in September, the Agency hosted a side event on 'Event Reporting of Medical Exposures', reviewing the importance of learning lessons from radiation incidents in medicine with the aim of enhancing patient safety. Since December, the Agency has been providing a voluntary safety reporting and learning system known as Safety in Radiation Oncology (SAFRON), which allows health professionals to learn lessons from reported radiation incidents in radiotherapy (Fig. 1).

The Agency held an international conference on Radiation Protection in Medicine: Setting the Scene for the Next Decade, in Bonn, Germany, in December. Co-sponsored by WHO and attended by participants from 77 Member States and 16 international organizations, the conference called for global action to improve patient and health worker protection. International bodies were urged to achieve the highest benefit with the least possible risk to patients. In addition, it was recommended

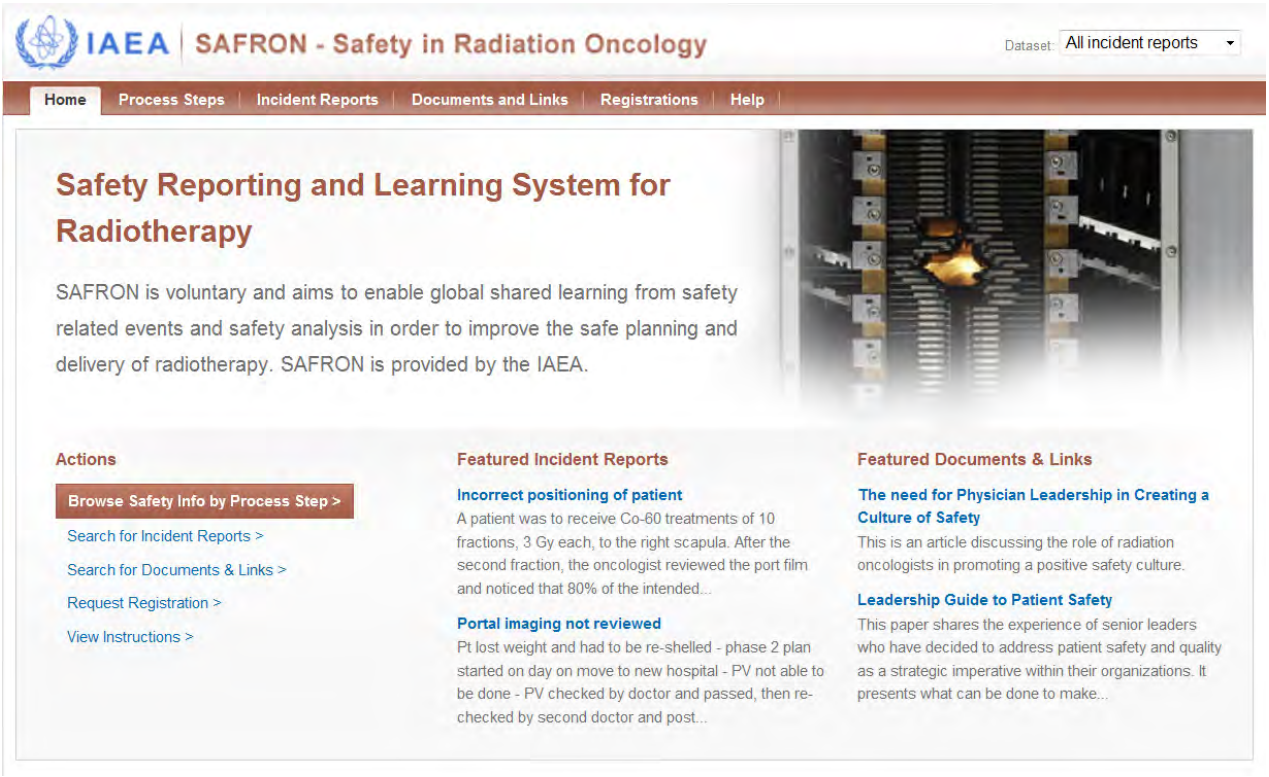


FIG. 1. Learning about safety in medical radiation therapy through the SAFRON system, available on the Agency's radiation patient protection web site at rpop.iaea.org.

that the responsibilities of stakeholders be identified regarding radiation protection in medicine for the next decade.

Occupational Radiation Protection

A Safety Report was published on occupational radiation protection in the titanium industry, an area with naturally occurring radioactive material (NORM). The publication examined the processes and materials involved in the related industries, and the radiological considerations that need to be taken into account by the regulatory body when determining the nature and extent of radiation protection measures to be taken.

Regulatory Infrastructure and Transport Safety

The Agency continued to support Member States in their enhancement of governmental, legal and regulatory frameworks for radiation safety through Integrated Regulatory Review Service (IRRS) missions. Four States were visited in 2012; in addition, advisory missions visited 15 States. The Agency also conducted a specific IRRS scoping mission in Kazakhstan.

In the area of national regulatory infrastructure for safety, the Agency's technical support to Afghanistan's regulatory body, as well as a regional workshop in Jamaica for Caribbean States, focused on strengthening the regulatory control of sources, in particular in the medical sector. Workshops on orphan source search and strategies to regain control over such sources were organized in Morocco, Turkey and the United Republic of Tanzania (Fig. 2).

Two major tools to help States ensure both the adequacy of their national radiation safety

FIG. 2. Participants at a training course on searching for orphan sources.

regulatory infrastructure and their compliance with the Agency's safety standards were updated. One was the Regulatory Authority Information System (RAIS) and other the Self-Assessment of Regulatory Infrastructure for Safety (SARIS) (*http://www-ns.iaea.org/tech-areas/radiation-safety/source.asp?s=3&l=22*).

Transport Safety

The 2012 edition of the *Regulations for the Safe Transport of Radioactive Material* (IAEA Safety Standards Series No. SSR-6) was issued and included, among other revisions, significant changes to fissile material exceptions that enhance safety and reduce costs to industry. In addition, the outcomes and recommendations of the international conference on the Safe and Secure Transport of Radioactive Material, held in 2011, and a follow-up technical meeting, held in 2012, received support by the General Conference and continued to be implemented by the Agency.

Efforts to further harmonize the UN Model Regulations on the Transport of Dangerous Goods (the 'Orange Book'), the European Agreement Concerning the International Carriage of Dangerous Goods by Road, and the Agency's Transport Regulations continued (Fig. 3). The International Steering Committee on Denials of Shipment of Radioactive Material updated its Action Plan identifying 12 key elements for 2012 (for example, increasing the focus on interagency cooperation), and proposed improvements to the reporting mechanism for instances of denial or delay. A regional project to strengthen effective compliance assurance for the transport of radioactive material was initiated in Africa, and implementation of a similar project continued in the Asia–Pacific region.

Education and Training in Radiation Safety

In line with the Agency's 'Strategic Approach to Education and Training in Radiation, Transport and Waste Safety', a series of regional workshops in 2012 assisted Member States in establishing their own national strategies in this area. The workshops described the key factors to be considered, with emphasis being placed on comprehensive training needs analysis as a basis for the strategy. The long term goal is to enhance national expertise in a sustainable and effective manner.

FIG. 3. A transport cask containing radioactive material being loaded for shipment.

"The 2012 edition of the Regulations for the Safe Transport of Radioactive Material*...was issued and included...significant changes to fissile material exceptions that enhance safety and reduce costs to industry."*

Radiation Safety Infrastructure Information Management

Member States and the Secretariat expanded their use of the Radiation Safety Information Management System (RASIMS) to collect and analyse information about national radiation safety infrastructures. The first workshop of RASIMS national coordinators led to a significant improvement in the quality and quantity of the data in RASIMS, which greatly enhances the planning and provision of Agency assistance.

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.

Waste and Environmental Safety

Radioactive waste and spent fuel management

The 4th Review Meeting of the Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management took place in May, with the participation of 600 delegates from 54 Contracting Parties. The Review Meeting noted that, although significant progress had been made since the last Review Meeting, challenges remained, including ensuring the robustness of the review process itself, the availability of spent fuel storage capacity and the delivery of disposal solutions.

In September, the Agency launched an international project on 'Human Intrusion in the Context of Disposal of Radioactive Waste' (HIDRA). This two year project seeks to provide guidance on how to address the aspects of potential human intrusion and human actions in the demonstration of safety of radioactive waste disposal facilities.

"...the Agency launched an international project...on how to address the aspects of potential human intrusion and human actions in the demonstration of safety of radioactive waste disposal facilities."

Assessment and management of environmental releases

In November, the Agency launched a four year project entitled 'Modelling and Data for Radiological Impact Assessments' (MODARIA) to strengthen the capabilities of Member States in assessing radiological impacts on people and the environment. The initial meeting was attended by 140 participants from more than 40 Member States, during which ten working groups were set up addressing such areas as remediation of contaminated areas, uncertainties and variability associated with model predictions, radiation exposures and effects on biota, and marine modelling.

The Agency, in its role as the competent international authority on technical matters related to radioactive waste, continued to advise the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (including radioactive waste) (the London Convention) and the Radioactive Substances Committee of the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) on the assessment and evaluation of radiological impacts to people and the environment. At the request of the Contracting Parties to the London Convention, the Agency provided a method to derive levels of activity concentrations for material that might be disposed of at sea providing a de minimis radiological impact. For the purpose of the OSPAR Convention, and as requested by its Radioactive Substances Committee, a methodology was developed to define radiological environmental assessment criteria for marine waters.

Decommissioning and remediation safety

The Agency's Safety Requirements for decommissioning, published in 2006, incorporate three strategies for decommissioning. One of these is 'entombment', which is a strategy by which radioactive contaminants are encased in a structurally long lived material until radioactivity decays to a level permitting the unrestricted release of the facility, or release with restrictions imposed by the regulatory body. In a revised Safety Requirements document sent to Member States for comment in 2012, entombment was proposed as an option for decommissioning, to be used under exceptional circumstances. Work is under way to better define when it might be appropriate to apply the entombment option for decommissioning.

In June, the Agency established the Coordination Group for Uranium Legacy Sites. The aim of the group is to optimize resources for the remediation

of former uranium production sites, primarily in Central Asia but in other regions as well.

In August, the Agency and the United States Department of Energy jointly hosted scientific visits to former uranium processing facilities in Utah and Colorado, as well as an international workshop on 'Management and Regulatory Oversight of Uranium Legacy Sites: Perspectives from Regulators and Operators'. The workshop was organized under the International Working Forum on Regulatory Supervision of Legacy Sites (Fig. 1).

FIG. 1. Remediation of a former uranium mill facility in Utah, USA.

Good Practices and Technologies for Radioactive Waste Management, Decommissioning and Environmental Monitoring

Management (predisposal and disposal) of radioactive waste and spent fuel

The Agency continued to assist Member States in training and capacity building in radioactive waste management, including through URF (Underground Research Facilities Network), DISPONET (International Low-Level Waste Disposal Network) and LABONET (International Network of Laboratories for Nuclear Waste Characterization). Several workshops and technical meetings were organized on policies and strategies for waste management (Austria); advanced technologies for waste treatment and conditioning (Argentina); predisposal waste management (Russian Federation); waste characterization (Belgium); and waste acceptance procedures (France). In addition, training events were organized on stakeholder dialogue for radioactive waste disposal (Poland) and on the interaction of technical and social aspects in waste disposal programmes (Turkey).

A new CRP on 'Processing Technologies for High Level Waste, Formulation of Matrices and Characterization of Waste Forms' was launched with the participation of 18 research groups from around the world. The objectives are to encourage further research and development and exchange of information among Member States on improved processing techniques, formulation of vitreous and ceramic matrices for immobilization of high level waste and the characterization of waste.

"A survey...was undertaken on the status of sites containing radioactive material and on factors that were constraining progress in the implementation of decommissioning and remediation programmes."

Decommissioning of nuclear facilities and environmental remediation of sites

Two projects were launched by the International Decommissioning Network (IDN): DRiMa (International Project on Decommissioning Risk Management) and DACCORD (International Project on Data Analysis and Collection for Costing of Research Reactors Decommissioning). The latter will utilize a software tool, CERREX (Cost Estimates for Research Reactor Decommissioning in Excel), that was recently developed by the Agency. A survey on the global Constraints to Implementing Decommissioning and Environmental Remediation was undertaken on the status of sites containing radioactive material and on factors that were constraining progress in the implementation of decommissioning and remediation programmes. An IAEA Nuclear Energy Series publication on *Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities* (NW-G-2.1) was issued.

