IAEA ANNUAL REPORT 2009

IAEA
International Atomic Energy Agency

Annual Report 2009

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 2009.

GC(54)/4

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(as of 31 December 2009)

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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 2009)

151 Member States.

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

52 years of international service.

2338 professional and support staff.

€285 million total regular budget for 2009, supplemented by extrabudgetary contributions received in 2009 amounting to **€58.1 million.**

$85 million target in 2009 for voluntary contributions to the Agency's Technical Cooperation Fund, supporting projects involving **3694** expert and lecturer assignments, **5090** meeting participants, **2493** participants in training courses and **1532** fellows and scientific visitors.

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

2 international laboratories and research centres (Seibersdorf and Monaco).

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

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

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

125 active CRPs involving **1588** approved research, technical and doctoral contracts and research agreements. In addition, **89** Research Coordination Meetings were held.

171 States with safeguards agreements in force, of which **94** States had additional protocols in force, with **1983** safeguards inspections performed in 2009. Safeguards expenditures in 2009 amounted to **€104.2 million** in regular budget and **€13.1 million** in extrabudgetary resources.

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

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

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

1.2 million documents, technical reports, standards, conference proceedings, journals and books in the IAEA Library and **12 300** visitors to the Library in 2009.

214 publications, brochures, leaflets and newsletters issued in 2009 (in print and electronic formats).

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 2009* and authorized the Director General to conclude and implement an agreement with the Russian Federation to establish a reserve of low enriched uranium for supply to the Agency for its Member States.

In the area of safety and security, the Board discussed the *Nuclear Safety Review for the Year 2008*. It also debated the *Nuclear Security Report 2009* and approved the Nuclear Security Plan for 2010–2013.

As regards verification, the Board considered the *Safeguards Implementation Report for 2008*. 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 2008* and approved the Agency's technical cooperation programme for 2010.

The Board appointed Yukiya Amano by acclamation to the post of Director General of the Agency to serve for four years from 1 December 2009.

Composition of the Board of Governors (2009–2010)

Chairperson: HE Mr. Dato' Muhammad Shahrul Ikram YAAKOB
Ambassador, Governor from Malaysia

Vice-Chairpersons: HE Mr. Rüdiger LÜDEKING
Ambassador, Governor from Germany

HE Mr. Cornel FERUTĂ
Ambassador, Governor from Romania

Afghanistan
Argentina
Australia
Azerbaijan
Brazil
Burkina Faso
Cameroon
Canada
China
Cuba
Denmark
Egypt
France
Germany
India
Japan
Kenya
Korea, Republic of
Malaysia
Mongolia
Netherlands
New Zealand
Pakistan
Peru
Romania
Russian Federation
South Africa
Spain
Switzerland
Turkey
Ukraine
United Kingdom of Great Britain and Northern Ireland
United States of America
Uruguay
Venezuela

The General Conference

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

In 2009, the Conference — upon the recommendation of the Board — approved Cambodia and Rwanda for membership of the Agency. By the end of 2009, the Agency's membership had risen to 151.

The Conference approved by acclamation the Board's appointment of Yukiya Amano as the new Director General for four years from 1 December 2009. On the recommendation of the Board, the Conference conferred on the outgoing Director General, Mohamed ElBaradei, the title "Director General Emeritus of the International Atomic Energy Agency".

Notes

- The *Annual Report 2009* 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 2008–2009* (GC(51)/2).

- The introductory chapter, '2009 in Perspective', 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 2009* and *Background to the Safeguards Statement.* For the convenience of readers, these documents are available on the CD-ROM attached to the inside back cover of this report.

- Additional information covering various aspects of the Agency's programme is provided on the attached CD-ROM, and is also available on the Agency's web site at *http://www.iaea.org/Publications/Reports/Anrep2009/index.html*

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

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

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

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

Abbreviations

ABACC	Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ARCAL	Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
BWR	Boiling water reactor
CRP	Coordinated research project
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ESTRO	European Society for Therapeutic Radiology 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
IAEA-MEL	IAEA Marine Environment Laboratory
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
ICTP	Abdus Salam International Centre for Theoretical Physics
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 (IAEA)
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/WHO
PHWR	Pressurized heavy water reactor
PWR	Pressurized water reactor
RBMK	Light boiling water cooled graphite moderated pressure tube reactor
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 and moderated energy reactor

2009 IN PERSPECTIVE

The International Atomic Energy Agency addresses global issues related to nuclear technology, in accordance with its Statute. In carrying out this mandate, the Agency has sought to provide independent and objective advice in the application of nuclear technologies for development, in promoting nuclear safety and security, and in its activities related to nuclear verification. In 2009, the Agency devoted particular attention to assisting Member States in meeting their energy needs, responding to concerns about climate change, helping to ensure food security and access to clean water, and improving health care through the use of nuclear techniques. The following is a survey of worldwide nuclear related developments in 2009 and how they affected the work of the Agency.

"Current national policies point to a significant expansion in the use of nuclear power, with many States, particularly developing countries, indicating an interest in introducing it into their energy mixes."

Nuclear Technology

Nuclear Power, Nuclear Fuel Cycle and Sustainable Development

Nuclear Power: Status and Trends

Both global energy demand and interest in nuclear power continued to grow in 2009. Construction started on 11 new nuclear power reactors, the largest number since 1987, and projections of future nuclear power growth were once again revised upwards. For instance, growth targets have been raised significantly in China, India and the Russian Federation. Only two new reactors, however, were connected to the grid and, with three reactors retired during the year, the total nuclear power capacity around the world dropped slightly for the second year in a row. With the closure of Ignalina-2 in Lithuania, the number of countries with operating nuclear power plants dropped to 29.