Training events and scientific visits were organized by the Agency on a range of decommissioning issues. These included the basics of decommissioning and remediation (USA); remediation policies and strategies (Austria); management of decommissioning waste (Canada); development of training programmes for decommissioning (Russian Federation); a scientific visit to the José Cabrera nuclear power plant decommissioning project (Spain); development of remediation infrastructure (Germany);

decommissioning planning and licensing (Germany); and stakeholder involvement in remediation (Denmark).

Facilitating information exchange

Integrated Nuclear Infrastructure Review missions, which assist countries considering embarking on a nuclear power programme, were undertaken in Poland and Vietnam. These missions emphasized the importance of establishing a spent fuel and waste management policy and providing adequate infrastructure for radioactive waste management. In addition, regional workshops on possible cooperation between Middle Eastern and North African countries on the management of radioactive waste were held in Tunisia and the United Arab Emirates.

An international peer review was performed at the Korea Atomic Energy Research Institute (KAERI), Republic of Korea, to assess the feasibility of KAERI's approach to the development of a geological disposal system for high level waste and metallic waste from the pyro-processing of spent nuclear fuel. A final report was provided to KAERI containing the recommendations and good practices on the project.

Another peer review, in December, reviewed the integrated approach of the United Kingdom's Nuclear Decommissioning Authority (NDA) to the storage of higher activity waste packages. The mission focused on a technical review of the NDA document *Industry Guidance: Interim Storage of Higher Activity Waste Packages — Integrated Approach* in the context of the United Kingdom's waste management policy and long term waste management strategy. It also examined the consistency of the integrated approach in terms of waste packaging, storage and transportation as well as future disposal.

Nuclear Security

Objective

To contribute to global efforts to achieve effective security of nuclear or other radioactive material, by supporting national and international efforts to establish and maintain effective nuclear security. To assist adherence to and implementation of nuclear security related international instruments and to strengthen the international cooperation and coordination of assistance in a way that underpins the use of nuclear energy and applications.

International Cooperation and Coordination

The Agency, in cooperation with Member States, continued to play a collaborative role in helping to coordinate nuclear security related initiatives, working jointly with relevant international and regional organizations and institutions to avoid duplication and overlap in related activities. In this regard, the Agency organized three information exchange meetings with international and regional organizations in February, May and November, and developed nuclear security initiatives with the United Nations Office for Disarmament Affairs and the G-8 Global Partnership. The Border Monitoring Working Group, involving the Agency and its partners, increased its work beyond the provision of radiation detection equipment and training to include the entire detection and response infrastructure.

Incident and Trafficking Database

The membership of the Agency's Incident and Trafficking Database (ITDB) has continued to expand, with seven States joining in 2012, bringing the total number of participating States to 119 Member States and one non-Member State. In 2012, the title of the database was changed to Incident and Trafficking Database: Incidents of Nuclear and Other Radioactive Material out of Regulatory Control. This was done to better reflect the broad scope of the system and was agreed by participant States at the Points of Contact meeting in July 2012.

At the end of 2012, States had reported — or otherwise confirmed via the ITDB — 2331 incidents since the database was established in 1995, with 147 incidents reported in 2012. Seventeen of these incidents reportedly involved illegal possession of and attempts to sell nuclear material or radioactive sources. In 24 cases, thefts or losses of radioactive sources were reported. One hundred and nineteen 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. During 2012, there were two incidents involving high enriched uranium in unauthorized activities. There were also three incidents involving Category 1–3 radioactive sources[1], two of which were thefts.

"At the end of 2012, States had reported — or otherwise confirmed via the ITDB — 2331 incidents since the database was established in 1995, with 147 incidents reported in 2012."

Peer Reviews and Advisory Services

The Agency continued to provide peer reviews and advisory services, at the request of States, to assess their nuclear security effectiveness, to identify needs, to provide a basis for formulating plans to improve national nuclear security regimes, and to serve as confidence building measures for States. One International Nuclear Security Advisory Service (INSServ) mission was conducted in Kenya as well as modular missions focusing on border monitoring capabilities to Bolivia, Colombia, Indonesia, Libya, Uruguay and Venezuela.

The recognition of International Physical Protection Advisory Service (IPPAS) missions has steadily increased, as demonstrated by requests from countries with large, mature nuclear programmes. The European Union's Ad Hoc Group on Nuclear Security, in its report published in 2012, encouraged

[1] The ITDB categorizes sealed radioactive sources on a scale of from 1 to 5, in accordance with IAEA Safety Standards Series No. RS-G-1.9. Exposure of only a few minutes to a Category 1 source can be fatal. Category 5 sources are potentially the least dangerous; however, even these sources could give rise to doses in excess of the safe limits if not properly controlled.

all European Union Member States with nuclear power plants to host an IPPAS mission at regular intervals.

In 2012, IPPAS missions were conducted in Finland, Kazakhstan, the Netherlands and Romania. In related work, the Agency conducted a technical meeting to review and update IPPAS guidelines to ensure that the service represents best current practices. Several new IPPAS modules were also developed, including a module on cyber security.

The Agency continued to provide other expert missions, at the request of States, to improve detection capabilities for illicit nuclear trafficking and response to nuclear security incidents. It also conducted a number of technical visits, which addressed security needs at locations including border crossings, medical facilities, scientific institutes and industrial sites.

"Investing in human resource development and capacity building continues to be vital to maintaining effective and sustainable nuclear security programmes in States."

Integrated Nuclear Security Support Plans (INSSPs)

The importance of INSSPs in building and strengthening nuclear security infrastructure was recognized in 2012 at the Agency's General Conference in a resolution adopted on nuclear security[2]. Also, in the course of 2012, 12 States formally approved their INSSPs, bringing the total number to 42. In addition, review missions were conducted in five States based on existing INSSPs to assess their progress in implementation as well as to plan future activities.

Implementation of the Nuclear Security Plan

A significant step in 2012 was the establishment of the Nuclear Security Guidance Committee (NSGC) — a standing body of senior experts that will review the IAEA Nuclear Security Series publications and make associated recommendations. At its first meeting, the NSGC approved the *Nuclear Security Fundamentals*, the highest level document in the IAEA Nuclear Security Series.

A further opportunity for Member State involvement was provided through the Working Group on Radioactive Source Security (RSWG), which was convened in November with representatives from 20 Member States. Discussions covered a range of technical issues related to the security of radioactive sources with a view to identifying realistic actions to help States improve source security in a sustainable manner.

Promotion of the Nuclear Security Framework

Despite being adopted in 2005, the Amendment to the Convention on the Physical Protection of Nuclear Material has yet to enter into force. The Agency organized workshops in the African, European and Latin American regions to make States aware of the importance of taking action to allow entry into force of the amendment as soon as possible.

Building Capacity

Investing in human resource development and capacity building continues to be vital to maintaining an effective and sustainable nuclear security programme in States. To this end, the Agency conducted over 80 training events covering all aspects of nuclear security, involving more than 2000 people.

The Agency established a network among the nuclear security training community to facilitate collaboration between Nuclear Security Support Centres (NSSCs) and to promote the concept of national NSSCs. To date, the concept has been implemented in Ghana, Morocco and Pakistan.

Major Public Events

To provide guidance on nuclear security at major public events, the Agency published *Nuclear Security Systems and Measures for Major Public* Events (IAEA Nuclear Security Series No. 18) in 2012. It also assisted nuclear security preparations by Poland and Ukraine for the UEFA European Football Championship held in June 2012.

[2] GC(56)/RES 10 on nuclear security adopted on 21 September 2012.

Nuclear Forensics

Nuclear forensics is a crucial tool to support law enforcement investigations and to assess and remedy nuclear security vulnerabilities of States. Important activities in 2012 included an international nuclear forensic methodologies training course for practitioners in conjunction with US national laboratories, identification of core capabilities required for nuclear forensic analysis, as well as extensive collaboration with technical experts on guidance on the development of a national nuclear forensics library (Fig. 1).

FIG. 1. Participants localize radioactive material as part of a measurement exercise in an IAEA–US National Nuclear Security Administration training course on nuclear forensic methodologies, held at the Pacific Northwest National Laboratory, Richland, Washington.

Crime Scene Management

Enhancements to plans, roles, responsibilities and procedures to better enable law enforcement to respond to a nuclear security event were included in technical guidance and training materials for radiological crime scene management. This work emphasized heightened awareness of the hazards and forensic considerations involving a crime scene containing nuclear or other radioactive material, or contaminated by such material.

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, and for physical protection upgrades (Fig. 2). For example, acceptance tests of 259 portable radiation detection instruments were performed and a number of radiation portal monitors installed. In addition, there were 49 shipments to Member States carried out for the donation of 209 instruments and the loan of 386 instruments.

"Enhancements to plans, roles, responsibilities and procedures to better enable law enforcement to respond to a nuclear security event were included in technical guidance and training materials for radiological crime scene management."

Nuclear Security Fund

In 2012, the implementation of the nuclear security programme continued to rely on extrabudgetary contributions. Revenue to the Nuclear Security Fund amounted to some €25 million. Financial contributions were received from 19 Member States and the European Commission as extrabudgetary funding.[3] In addition, a number of Member States made contributions in kind through the donation of equipment and expert services.

FIG. 2. Officials from Malaysia's Atomic Energy Licensing Board along with customs, police and port officials discuss a reading with Indonesian counterparts as part of a training exercise on inspecting suspicious cargo held in Kuala Lumpur.

[3] Belgium, Canada, China, the European Commission, Denmark, Estonia, Finland, France, Germany, India, Italy, the Republic of Korea, the Netherlands, New Zealand, Norway, the Russian Federation, Spain, Sweden, the United Kingdom and the USA.

Nuclear Verification

Nuclear Verification

Objectives

To deter the proliferation of nuclear weapons by detecting, as early as possible, the misuse of nuclear material or technology, and by providing credible assurances that States are honouring their safeguards obligations. To contribute to nuclear arms control and disarmament by responding to States' requests for verification and other technical assistance associated with related agreements and arrangements. To continually improve and optimize operations and capabilities to effectively carry out the Agency's verification mission.

Implementation of Safeguards in 2012

At the end of each year, the Agency draws a safeguards conclusion for each State for which safeguards are applied. This conclusion is based on an evaluation of all safeguards relevant information available to the Agency in exercising its rights and fulfilling its safeguards obligations for that year.

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 Agency must ascertain that: first, 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 second, there are no indications of undeclared nuclear material or activities in 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, both a CSA and an AP must be in force in the 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, the Agency implements integrated safeguards: an optimized combination of measures available under CSAs and APs to maximize effectiveness and efficiency in fulfilling the Agency's safeguards obligations. By the end of 2012, integrated safeguards were implemented for 53 States[1].

In 2012, safeguards were applied for 179 States[2] with safeguards agreements in force with the Agency [3, 4]. Of the 114 States that had both a CSA and an AP in force, the Agency concluded that *all* nuclear material remained in peaceful activities in 60 States[5]; for the remaining 54 States, as all the necessary evaluations had yet to be completed, the Agency was unable to draw the same conclusion. For these 54 States, and for the 57 States with a CSA but with no AP in force, the Agency concluded only that *declared* nuclear material remained in peaceful activities.

"In 2012, safeguards were applied for 179 States...with safeguards agreements in force with the Agency..."

Safeguards were also implemented with regard to declared nuclear material in selected facilities

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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, Iceland, Indonesia, Ireland, Italy, Jamaica, Japan, the Republic of Korea, Latvia, Libya, Lithuania, Luxembourg, Madagascar, Mali, Malta, Monaco, the Netherlands, Norway, Palau, Peru, Poland, Portugal, Romania, Seychelles, Singapore, Slovakia, Slovenia, Spain, Sweden, The former Yugoslav Republic of Macedonia, Ukraine, Uruguay and Uzbekistan.

2 The 179 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 And Taiwan, China.

4 The status with regard to the conclusion of safeguards agreements, APs and small quantities protocols (SQPs) is given in the Annex to this report.

5 And Taiwan, China.

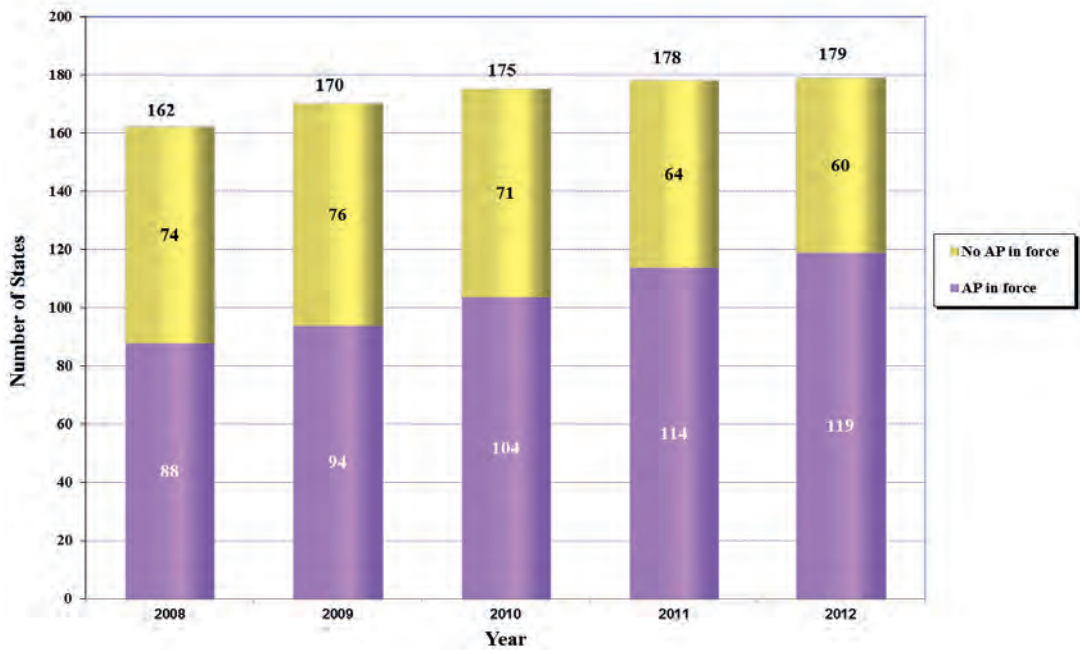

FIG.1. Number of APs for States with safeguards agreements in force, 2008–2012 (the Democratic People's Republic of Korea is not included).

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 from safeguards 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 (SQPs)..."

For the three States in which the Agency implemented safeguards pursuant to safeguards agreements 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.

As of 31 December 2012, 13 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 APs, and Amendment and Rescission of SQPs

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of small quantities protocols (SQPs)[6]. During 2012, a CSA entered into force for one State[7], and APs entered into force for five States[8]. The status of safeguards agreements and APs as of 31 December 2012 is shown in Table A6 in the Annex to this report. During the year, one State[9] signed a CSA and an AP.

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6 Many States with minimal or no nuclear activities have concluded an SQP to their CSA. Under an SQP, 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.

7 Togo.

8 Iraq, Namibia, Republic of Moldova, Togo and Vietnam.

9 Bosnia and Herzegovina.

The Secretariat continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols,* which was updated in September 2012. During the year, the Director General wrote to each of the 13 non-nuclear-weapon States party to the NPT which had yet to conclude a CSA to encourage them to bring such an agreement into force. The Agency convened a briefing on the Agency's safeguards for States in the Pacific region (held in Fiji in June 2012), and a regional seminar on safeguards for States in the greater Caribbean region with limited nuclear material and activities (held in Mexico City in June 2012). In addition, consultations on the amendment or rescission of SQPs and the conclusion of safeguards agreements and APs were held throughout the year with representatives from Member and non-Member States in Berlin, Fiji, New York and Vienna, and also during training events organized by the Agency in Vienna and elsewhere.

Amendment and rescission of SQPs

The Secretariat continued to communicate with States in order to implement the Board's 2005 decisions regarding the amendment or rescission of SQPs to reflect the revised standardized text and changed eligibility criteria. During the year, an SQP with one State[10] was amended and two States rescinded their SQPs[11]. This means that 46 States have amended their SQPs and 48 States have yet to amend or rescind their SQPs.

Implementation of Safeguards in the Islamic Republic of Iran (Iran)

During 2012, the Director General submitted four reports to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran* (GOV/2012/9, GOV/2012/23, GOV/2012/37 and GOV/2012/55).

In 2012, contrary to the relevant binding resolutions of the Board of Governors and the United Nations 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 Safeguards Agreement; suspend its enrichment related activities; suspend its heavy water related activities; or address the Agency's serious concerns about possible military dimensions to Iran's nuclear programme, in order to establish international confidence in the exclusively peaceful nature of Iran's nuclear programme.

While the Agency continued throughout 2012 to verify the non-diversion of declared nuclear material at the nuclear facilities and locations outside facilities (LOFs) declared by Iran under its Safeguards Agreement, as Iran did not provide the necessary cooperation, including not implementing its AP, as required in the binding resolutions of the Board of Governors and the United Nations Security Council, the Agency was unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran and, therefore, was unable to conclude that all nuclear material in Iran was in peaceful activities.

In light of the Board of Governors' resolution GOV/2011/69 of November 2011 (adopted by a vote), in which, inter alia, the Board had called on Iran to engage seriously and without preconditions in talks aimed at restoring international confidence in the exclusively peaceful nature of Iran's nuclear programme, in 2012 Agency and Iranian officials held seven rounds of talks in Vienna and Tehran, including during a visit by the Director General to Tehran in May 2012, aimed at reaching agreement on a structured approach to the clarification of all outstanding issues related to Iran's nuclear programme.

On 13 September 2012, the Board of Governors adopted, by a vote, resolution GOV/2012/50 in which, inter alia, the Board stressed that it was essential for Iran to immediately conclude and implement such an approach, including as a first step providing the access the Agency had requested to relevant sites. By the end of the year, however, no agreement had been reached on the structured approach and substantive work on the outstanding issues, including those related to the possible military dimensions of Iran's nuclear programme, had yet to begin.

Implementation of Safeguards in the Syrian Arab Republic (Syria)

On 30 August 2012, the Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic* (GOV/2012/42). The Director General informed the Board that the Agency had not received any new information from Syria or other Member States that would have an impact on

[10] Antigua and Barbuda.

[11] Ghana and Nigeria.

the Agency's assessment that it was very likely that a building destroyed at the Dair Alzour site was a nuclear reactor which should have been declared to the Agency by Syria.

The Board of Governors, in its resolution GOV/2011/41 of June 2011 (adopted by a vote), had, inter alia, called on Syria to remedy urgently its non-compliance with its NPT Safeguards Agreement and, in particular, to provide the Agency with updated reporting under its Safeguards Agreement and access to all information, sites, material and persons necessary for the Agency to verify such reporting and resolve all outstanding questions so that the Agency could provide the necessary assurances as to the exclusively peaceful nature of Syria's nuclear programme.

In February 2012, in response to an Agency proposal to hold further discussions to address all the outstanding questions, Syria indicated that it would provide a detailed response at a later time, noting the difficult prevailing security situation in the country. The Agency has taken note of Syria's position and has reiterated its request to Syria to hold further discussions to address all the outstanding questions.

For 2012, the Agency was able to conclude for Syria that declared nuclear material remained in peaceful activities.

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

In August 2012, the Director General submitted a report to the Board of Governors and General Conference entitled *Application of Safeguards in the Democratic People's Republic of Korea* (GOV/2012/36–GC(56)/11), which provided an update of developments since the Director General's report of September 2011.

Since 1994, the Agency has not been able to conduct all necessary safeguards activities provided for in the DPRK's NPT Safeguards Agreement. From the end of 2002 until July 2007, the Agency was not able, and since April 2009 has not been able, to implement any verification measures in the DPRK and, therefore, could not draw any safeguards conclusion regarding the DPRK.

Since 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. Statements by the DPRK about uranium enrichment activities and the construction of a light water reactor in the DPRK continued to be deeply troubling.

Although not implementing any verification activities in the field, the Agency continued to monitor the DPRK's nuclear activities by using open source information, satellite imagery and trade information. 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 DPRK.

Enhancing Safeguards Implementation

In 2012, within its existing legal authority, the Agency continued to seek means for pursuing safeguards implementation that enhance the Agency's ability to provide credible assurances on the peaceful use of nuclear energy and are as effective and efficient as possible. In doing so, the Agency continued to focus on addressing safeguards objectives that are derived from safeguards agreements in a manner that better took into account all safeguards relevant information about a State.

Efforts during the year continued to focus on ways to better integrate verification activities at Headquarters and in the field with those related to performing State evaluations. In addition, the Agency continued to improve internal work practices through, inter alia, clarification of roles and responsibilities, streamlining the evaluation process, and enhancement of Agency oversight to ensure consistency and non-discrimination in the application of safeguards.

Cooperation with State and regional authorities

The effectiveness and efficiency of Agency safeguards depend, to a large extent, on the effectiveness of State systems of accounting for and control of nuclear material (SSACs) and, where relevant, regional systems (RSACs), and on the level of cooperation between State or regional safeguards authorities and the Agency. The Secretariat 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 the support provided for the Agency's verification activities.

The IAEA SSAC Advisory Service (ISSAS) provides States, at their request, with advice

and recommendations on the establishment and strengthening of SSACs. Although no ISSAS missions were conducted in 2012, preparations for missions to Tajikistan and Romania were initiated. The Agency also organized 12 international, regional and national training courses for personnel responsible for overseeing and implementing SSACs, and participated in meetings or workshops supporting the development of national infrastructures, particularly for States developing a nuclear power programme.

The Agency published the *Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols* (IAEA Services Series No. 21) in March 2012, which contains detailed and up to date practical guidance for States on the implementation of safeguards. The Agency also established a web page (located at *www.iaea.org/safeguards*) providing State and regional authorities with access to associated guidance, forms, templates and other reference documents.

Information analysis

The analysis of safeguards relevant information is an essential part of evaluating a State's nuclear activities and drawing safeguards conclusions. In drawing its safeguards conclusions, the Agency processes, evaluates and conducts consistency analysis of State declarations, verification data and other safeguards relevant information available to the Agency. In support of this process, the Agency draws on an increasing amount of data from verification activities performed at Headquarters and in the field, including the results from non-destructive assay (NDA), destructive assay (DA), environmental sample analyses and remotely monitored equipment, and from a diverse range of information sources, including satellite imagery, trade data, open sources, and other sources of information. Throughout 2012, the Agency enhanced and diversified its capabilities to acquire and process data, analyse and evaluate information, generate knowledge, and securely distribute information internally. It also continued to investigate new tools and methodologies to streamline and prioritize workflows and processes.

The Agency also analyses an increasing amount of field data, including NDA measurement results, as well as laboratory analysis of samples for DA of nuclear material and from environmental sampling — essential contributions to State evaluations.

In an effort to continuously improve the quality of reporting, the Agency: monitored laboratory and measurement systems performance; organized international technical meetings; and provided to States training and workshops on nuclear material accounting, including measurement and material balance evaluation concepts. Workshops on the procurement outreach programme yielded reports on suspicious procurement attempts and current procurement trends. Ongoing reviews of technical cooperation projects and procurements provided relevant safeguards input to decision making. Information analysts made important contributions to continuous State evaluations through their analyses of satellite imagery, material balance evaluations, statistical safeguards approaches, field measurements, nuclear material and environmental samples, procurement data, and scientific and technical literature.

"Throughout 2012, the Agency enhanced and diversified its capabilities to acquire and process data, analyse and evaluate information, generate knowledge, and securely distribute information internally."

Safeguards equipment and tools

Throughout 2012, the Agency ensured that across the world its instrumentation and monitoring equipment vital to the implementation of effective safeguards continued to function as required.

During 2012, 1948 separate pieces of equipment were prepared and assembled into 892 portable and resident NDA systems. By the end of 2012, a total of 153 unattended monitoring systems were in operation worldwide, and the Agency had 1283 cameras connected to 591 systems operating at 251 facilities in 33 States.[12] In addition, the Agency is responsible for maintaining approximately 200 further cameras used jointly with other regional/State authorities. The total number of electronic seals transmitting remote data to Headquarters was 163. By the end of 2012, there were 288 safeguards systems with remote monitoring installed at 118

[12] And Taiwan, China.

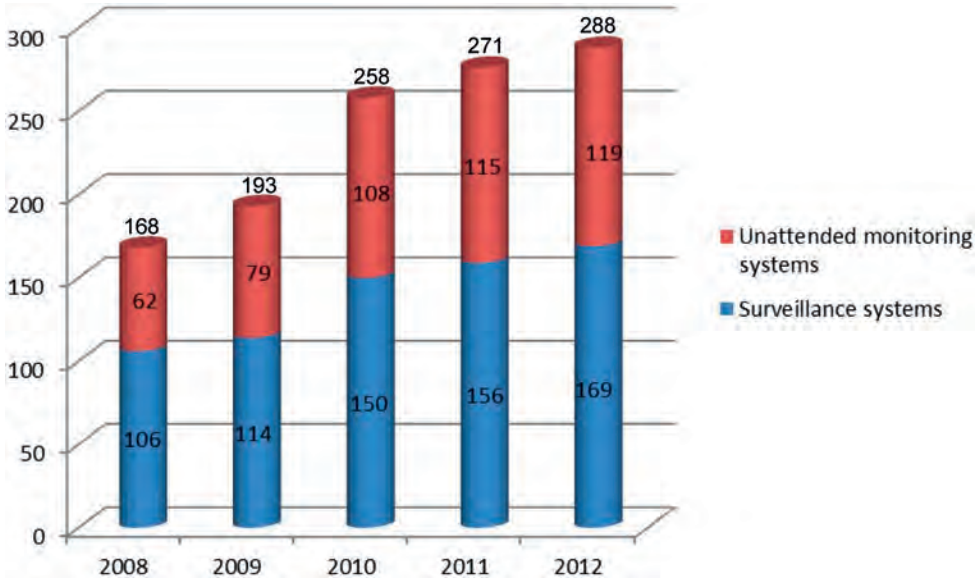


FIG. 2. Implementation of safeguards systems in remote monitoring mode, 2008–2012.

facilities in 22 States[13] (Fig. 2 illustrates the increased use of remote monitoring over the past five years).

Member State Support Programmes continued to provide significant resources to safeguards equipment innovations. During 2012, this contributed, inter alia, towards the successful completion of the Next Generation Surveillance System project and the upgrade of the mini multichannel analyser, along with numerous other improvements and upgrades aimed at achieving better standardization of safeguards instrumentation.

"Throughout the year, numerous workshops were held to further international cooperation in addressing safeguards needs..."

Throughout the year, numerous workshops were held to further international cooperation in addressing safeguards needs, as well as technical meetings to evaluate techniques with potential safeguards applications, such as image processing and inertial navigation. A security policy for the development of instrumentation was also established.

In 2012, the Agency refurbished its surveillance laboratories and began work on the assembly and long term testing area for unattended monitoring systems.

The Network of Analytical Laboratories (NWAL) consists of the Safeguards Analytical Laboratories (SAL) and 20 other qualified laboratories in Australia, Brazil, France, Hungary, Japan, the Republic of Korea, the Russian Federation, the United Kingdom and the USA, as well as of the European Commission. In 2012, the NWAL was enlarged by two laboratories — from Australia and the Republic of Korea, for particle analysis of environmental samples and bulk analysis of environmental samples, respectively. Additional laboratories in the areas of environmental and/or nuclear material sample analysis are in the process of qualification in Argentina, Belgium, Canada, China, France, Hungary, the Netherlands and the USA. In 2012, SAL analysed all nuclear material samples (506) collected by inspectors in the field and 949 sub-samples from environmental swipe sampling were analysed in the NWAL (including at SAL). Proficiency tests and quality procedures were applied to ensure the correctness and accuracy of all results.

Support

Developing the safeguards workforce

As demands on its workforce evolve, so does the Agency's training curriculum. In 2012, the Agency conducted 117 safeguards training courses for safeguards staff, including its revised 'Introductory Course on Agency Safeguards'. Training courses were developed, improved or updated in order to provide all safeguards staff with the necessary competencies. Examples of such training included a complementary access exercise; an analytical

[13] And Taiwan, China.

skills workshop; a nuclear fuel cycle indicators course; and advanced training in fuel cycle facilities supporting State evaluation. Advanced training on a range of more specialized areas was also organized, including proliferation indicators for different types of nuclear fuel cycle facilities. Training on safeguards activities at facilities and at Headquarters was complemented by seven new courses including an advanced uranium gas centrifuge enrichment plant course, a course on analytical techniques for State evaluation and a course on preparing and conducting complementary access in a facility involved in research and development in reprocessing.

The Agency's long-standing, ten month Safeguards Traineeship Programme graduated six participants in 2012 — from Central African Republic, Chile, Malaysia, Namibia, South Africa and Sudan.

Quality management

In 2012, improvements were made to the safeguards reporting processes, including the statements provided to States on the verification activities performed in the field and the reporting of verification activities internally within the Agency. Quality audits were conducted on the handling and processing of surveillance media and review of surveillance data, the radiation protection programme and the training of Safeguards Analytical Services staff. Training courses were provided on management system tools, such as the corrective action report system, the document management system and internal quality audits. The safeguards cost calculation methodology has been improved, performance indicators for monitoring the efficiency of safeguards processes have been developed and knowledge management efforts focused on retaining the critical knowledge of retiring staff were conducted. Development was started of a role based access system to streamline controls over internal access to safeguards information.

Standing Advisory Group on Safeguards Implementation

The Standing Advisory Group on Safeguards Implementation (SAGSI) held two series of meetings in 2012, at which, inter alia, it considered: efforts to further the application of the State level concept; internal guidance on preparing State level safeguards approaches for States with CSAs; and the Agency's safeguards information management systems. Australia hosted a meeting of the SAGSI working group and provided a tour of mines and conversion facilities, in support of SAGSI's consideration of safeguards activities at the front end of the nuclear fuel cycle.

Significant Safeguards Projects

ECAS

To maintain and strengthen its capabilities to provide independent and timely analysis of environmental and nuclear material samples, the Agency continued and expanded the project entitled Enhancing Capabilities of the Safeguards Analytical Services (ECAS). Construction of the Nuclear Material Laboratory (NML) building progressed on schedule and within budget, reaching 70% completion in 2012 (Fig. 3). The building is expected to be approved for operation in mid-2013. Thereafter, a phased transition of functions from the old Safeguards Analytical Laboratory to the NML will commence, extending into 2014 when the old laboratory will be fully vacated. Construction of additional non-laboratory space for the NML and of site infrastructure is expected to be completed in 2015.

FIG. 3. View of the construction activities for the Nuclear Material Laboratory in Seibersdorf, Austria, November 2012.

"Construction of the Nuclear Material Laboratory (NML) building progressed on schedule and within budget, reaching 70% completion in 2012..."

In the Environmental Sample Laboratory, the Agency's first multi-collector inductively coupled

plasma mass spectrometer was brought into service to further improve the precision of analysis of uranium and plutonium particles collected through environmental swipe sampling. A laser ablation module was procured to further complement this technology.

In 2012, significant progress was also made in defining requirements and designing the infrastructure and security components necessary for efficient, sustainable laboratory operations. With the help of continuing support from Member States, and in order to minimize long term costs and avoid interruptions to analytical services during the transition, additional activities were incorporated into the project during 2012. These activities, financed exclusively through extrabudgetary funding, lifted the total project budget to an approved €80.82 million.[14]

Information technology

In 2012, the Agency continued to make improvements to the overall performance and security of its safeguards information systems. To further strengthen the capability to protect confidential information, the Agency started using a highly secure internal network. Stricter measures were enforced to encrypt all newly configured laptops, and industry standard best practices and process improvements were implemented.

"In 2012, significant progress was also made in defining requirements and designing the infrastructure and security components necessary for efficient, sustainable laboratory operations."

To provide better support for analytical capabilities, two new systems were developed and released and a new collaborative analysis platform was developed. Several systems, including the 'State File', became available in the highly secure internal network and continue to mature. Advancements in IT security included the enhancement of forensic IT capabilities with more mature and standardized procedures and reporting methodologies. The entire firewall infrastructure was upgraded with new hardware and software.

MOX fuel fabrication plant in Japan

Construction of the MOX fuel fabrication plant in Japan (J-MOX), which had been suspended following the major earthquake of March 2011, resumed in April 2012. Design information verification was performed in October 2012 to verify the conformity of the basement construction of the main process building. The conceptual design of some safeguards equipment, as well as testing of some prototype equipment that will be needed at the plant, were finalized.

Chernobyl

The objective of the Chernobyl Safeguards Project is to develop safeguards approaches and instrumentation for routine safeguards implementation at the Chernobyl facilities. The Agency is involved in the early design stages in order to integrate appropriate safeguards measures in an effective and efficient manner. During 2012, discussions took place with the Chernobyl site operator and State Regulatory Authority concerning the construction schedule for the New Safe Confinement and the Interim Storage Facility for Spent Nuclear Fuel No. 2, and the submission of revised design information. Construction of the spent fuel conditioning and dry storage facility is now expected to be in operation in 2015. The New Safe Confinement over the damaged Reactor Unit 4 is expected to be completed in 2016.

Preparing for the Future

The long term strategic planning process for the Agency's nuclear verification programme, which began in 2012, addresses the conceptual framework for safeguards implementation, legal authority, technical capabilities (expertise, equipment and infrastructure) as well as the human and financial resources necessary for the Agency's verification efforts. It also considers communication, cooperation and partnerships with the Agency's stakeholders and sets in motion various improvements. In 2012, the

[14] The additional activities are explained in the report of the Director General contained in document GOV/INF/2012/15, Enhancing Capabilities of the Safeguards Analytical Services: Delivery of Fully Integrated Safeguards Laboratories at Seibersdorf (6 September 2012).

Agency also began implementation of the *Medium Term Strategy 2012–2017*.

Research and development are essential to meet the safeguards needs of the future. The Agency prepared the *Department of Safeguards Long-Term R&D Plan, 2012–2023.* This document outlines the capabilities that are needed to achieve its strategic objectives and for which Member State R&D support is needed. In doing so, the Plan covers a number of topics, including concepts and approaches, detection of undeclared nuclear material and activities, safeguards equipment and communication, information technology, analytical services and training.

To address near term development objectives and to support the implementation of its verification activities, the Agency continued to rely on Member State Support Programmes (MSSPs) in implementing its *Research and Development Programme for Nuclear Verification 2012–2013.* At the end of 2012, 20 States[15] and the European Commission had formal support programmes with the Agency, supporting over 300 tasks, valued at over €20 million per year. During 2012, the Secretariat finalized the review of its R&D activities implemented in 2010–2011 and published the *Biennial Report on the Research and Development Programme for Nuclear Verification 2010–2011*, which presented its accomplishments over this two year period.

[15] Argentina, Australia, Belgium, Brazil, Canada, China, the Czech Republic, 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 enhance the use of nuclear technology for sustainable development and social and economic benefits in Member States.

The Agency's technical cooperation programme builds capacities in Member States that support the use of nuclear technologies to address development priorities in human health, food and agriculture, water and the environment, and industry, thereby helping to achieve the Millennium Development Goals. The programme also helps Member States to identify and meet future energy needs, and to improve nuclear safety and security worldwide.

Country Programme Frameworks and Revised Supplementary Agreements

Country Programme Frameworks (CPFs) provide a comprehensive context for technical cooperation activities at the national level. In 2012, 18 CPFs were signed (Albania, Brazil, Costa Rica, El Salvador, Ethiopia, Indonesia, Iraq, Israel, Latvia, Lesotho, Libya, Lithuania, Mali, Malta, Morocco, Peru, Republic of Moldova and South Africa).[1]

As of 31 January 2013, a total of 121 Member States had signed a Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA).

Managing the Agency's Technical Cooperation Programme

In the first year of the 2012–2013 technical cooperation cycle, 686 new core projects were approved and three Programme Reserve projects were implemented. During the course of the year, 417 projects were closed, of which seven were cancelled. Active projects at the end of 2012 totalled 894, with an additional 145 in the process of being closed. Member State priorities, as reflected in programme disbursements, were human health, safety and security, and food and agriculture, with some variations in emphasis across regions.

[1] Total CPF signatures are calculated according to the year in which the Member State signs the document.

Financial highlights

Pledges against the 2012 Technical Cooperation Fund (TCF) totalled €55.6 million (not including national participation costs (NPCs) and assessed programme costs (APCs)), against the target of €62.3 million, with the rate of attainment on payments at the end of 2012 standing at 88.3%. The use of these resources resulted in a TCF implementation rate of 76.5%.

Improving the quality of the technical cooperation programme

The Agency emphasizes continuous improvement in the quality of the technical cooperation programme, and a systematic review process has been adopted to measure the quality of projects and their compliance with programme criteria. A quality review of project concepts submitted for the 2014–2015 programme cycle was conducted in 2012, and lessons learned and areas for improvement were identified. Member States were informed of necessary improvements through regular feedback.

"Member State priorities, as reflected in programme disbursements, were human health, safety and security, and food and agriculture, with some variations in emphasis across regions."

An e-learning course for technical cooperation stakeholders on the 'logical framework approach' planning methodology was developed in 2012 and launched in early 2013.

Monitoring and evaluating technical cooperation projects

A strategy to improve the monitoring of projects, prepared in 2011, was put into practice in 2012. Project monitoring and evaluation tools for stakeholders were piloted, with the aim of enhancing project implementation. Following internal review and consultation with counterparts and National Liaison

Officers, the Project Progress Assessment Report format was revised, and the new format will be used for future project progress reporting and closure.

Collecting best practices in technical cooperation project design and management

For the first time, best practices in project management were collected and validated, according to a methodology developed in 2012. The specific mechanism created will be used to foster the collection and sharing of best practices between all stakeholders (*http://www.iaea.org/technicalcooperation/programme/Quality/Best-Practices/index.html*).

Coordination with the United Nations and Other International Organizations

Partnerships with various United Nations and other international organizations were extended throughout 2012. The Agency worked with UNIDO on cleaner industrial production processes and energy planning; with FAO regarding closer country level cooperation; with UNICEF and WHO in the field of nutrition; and with the United Nations Convention to Combat Desertification (UNCCD), the World Overview of Conservation Approaches and Technologies and the Global Soil Partnership regarding the fight against desertification, land degradation and drought. It also collaborated with WHO and PAHO in the areas of cancer, medical physics, non-communicable diseases and nutrition.

"Partnerships with various United Nations and other international organizations were extended throughout 2012."

The Agency's involvement in the United Nations Development Assistance Framework (UNDAF), the strategic programme framework that describes the collective response of the UN system to national development priorities, continued to increase. As of December 2012, the Agency was participating actively in 95 UNDAF processes and had signed a total of 29 UNDAFs.

Contributions were also made to several global development reports, initiatives and discussions in 2012, including to ongoing discussions on the post-2015 UN Development Agenda, the Annual Ministerial Review of the Economic and Social Council, the Global Technology Facilitation Mechanism as requested by the Rio+20 outcome document, the UN Secretary-General's High-Level Task Force on the Global Food Security Crisis, the UN Secretary-General's report on the implementation of the Istanbul Programme of Action and the report of the UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States on UN system support to such countries.

In Africa, a partnership with the Islamic Development Bank (IDB) and the Organization of Islamic Cooperation (OIC) seeks to mobilize resources for African Member States for cancer control. In September 2012, the Agency, IDB and OIC jointly organized a high level seminar in Jeddah, Saudi Arabia, for the African Member States of the IDB and the Agency. The seminar prepared a set of recommendations and adopted a roadmap to guide follow-up actions, including the preparation of project documents for consideration by the IDB and other donors.

The Member States of the Sahel region developed a draft project proposal in consultation with the Agency entitled 'Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region'. The project, approved by the Board of Governors at its session in June 2012, aims to support the sustainable management of shared groundwater resources in the region that will contribute to socioeconomic development (Fig. 1). Japan, Sweden and the USA have provided extrabudgetary contributions through the Peaceful Uses Initiative.

In the Asia and the Pacific region, cooperation with regard to the Synchrotron-light for Experimental

FIG. 1. Studying rainwater infiltration rates for artificial recharge of groundwater tables in Moroccan aquifers.

Science and Applications in the Middle East (SESAME), ongoing since the signature of a Memorandum of Understanding in December 2006, continued to be supported by a technical cooperation project. The SESAME centre, set up under the auspices of UNESCO on the model of the European Organization for Nuclear Research (CERN) with training provided through a technical cooperation project, aims to improve basic and applied research in medicine, the environment and technology in the Middle East. It will be the region's first major international research centre and is expected to facilitate North–South and South–South cooperation.

In Europe, close cooperation was maintained with UNDP Resident Coordinator Offices in relevant Member States, and with UN Country Teams. The Agency participated in the 'One UN' process through the UN Europe and Central Asia Regional Coordination Mechanisms, and in the UNDAF process. Cooperation with other UN agencies within the framework of specific projects continued in areas addressing the problem of uranium production legacy sites, and improving health care.

The implementation of projects in Latin America was coordinated with international and regional organizations operating in the region, in particular the US National Oceanic and Atmospheric Administration, on designing and implementing systems for early warning and evaluation of the toxicity of harmful algal blooms, and the Instituto Interamericano de Cooperación para la Agricultura to help achieve regional objectives for food security. The Agency continued to work closely with UN organizations at both the national and regional levels, and with PAHO in the area of human health. For example, the Agency is following the preparation of the 2014–2018 UNDAF for Cuba, and has participated in a strategic prioritization workshop with 12 UN organizations to identify the comparative advantages of the UN system for effectively contributing to national priorities, and to analyse possibilities for establishing partnerships with key stakeholders. The Agency seeks to leverage partnerships with the specialized agencies of the UN system to strengthen adaptation and innovation in science and technology for food production, with FAO, and with UNEP and UNESCO's Intergovernmental Oceanographic Commission, on coastal zone management.

At the global level, significant efforts were made to reach out to and deepen engagement with the European Union (EU). Various high level visits were conducted and close cooperation was established with the UN Brussels Team as a means to advance the Agency's message to the various EU institutions. Cooperation between the EU and the Agency is well established in the fields of nuclear and radiation safety, nuclear security and safeguards. The cooperation between the European Commission and the Agency, for example, has focused on several areas of nuclear safety, such as capacity building, waste management, environmental remediation and strengthening regulatory authorities.

Regional Agreements and Programming

Regional agreements and other Member State groups promote horizontal cooperation, self-reliance and sustainability. Agency collaboration with these groups has led to stronger technical cooperation programmes that are focused on priorities identified at the regional level.

"Regional agreements and other Member State groups promote horizontal cooperation, self-reliance and sustainability."

In 2012, AFRA continued to be the primary mechanism for technical cooperation among developing countries in Africa and for enhancing regional cooperation among States Parties. Following the final assessment of the AFRA Regional Strategic Cooperative Framework for 2008–2013, a new Regional Strategic Framework document covering the period 2014–2018 was developed and endorsed by AFRA States Parties during the 23rd Meeting of Representatives in September 2012. The framework defines and prioritizes areas of regional cooperation for the sustainable and peaceful application of nuclear technology, and defines the AFRA strategy for resource mobilization and partnership building with relevant organizations and partners. AFRA also participated in the Second Conference of States Parties to the African Nuclear-Weapon-Free Zone Treaty (the Pelindaba Treaty), which took place in November 2012 at the African Union Commission.

In the Asia–Pacific region, the Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) promotes and coordinates activities for training, research, development and applications of nuclear science and technology

(Fig. 2). In 2012, ARASIA adopted a new mechanism further promoting the principle of shared commitments and responsibilities, through which the ARASIA Chairmanship and ARASIA Secretariat rotate among the States Parties every four years. In its regional annual meeting in March 2012 in Beirut, ARASIA formed a working group to review the Guidelines and Operating Rules against the document establishing the Agreement and other ARASIA documents, such as the Medium Term Strategy and the ARASIA Programme Profile, in order to improve the management of the Agreement and to ensure effective development and delivery of the ARASIA programme.

"Agency outreach to the international development community was strengthened through participation in several global conferences, including Rio+20, the World Water Forum, the Soil Symposium and the European Development Days."

RCA celebrated the 40th anniversary of its founding. Various events were organized at both the national and regional levels, including exhibitions in Beijing and Vienna, and a panel discussion during the IAEA's 56th General Conference. RCA has continued its efforts to improve the quality and effectiveness of the programme. A Project Monitoring Committee for RCA Programme Development was established to monitor and report on progress. RCA mechanisms were recognized as examples of 'best practice' in the first Agency's Technical Cooperation Best Practice awards in January 2013. The Fifth RCA Extension Agreement entered into force in June 2012 for a further five years.

FIG. 2. Supporting improved crop productivity through induced mutations in ARASIA countries.

In the Europe region, a major effort is continuing to strengthen regional cooperation in line with the strategy for technical cooperation in the region adopted in 2010. The strategy is being applied to design a focused regional programme for 2014–2015 that addresses Member State priorities identified in the Europe Regional Profile (the medium term plan for 2009–2013, updated for 2014–2018). Member States in the region played the lead role in the development of both national and regional technical cooperation programmes, working with the Secretariat to ensure high quality concepts and project designs, and supporting continuous dialogue with all project stakeholders, in line with the logical framework approach.

In Latin America, a review of the 2007–2013 Regional Strategic Profile for Latin America and the Caribbean was initiated in 2012, in close collaboration with ARCAL. A planning and coordination working group and six thematic working groups have been established to assess future regional priorities in the areas of human health, environment, food security, energy, industry and radiation safety. The assessment results will establish the basis for the new Regional Strategic Profile. Special importance will be placed on establishing strategic objectives and defining smart performance indicators to monitor progress as well as the impact of future regional projects. A regional project was set up to strengthen communication and partnerships in ARCAL countries to enhance nuclear applications and sustainability. The project is expected to establish mechanisms and procedures to increase the visibility of the projects developed within the ARCAL framework and implemented under the technical cooperation programme. In particular, a strategic communication plan and guidelines for strategic partnerships will be drafted, and an integrated information management system for ARCAL will be put in place.

Outreach and Communication

Agency outreach to the international development community was strengthened through participation in several global conferences, including Rio+20, the World Water Forum, the Soil Symposium and the European Development Days. During these events, the Agency's work was presented to raise awareness of the technical cooperation programme among potential partners, and to build understanding of the contribution of nuclear science and technology to development.

Agency exhibitions, with complementary flyers and postcards, were organized at the World Water Forum, Rio+20, the 56th IAEA General Conference and the Global South–South Development Expo, and an event

on science and development was also held at the General Conference. Exhibitions focusing on technical cooperation activities were also organized for World Cancer Day, World Water Day, the NPT PrepCom, the General Conference, Africa Industrialization Day, and on the occasion of the meeting of the Technical Assistance and Cooperation Committee.

A third Seminar on Technical Cooperation, designed to provide Permanent Missions with a comprehensive overview of the programme, was held in October 2012.

Regarding web outreach and social media, the Agency's technical cooperation web site was relaunched in February 2012. The new site garnered 11 079 visits and 7307 unique visitors in the period February–April 2012, and now has around 1000 visitors a week. Over 60 new web highlights were posted during the course of the year. More than 300 tweets were sent out from the *@IAEATC* Twitter account, which now has 1200 followers.

Programme Cycle Management Framework (PCMF) and TCPRIDE

The PCMF IT platform was enhanced in 2012 to include improvements to the programme cycle development process. This included changes to both the concept and design workflows to include enhanced quality checks with feedback to Member States. The PCMF has also been adjusted to align budget calculations with the approach of the Regular Budget 'Oracle Hyperion Planning' tool implemented as part of the Agency-wide Information System for Programme Support.

The initial phase of the incorporation of the TC Project Information Dissemination Environment (TCPRIDE) web site in the PCMF IT platform was completed in 2012. Further enhancements were initiated, including capacity for Member State work plan monitoring and a search function for unfunded footnote-a/ items, in line with a General Conference resolution on secured, searchable current and unfunded footnote-a/ items.

Legislative Assistance

In 2012, the Agency continued to provide legislative assistance to its Member States within the technical cooperation programme. Country specific bilateral legislative assistance was provided to 18 Member States. The Agency also organized short term scientific visits to Headquarters for a number of individuals, allowing fellows to gain further practical experience in nuclear law.

The second session of the Nuclear Law Institute was organized in Baden, Austria, in September–October. The comprehensive two week course was established to meet the increasing demand by Member States for legislative assistance and to enable participants to acquire an understanding of all aspects of nuclear law, as well as to draft, amend or review their national nuclear legislation. A total of 60 representatives from 51 Member States participated. The Agency also continued to contribute to the activities organized at the World Nuclear University and the International School of Nuclear Law by organizing lectures and funding participants through appropriate technical cooperation projects.

A Workshop for Diplomats on Nuclear Law was organized in July 2012 to provide Member State representatives with a broad understanding of all aspects of nuclear law. The workshop was attended by 87 participants from 51 Member States.

The Agency is also enhancing outreach activities through the development of new on-line training material.

"In order to raise the awareness of national policy makers about the importance of adhering to relevant international legal instruments adopted under its auspices, the Agency organizes 'awareness missions' to Member States..."

The second treaty event organized by the Secretariat took place during the 56th regular session of the General Conference, and provided Member States with a further opportunity to deposit their instruments of ratification, acceptance or approval of, or accession to, the treaties deposited with the Director General. These include, notably, those related to nuclear safety, nuclear security and liability for nuclear damage.

In order to raise the awareness of national policy makers about the importance of adhering to relevant international legal instruments adopted under its auspices, the Agency organizes 'awareness missions' to Member States, the latest of which took place in Ghana in October 2012.

Annex

Note: Tables A16–A21 are available on the attached CD-ROM.

Table A1. Regular budget allocation and utilization of resources in 2012 by Programme and Major Programme (in euros)

Programme / Major Programme	Original budget $1/€1[a]	Adjusted budget $1.2858/€1[b]	Obligations[c]	Actuals	Expenditure	Unobligated balances
1 Nuclear Power, Fuel Cycle and Nuclear Science						
Overall management, coordination and common activities	1 021 587	964 236	78 288	1 100 488	1 178 776	(214 540)
Nuclear Power	7 577 688	7 148 587	376 397	6 785 211	7 161 608	(13 021)
Nuclear Fuel Cycle and Materials Technologies	3 343 719	3 133 806	196 735	2 609 087	2 805 822	327 984
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	10 607 933	10 121 761	1 155 540	8 304 773	9 460 313	661 448
Nuclear Science	9 823 768	9 430 759	786 120	8 670 819	9 456 939	(26 180)
Corporate Shared Services	1 349 852	1 296 289	73 036	1 101 380	1 174 416	121 873
Total Major Programme 1	**33 724 547**	**32 095 438**	**2 666 116**	**28 571 758**	**31 237 874**	**857 564**
2 Nuclear Techniques for Development and Environmental Protection						
Overall management, coordination and common activities	4 628 000	4 458 413	362 479	3 361 624	3 724 103	734 310
Management of the coordinated research activities	705 082	668 926	31 642	590 974	622 616	46 310
Food and Agriculture	11 188 489	10 734 381	1 753 772	9 261 511	11 015 283	(280 902)
Human Health	9 545 210	9 127 542	1 299 933	7 158 899	8 458 832	668 710
Water Resources	3 397 127	3 248 549	639 017	2 804 692	3 443 709	(195 160)
Environment	5 970 964	5 712 050	147 391	4 703 642	4 851 033	861 017
Radioisotope Production and Radiation Technology	2 198 683	2 086 620	239 749	1 766 096	2 005 845	80 775
Corporate Shared Services	1 030 519	987 337	73 486	856 205	929 691	57 646
Total Major Programme 2	**38 664 074**	**37 023 818**	**4 547 469**	**30 503 643**	**35 051 112**	**1 972 706**
3 Nuclear Safety and Security						
Enhancing the global nuclear safety and security framework	757 180	722 482	19 862	767 159	787 021	(64 539)
Enhancing and strengthening capacity building, communications, knowledge networking, education and training	513 381	486 489	1 451	361 891	363 342	123 147
Incident and Emergency Preparedness and Response	3 440 715	3 240 405	281 972	2 574 034	2 856 006	384 399
Safety of Nuclear Installations	10 414 252	9 920 549	151 586	9 440 690	9 592 276	328 273
Radiation and Transport Safety	5 910 303	5 640 273	107 470	5 489 380	5 596 850	43 423
Management of Radioactive Waste	7 018 399	6 648 809	198 754	6 165 606	6 364 360	284 449
Nuclear Security	4 437 402	4 232 450	41 562	4 161 153	4 202 715	29 735
Corporate Shared Services	1 506 904	1 447 385	75 597	1 223 731	1 299 328	148 057
Total Major Programme 3	**33 998 536**	**32 338 842**	**878 254**	**30 183 644**	**31 061 898**	**1 276 944**
4 Nuclear Verification						
Overall management and coordination	2 484 902	2 371 768	30 665	2 882 698	2 913 363	(541 595)
Quality management	1 117 857	1 070 276	1 946	666 232	668 178	402 098
Resources management	1 260 260	1 208 472	8 259	1 062 640	1 070 899	137 573
Safeguards Implementation	110 161 741	105 157 142	9 396 245	93 669 167	103 065 412	2 091 730
Other Verification Activities	587 780	562 618	198	495 445	495 643	66 975
Development	10 410 093	9 927 443	1 082 204	9 182 687	10 264 891	(337 448)
Corporate Shared Services	2 757 916	2 633 746	218 498	2 455 425	2 673 923	(40 177)
Total Major Programme 4	**128 780 549**	**122 931 465**	**10 738 015**	**110 414 294**	**121 152 309**	**1 779 156**
5 Policy, Management and Administration Services						
Policy, Management and Administration Services	72 544 333	70 146 559	4 773 853	62 609 067	67 382 920	2 763 639
Corporate Shared Services	2 810 616	2 693 680	153 292	2 401 263	2 554 555	139 125
Total Major Programme 5	**75 354 949**	**72 840 239**	**4 927 145**	**65 010 330**	**69 937 475**	**2 902 764**
6 Management of Technical Cooperation for Development						
Management of Technical Cooperation for Development	19 603 401	18 814 345	211 184	17 707 915	17 919 099	895 246
Corporate Shared Services	786 504	751 592	55 327	691 418	746 745	4 847
Total Major Programme 6	**20 389 905**	**19 565 937**	**266 511**	**18 399 333**	**18 665 844**	**900 093**
Total Operational Regular Budget	**330 912 560**	**316 795 739**	**24 023 510**	**283 083 002**	**307 106 512**	**9 689 227**
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	7 137 905	7 137 905	5 575 350	–	5 575 350	1 562 555
5. Policy, Management and Administration Services	1 015 550	1 015 550	238 166	759 126	997 292	18 258
6. Management of Technical Cooperation for Development	–	–	–	–	–	–
Capital Regular Budget	**8 153 455**	**8 153 455**	**5 813 516**	**759 126**	**6 572 642**	**1 580 813**
Total Agency Programmes	**339 066 015**	**324 949 194**	**29 837 026**	**283 842 128**	**313 679 154**	**11 270 040**
Reimbursable work for others	2 385 239	2 246 691		2 966 349	2 966 349	(719 658)
Total Regular Budget	**341 451 254**	**327 195 885**	**29 837 026**	**286 808 477**	**316 645 503**	**10 550 382**

[a] General Conference resolution GC(55)/RES/5 of September 2011 — adjusted to reflect the share of the Corporate Shared Services under each of the operational Major Programmes.
[b] Original budget revalued at the United Nations average rate of exchange of $1.2858 to €1 or €0.7777 to $1.
[c] Amounts related to purchase orders involving claims against resources for which expenditure authority has been given but not yet invoiced (paid).

Table A2. Extrabudgetary regular programme fund resource utilization in 2012 by Programme and Major Programme, and Fund (in euros)

Extrabudgetary regular programme funds	Obligations[a]	Actuals	Expenditure
Extrabudgetary fund	7 967 109	52 049 428	60 016 537
International Nuclear Fuel Bank (NFB)	11 790	1 445 841	1 457 631
Peaceful Uses Initiative (PUI)	657 224	2 611 820	3 269 044
Nuclear Security Fund (NSF)	2 991 250	15 063 667	18 054 917
Total extrabudgetary regular programme funds	**11 627 373**	**71 170 756**	**82 798 129**
Programme / Major Programme			
1 Nuclear Power, Fuel Cycle and Nuclear Science			
Overall management, coordination and common activities	1 664	148 725	150 389
Nuclear Power	370 669	3 434 177	3 804 846
Nuclear Fuel Cycle and Materials Technologies	17 754	1 684 314	1 702 068
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	10 750	251 116	261 866
Nuclear Science	106 235	802 452	908 687
Total Major Programme 1	**507 072**	**6 320 784**	**6 827 856**
2 Nuclear Techniques for Development and Environmental Protection			
Overall management, coordination and common activities	8 426	211 278	219 704
Food and Agriculture	512 365	2 539 549	3 051 914
Human Health	113 650	1 599 975	1 713 625
Water Resources	145 544	513 351	658 895
Environment	29 476	745 813	775 289
Radioisotope Production and Radiation Technology	–	–	–
Total Major Programme 2	**809 461**	**5 609 966**	**6 419 427**
3 Nuclear Safety and Security			
Enhancing the global nuclear safety and security framework	456	224 388	224 844
Enhancing and strengthening capacity building, communications, knowledge networking, education and training	209 339	2 297 115	2 506 454
Incident and Emergency Preparedness and Response	160 827	815 072	975 899
Safety of Nuclear Installations	691 507	6 932 234	7 623 741
Radiation and Transport Safety	123 015	1 269 532	1 392 547
Management of Radioactive Waste	67 519	1 487 834	1 555 353
Nuclear Security	2 980 313	14 753 438	17 733 751
Total Major Programme 3	**4 232 976**	**27 779 613**	**32 012 589**
4 Nuclear Verification			
Overall management and coordination	218	74 032	74 250
Resources management	–	26 927	26 927
Safeguards Implementation	1 308 965	7 804 799	9 113 764
Other Verification Activities	–	9 918	9 918
Development	4 738 050	22 475 324	27 213 374
Total Major Programme 4	**6 047 233**	**30 391 000**	**36 438 233**
5 Policy, Management and Administration Services			
Policy, Management and Administration Services	30 631	1 011 913	1 042 544
Total Major Programme 5	**30 631**	**1 011 913**	**1 042 544**
6 Management of Technical Cooperation for Development			
Management of Technical Cooperation for Development	–	57 480	57 480
Total Major Programme 6	**–**	**57 480**	**57 480**
Total extrabudgetary programme funds	**11 627 373**	**71 170 756**	**82 798 129**

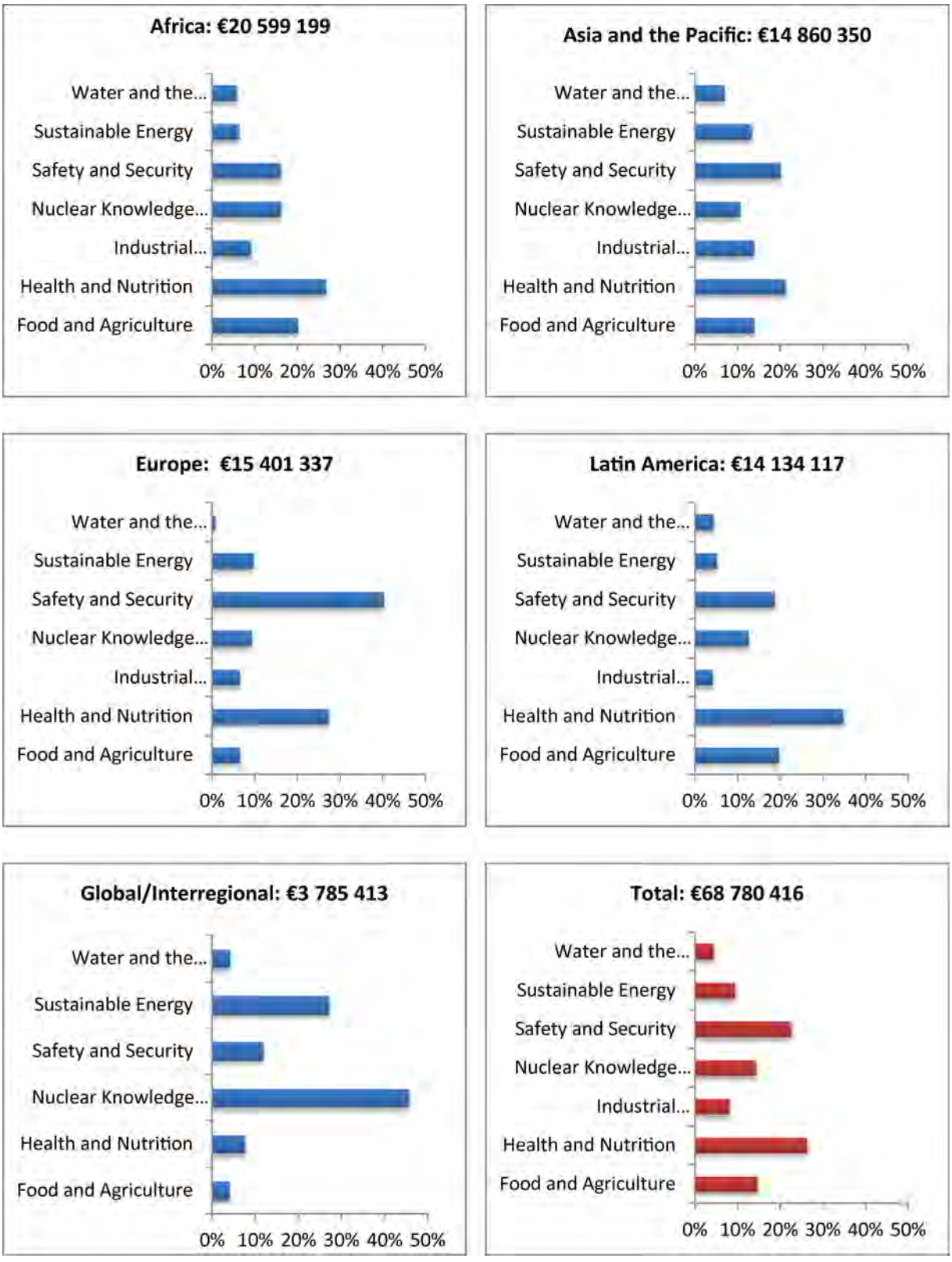
[a] Represents the amounts related to purchase orders involving claims against resources for which expenditure authority has been given but not yet invoiced (paid).

Table A3(a). Disbursements (actuals) by technical field and region in 2012

Summary of all regions (in euros)

Technical field		Africa	Asia and the Pacific	Europe	Latin America	Global/inter-regional	Total
1	Food and Agriculture	4 143 973	2 058 888	998 467	2 802 309	149 330	10 152 967
2	Health and Nutrition	5 481 034	3 148 294	4 192 762	4 937 687	286 040	18 045 817
3	Industrial Applications/ Radiation Technology	1 859 250	2 063 363	999 175	606 779	0	5 528 566
4	Nuclear Knowledge Development and Management	3 350 798	1 578 819	1 420 622	1 768 977	1 724 777	9 843 994
5	Safety and Security	3 282 766	2 991 223	6 202 426	2 651 775	444 773	15 572 963
6	Sustainable Energy	1 315 785	1 992 657	1 475 671	739 066	1 025 541	6 548 719
7	Water and the Environment	1 165 593	1 027 106	112 215	627 523	154 952	3 087 390
Total		**20 599 199**	**14 860 350**	**15 401 337**	**14 134 117**	**3 785 413**	**68 780 416**

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



Note: See Table A3(a) for the full titles of the technical fields.

Table A4. Amount of nuclear material at the end of 2012 by type of agreement

Nuclear material	Comprehensive safeguards agreement[1]	INFCIRC/66[2] type agreement	Voluntary offer agreement	Quantity in SQs
Plutonium[3] contained in irradiated fuel and in fuel elements in reactor cores	122 141	1 797	17 891	141 829
Separated plutonium outside reactor cores	1 466	10	10 604	12 080
HEU (equal to or greater than 20% U-235)	211	1	0.2	212
LEU (less than 20% U-235)	16 445	211	927	17 583
Source material[4] (natural and depleted uranium and thorium)	9 477	342	2 226	12 045
U-233	18	0.001	0	18
Total significant quantities (SQs)	**149 758**	**2 362**	**31 648**	**183 767**

Amount of heavy water at the end of 2012 by type of agreement

Non-nuclear material[5]	Comprehensive safeguards agreement[6]	INFCIRC/66[7] type agreement	Voluntary offer agreement	Quantity in tonnes
Heavy water (tonnes)	**0.7[8]**	**436**	**0**	**437**

1 Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other CSAs; including facilities in Taiwan, China.

2 Covering facilities in India, Israel and Pakistan.

3 The quantity includes an estimated amount (11 220 SQs) of plutonium (Pu) in irradiated fuel, which has not yet been reported to the Agency under the reporting procedures agreed to (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.

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

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

6 Covering safeguards agreements pursuant to NPT and/or the Treaty of Tlatelolco and other CSAs; including facilities in Taiwan, China.

7 Covering facilities in India, Israel and Pakistan.

8 In Taiwan, China.

Table A5. Number of facilities under safeguards during 2012

Facility type	Number of facilities			
	Comprehensive safeguards agreements (CSAs)[a]	INFCIRC/66[b] atype agreements	Voluntary offer agreements	Totals
Power reactors	234	9	1	244
Research reactors	148	3	1	152
Conversion plants	17	0	0	17
Fuel fabrication plants	43	2	1	46
Reprocessing plants	11	1	1	13
Enrichment plants	16	0	3	19
Separate storage facilities	121	1	5	127
Other facilities	74	0	0	74
Subtotals	**664**	**16**	**12**	**692**
Material balance areas containing LOFs[c]	621	1	0	622
Totals	**1285**	**17**	**12**	**1314**

[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 material balance areas containing locations outside facilities (LOFs) of the Agency (2) and the European Commission in Luxembourg (1).

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
Afghanistan	X	In force: 20 Feb. 1978	257	In force: 19 July 2005
Albania[1]		In force: 25 March 1988	359	In force: 3 Nov. 2010
Algeria		In force: 7 Jan. 1997	531	Approved: 14 Sept. 2004
Andorra	X	In force: 18 Oct. 2010	808	In force: 19 Dec. 2011
Angola	In force: 28 April 2010	In force: 28 April 2010	800	In force: 28 April 2010
Antigua and Barbuda[2]	Amended: 5 March 2012	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	In force: 20 July 2011
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 Signed: 6 June 2012	204	Signed: 6 June 2012
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

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
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
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	In force: 28 Oct. 2011	In force: 28 Oct. 2011	831	In force: 28 Oct. 2011
Costa Rica[2]	Amended: 12 Jan. 2007	In force: 22 Nov. 1979	278	In force: 17 June 2011
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]	Amended: 10 June 2011	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	*Approved: 13 June 1986*	*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

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
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
Gambia	Amended: 17 Oct. 2011	In force: 8 Aug. 1978	277	In force: 18 Oct. 2011
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	Rescinded: 24 Feb. 2012	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]	Amended: 26 April 2011	In force: 1 Feb. 1982	299	In force: 28 May 2008
Guinea	*Signed: 13 Dec. 2011*	*Signed: 13 Dec. 2011*		*Signed: 13 Dec. 2011*
Guinea-Bissau	*Approved: 6 March 2012*	*Approved: 6 March 2012*		*Approved: 6 March 2012*
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	In force: 10 Oct. 2012
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

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
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	In force: 10 Nov. 2011
Lao P.D.R.	X	In force: 5 April 2001	599	
Latvia[19]		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				
Libya		In force: 8 July 1980	282	In force: 11 Aug. 2006
Liechtenstein		In force: 4 Oct. 1979	275	Signed: 14 July 2006
Lithuania[20]		Accession: 1 Jan. 2008	193	Accession: 1 Jan. 2008
Luxembourg		In force: 21 Feb. 1977	193	In force: 30 April 2004
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[21]		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[22]		In force: 14 Sept. 1973	197	In force: 4 March 2011
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

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
Montenegro	In force: 4 March 2011	In force: 4 March 2011	814	In force: 4 March 2011
Morocco	Rescinded: 15 Nov. 2007	In force: 18 Feb. 1975	228	In force: 21 April 2011
Mozambique	In force: 1 March 2011	In force: 1 March 2011	813	In force: 1 March 2011
Myanmar	X	In force: 20 April 1995	477	
Namibia	X	In force: 15 April 1998	551	In force: 20 Feb. 2012
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[23]	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	Rescinded: 14 Aug. 2012	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	
		In force: 15 April 2011	816	
Palau	Amended: 15 March 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[9]	Amended: 4 March 2011	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[24]		Accession: 1 March 2007	193	Accession: 1 March 2007

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
Portugal[25]		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	Amended: 1 Sept. 2011	In force: 17 May 2006	690	In force: 1 June 2012
Romania[26]		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	Amended: 13 May 2011	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[27]		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[28]		Accession: 1 Dec. 2005	193	Accession: 1 Dec. 2005
Slovenia[29]		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[30]		Accession: 1 June 1995	193	In force: 30 April 2004
Switzerland		In force: 6 Sept. 1978	264	In force: 1 Feb. 2005
Syrian Arab Republic		In force: 18 May 1992	407	

Table A6. Conclusion of safeguards agreements, additional protocols (APs) and small quantities protocols (SQPs) (as of 31 December 2012) (cont.)

State	SQP[a]	Safeguards agreements[b]	INFCIRC	Additional protocols
Tajikistan[31]	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	In force: 18 July 2012		In force: 18 July 2012
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[32]	175	
		In force: 14 Aug. 1978	263*	In force: 30 April 2004
	X	Signed: 6 Jan. 1993[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	In force: 17 Sept. 2012
Yemen, Republic of	X	In force: 14 Aug. 2002	614	
Zambia	X	In force: 22 Sept. 1994	456	Signed: 13 May 2009
Zimbabwe	Amended: 31 Aug. 2011	In force: 26 June 1995	483	

Key

States: States not party to the NPT whose safeguards agreements are of INFCIRC/66-type.

States: Non-nuclear-weapon States 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.

Note: 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.

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[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 Grenadines on 18 March 1997) confirming that the safeguards agreement satisfies the requirement of Article 13 of the Treaty of Tlatelolco.

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

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

[8] 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 January 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 January 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] 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.

[20] 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.

[21] 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.

[22] 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.

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

[24] The application of safeguards in Poland under the NPT safeguards agreement INFCIRC/179, in force since 11 Oct. 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.

[25] 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.

[26] 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.

[27] 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.

[28] 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.

[29] 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.

[30] 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.

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

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

Table A7. Participation 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 2012)

	State/Organization	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	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	CS	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	Pr			P				P		
*	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 and Herzegovina	Pr	P	P	CS	P	P		P	P			P		
*	Botswana			P		P	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		

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Burundi												P		
*	Cambodia			P		P			P				P		
*	Cameroon	P	P	P		P	P	P					P		
*	Canada	Pr		P		Pr	Pr		P	P				X	X
	Cape Verde			P											
*	Central African Republic			P											
*	Chad												P		
*	Chile	Pr	Pr	P	CS	P	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			P		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	X	X
*	Czech Republic	P	P	P	CS	P	P	P	P	P	S	S	P	X	X
	DPRK					Sr	Sr								
*	Dem. Rep. of the Congo	P		P		S	S						P		
*	Denmark	Pr		P	CSr	P	Pr	P	Pr	Pr				X	X
	Djibouti			P											
*	Dominica			P											
*	Dominican Republic			P		P							P		
*	Ecuador	P		P									P		
*	Egypt	P	P			Pr	Pr	P	S				P		
*	El Salvador			Pr		Pr	Pr						P	X	

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	Equatorial 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	CS	P	Pr	P	P	P				X	X
*	France			Pr		Pr	Pr	S	P	P				X	X
*	Gabon			P	CS	P	P			P			P		
	Gambia														
*	Georgia			P	CS	P				P			P		
*	Germany	Pr		Pr	CS	Pr	Pr	P	P	P				X	X
*	Ghana	P		P	CS				P	P			P		
*	Greece	P		Pr	CS	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	P	S	S	P		
*	Iran, Islamic Republic of	P				Pr	Pr						P		X
*	Iraq	P				Pr	Pr						P		

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Ireland	P		Pr		P	Pr		P	P			P	X	X
*	Israel		Sr	Pr	CSr	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	CS	P	P		P	P	P		P		
*	Kenya			P	CS								P		X
	Kiribati														
*	Korea, Republic of	Pr		Pr		P	Pr		P	P			P	X	X
*	Kuwait	P		Pr		P	P		P				P		
*	Kyrgyzstan									P			P		
*	Lao People's Democratic Republic			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	CS								P		
*	Liberia														
*	Libya			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	CS	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

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Marshall Islands			P											
*	Mauritania			P	CS	P	P			P			P		
*	Mauritius	P				Pr	Pr						P		
*	Mexico	Pr	P	P	CS	P	P		P				P	X	X
	Micronesia														
*	Monaco			P		Pr	Pr		S					X	X
*	Mongolia	P		P		P	P						P		
*	Montenegro	P	P	P		P	P			P	P		P		
*	Morocco	Pr	S	P		P	P	S	S	P	P	CS	P	X	
*	Mozambique	P		Pr		P	P						P		
*	Myanmar					Pr							P	X	X
*	Namibia			P									P		
	Nauru			P	CS										
*	Nepal												P		
*	Netherlands	P		Pr	CS	Pr	Pr	P	P	P				X	X
*	New Zealand	P		P		P	Pr								
*	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				X	X
*	Oman	Pr		Pr		Pr	Pr						P		
*	Pakistan	Pr		Pr		Pr	Pr		P				P	X	X
*	Palau			P									P		
*	Panama			P		P	P						P	X	
*	Papua New Guinea														
*	Paraguay			P		S	S						P		

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	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		
*	Republic 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			Pr	CS										
	St Vincent and Grenadines		P			P	P	P							
	Samoa														
	San Marino														
	Sao Tome and Principe														
*	Saudi Arabia		P	Pr	CS	Pr	Pr		P	P	Pr		P		
*	Senegal	P	P	P		P	P		P	P		S	P		
*	Serbia	P	P	P		P	P						P		
*	Seychelles			P	CS								P		X
*	Sierra Leone					S	S						P		
*	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	X	X
*	Spain	P	S	Pr	CS	Pr	Pr	S	P	P			P	X	X

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Sri Lanka					Pr	Pr		P				P		
*	Sudan			P		S	S		S				P		
	Suriname														
	Swaziland			P											
*	Sweden	P		Pr	CS	P	Pr	P	P	P				X	X
*	Switzerland	Pr		Pr	CS	P	P	S	P	P				X	X
*	Syrian Arab Republic	P				S	S		S				P		X
*	Tajikistan	P		P		P	P			P			P		
*	Thailand	Pr				Pr	Pr						P		
*	TFYR of Macedonia		P	P	CS	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
*	United Arab Emirates			P	CS	Pr	Pr	P	P	P	Pr		P		
*	United Kingdom	P	S	Pr	CS	Pr	Pr	S	P	P				X	X
*	United Republic of Tanzania			P		P	P						P		
*	USA			P		Pr	Pr		P	P		CSr			
*	Uruguay		P	P		P	P	P	P	P			P	X	
*	Uzbekistan			P						P			P		
	Vanuatu														

Table A7. Participation 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 2012) (cont.)

	State/Organization	P&I	VC	CPPNM	CPPNMAM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	Venezuela												P		
*	Vietnam	P		Pr	CS	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 (not yet in force)
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
CSC	Convention on Supplementary Compensation for Nuclear Damage (not yet in 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 2012, the status remained unchanged with 83 Parties.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2012, the status remained unchanged with 38 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2012, the status remained unchanged with 2 Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2012, 3 States became Party to the Convention. By the end of the year, there were 148 Parties.

Amendment to the Convention on the Physical Protection of Nuclear Material. Adopted on 8 July 2005. In 2012, 9 States adhered to the Amendment, bringing the total to 61 Contracting States.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2012, 1 State became Party to the Convention. By the end of the year, there were 114 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 2012, the status remained unchanged with 108 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 2012, 1 State became Party to the Protocol. By the end of the year, there were 27 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2012, 1 State became Party to the Convention. By the end of the year, there were 75 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 2012, 1 State became Party to the Convention. By the end of the year, there were 64 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 2012, 1 State became Party to the Protocol. By the end of the year, there were 10 Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Opened for signature on 29 September 1997. In 2012, the status remained unchanged with 4 Contracting States and 15 Signatories.

Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA). In 2012, 4 States concluded a RSA. By the end of the year, there were 121 States party to a RSA Agreement.

Fifth 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.23). Entered into force on 31 August 2011 with effect from 12 June 2012. In 2012, 9 States became Party to the Agreement. By the end of the year, there were 12 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 2012, 3 States became Party to the Agreement. By the end of the year, there were 34 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 2012, the status remained unchanged with 21 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 2012, the status remained unchanged with 9 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 2012, the status remained unchanged with 7 Parties.

Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/703). Entered into force on 24 October 2007. In 2012, the status remained unchanged with 6 Parties.

Table A9. Nuclear power reactors in operation and under construction in the world (as of 31 December 2012)[a]

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2012		Total operating experience through 2012	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW·h	% of total	Years	Months
Argentina	2	935	1	692	5.9	4.7	68	7
Armenia	1	375			2.1	26.6	38	4
Belgium	7	5 927			38.5	51.0	254	7
Brazil	2	1 884	1	1 245	15.2	3.1	43	3
Bulgaria	2	1 906			14.9	31.6	153	3
Canada	19	13 500			89.1	15.3	634	5
China	17	12 860	29	28 844	92.7	2.0	141	7
Czech Republic	6	3 804			28.6	35.3	128	10
Finland	4	2 752	1	1 600	22.1	32.6	135	4
France	58	63 130	1	1 600	407.4	74.8	1874	4
Germany	9	12 068			94.1	16.1	790	2
Hungary	4	1 889			14.8	45.9	110	2
India	20	4 391	7	4 824	29.7	3.6	377	3
Iran, Islamic Republic of	1	915			1.3	0.6	1	4
Japan	50	44 215	2	2 650	17.2	2.1	1596	4
Korea, Republic of	23	20 739	4	4 980	143.5	30.4	404	1
Mexico	2	1 530			8.4	4.7	41	11
Netherlands	1	482			3.7	4.4	68	0
Pakistan	3	725	2	630	5.3	5.3	55	8
Romania	2	1 300			10.6	19.4	21	11
Russian Federation	33	23 643	11	9 297	166.3	17.8	1091	4
Slovakia	4	1 816	2	880	14.4	53.8	144	7
Slovenia	1	688			5.2	36.0	31	3
South Africa	2	1 860			12.4	5.1	56	3
Spain	8	7 560			58.7	20.5	293	6
Sweden	10	9 395			61.5	38.1	402	6
Switzerland	5	3 278			24.4	35.9	189	11
Ukraine	15	13 107	2	1900	84.9	46.2	413	6
United Arab Emirates			1	1345				
United Kingdom	16	9 231			64.0	18.1	1511	8
United States of America	104	102 136	1	1 165	770.7	19.0	3834	8
Total[b, c]	**437**	**372 069**	**67**	**64 252**	**2 346.2**		**15 246**	**9**

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

[b] Note: The total figures include the following data from Taiwan, China:
6 units, 5028 MW(e) in operation; 2 units, 2600 MW(e) under construction;
40.4 TW·h of nuclear electricity generation, representing 19.0% of the total electricity generated.

[c] The total operating experience also includes shut down plants in Italy (81 years), Kazakhstan (25 years, 10 months), Lithuania (43 years, 6 months) and Taiwan, China (188 years, 1 month).

Table A10. Integrated Regulatory Review Service (IRRS) missions in 2012

Type	Country
IRRS mission	Finland, Greece, Slovakia, Sweden

Table A11. Safe Long Term Operation (SALTO) missions in 2012

Type	Location/nuclear power plant	Country
SALTO	Wolsong	Republic of Korea
SALTO	Borssele	Netherlands
SALTO	Tihange 1	Belgium

Table A12. Operational Safety Review Team (OSART) missions in 2012

Type	Location/nuclear power plant	Country
OSART	Hongyanhe	China
OSART	Angra 1	Brazil
OSART	Laguna Verde	Mexico
OSART	Muehleberg	Switzerland
OSART	Rajasthan	India
OSART	Temelin	Czech Republic
OSART	Gravelines	France
OSART	Kozloduy	Bulgaria
OSART Follow-up	Doel	Belgium
OSART Follow-up	St. Alban	France
OSART Follow-up	Bohunice	Slovakia
OSART Follow-up	Angra 2	Brazil
OSART-based expert mission	Kori	Republic of Korea
OSART-based expert mission	Loviisa	Finland

Table A13. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2012

Type	Country
Follow-up INSARR mission, WWR-K Research Reactor	Kazakhstan
INSARR mission, Slovenian Research Reactors	Slovenia
Pre-INSARR mission, IRR-1	Israel

Table A14. Integrated Site Safety Review Service missions in 2012

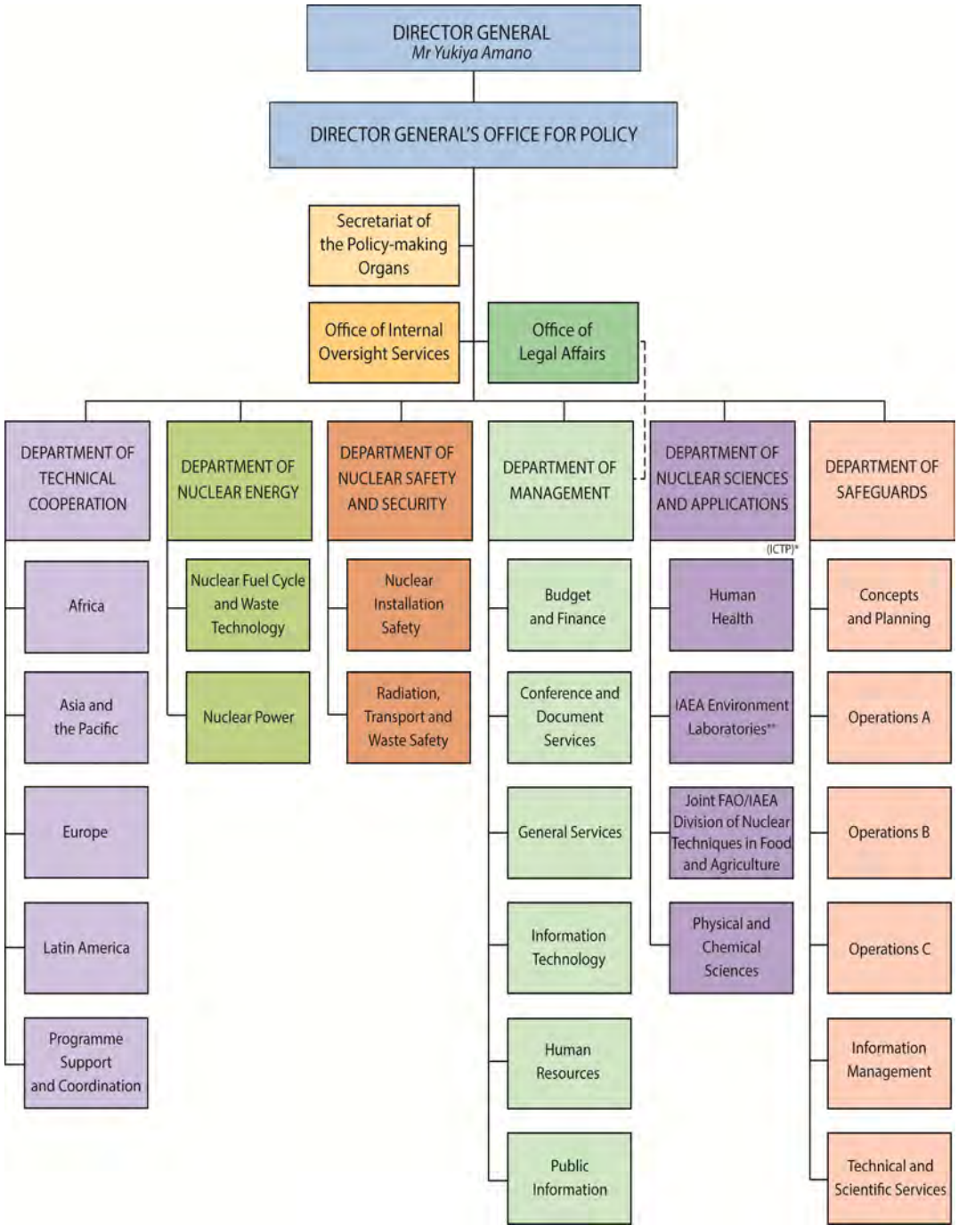
Type	Country
Advisory mission	Hungary, Indonesia, Japan, Kazakhstan, Lebanon, Nigeria, Romania, South Africa, Turkey, Vietnam

Table A15. Emergency Preparedness Review (EPREV) missions in 2012

Type	Country
EPREV	Armenia
EPREV	Bosnia and Herzegovina
EPREV	Croatia
EPREV	Kazakhstan
EPREV	Lithuania
EPREV	Serbia
EPREV	Uruguay
EPREV	Vietnam
EPR as a core component of the IRRS missions in 2012	
IRRS	Finland
IRRS	Greece
IRRS	Slovakia
IRRS	Sweden

ORGANIZATIONAL CHART

(as of 31 December 2012)



* 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

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