As of 1 January 2010, there were 437 nuclear power reactors in operation, with a total capacity of 370 gigawatts (electric) (GW(e)). Fifty-five reactors were under construction, the largest number since 1992. Current expansion, as well as near term and long term growth prospects, remain centred in Asia, not least because of this region's robust economic growth. Of the 11 construction starts, 10 are in Asia, as are 36 of the 55 reactors under construction and 30 of the last 41 new reactors to have been connected to the grid.

The global financial crisis that started in the second half of 2008 was cited as a contributing factor in delays affecting nuclear projects in some regions of the world. However, the Agency revised its low and high projections for global growth in nuclear power upwards by 8%, in part due to increasingly firm commitments by governments, utilities and vendors to build new reactors. The financial crisis did not substantially change the factors driving rising expectations for nuclear power. Specifically, nuclear power's good performance and safety record and continuing concerns about climate change, security of energy supplies, high (and volatile) fossil fuel prices and energy demand growth remain key drivers.

In April, the Agency organized an International Ministerial Conference on Nuclear Energy in the 21st Century in Beijing, China. Hosted by the Government of China, the conference reviewed the status and prospects of nuclear power, including progress in the evolution of technology, and discussed the actions necessary for the further expansion of nuclear power. The concluding statement by the President of the Conference noted that:

> "While respecting the right of each State to define its national energy policy in accordance with its international obligations, the vast majority of participants affirmed that *nuclear energy, as a proven, clean, safe, competitive technology, will make an increasing contribution to the sustainable development of humankind throughout the 21st century and beyond*."

Launching Nuclear Power Programmes

Current national policies point to a significant expansion in the use of nuclear power, with many States, particularly developing countries, indicating an interest in introducing it into their energy mixes. In addition, many of the countries already operating nuclear power plants plan to expand their output.

More than 60 countries — mostly in the developing world — have informed the Agency

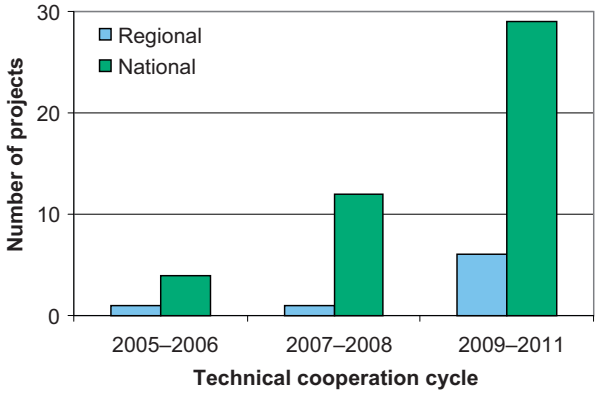

FIG. 1. Technical cooperation projects related to nuclear power.

that they might be interested in launching nuclear power programmes. Fifty-eight Member States are participating in regional or national technical cooperation projects related to the introduction of nuclear power. Seventeen of these countries are actively preparing national nuclear power programmes, one selected a plant construction bid at the end of the year, and one has its first nuclear power plant under construction. The increased interest among Member States led to a threefold increase in technical cooperation projects related to nuclear power in the Agency's 2009–2011 technical cooperation cycle (Fig. 1). The Agency launched a new Integrated Nuclear Infrastructure Review (INIR) service to examine national infrastructure needs based on milestones it has developed to guide Member States as they embark on a nuclear power programme.[1] The first three INIR missions visited Indonesia, Jordan and Vietnam. Opportunities for international cooperation between newcomer countries and the vendor community were identified in an Agency workshop in November, and new publications were issued on financing nuclear power plants and on the responsibilities and capabilities of owners and operators implementing new nuclear power programmes.

Energy Assessment Services

The Agency supports national energy assessments for all interested Member States, not only for those interested in nuclear power. Agency assistance contributes to building local analytical capacity by transferring assessment tools and by training experts to chart energy strategies consistent with national development objectives. Increasingly, Member States are applying these tools to analyse cost effective options for reducing greenhouse gas emissions, and those interested in nuclear energy are using them to explore the feasibility of adding nuclear power to their energy systems. Over 500 energy analysts from 74 countries were trained in 28 courses, mostly organized through Agency technical cooperation projects.

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

Human Resource Issues

With increased interest in nuclear power, concerns have been expressed about possible shortages of individuals with the necessary skills. These concerns have prompted initiatives by government and industry in several Member States to attract students and to expand education and training in nuclear related fields. Based on available data, these initiatives appear to be successful, although if there is a significant expansion in the use of nuclear power, these successes will have to be replicated many times over. The Agency is developing guidance on workforce planning, particularly for countries embarking on new nuclear power programmes.

The Agency organized an interregional training course on leadership and management of nuclear power programmes in countries introducing nuclear power. It also held regional workshops in Latin America and Europe on human resources

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

for new nuclear power programmes, and national workshops in Belarus, Chile, Egypt, Ghana, Thailand and Vietnam. Other assistance included staff training at nuclear power plants under continuing technical cooperation projects and a meeting in Vienna on simulators, advanced training tools and technologies for the nuclear industry, with a special session on the development of training systems for countries introducing nuclear power. A new guide, *Managing Human Resources in the Field of Nuclear Energy*, was also published on the steps needed to ensure the supply of the skilled workforce necessary for nuclear power programmes.

"Member States continued to request Agency assistance in uranium exploration, resource evaluation, and mine development, planning, safety and regulation."

Supply of Uranium

The growing interest in nuclear power, as a result of both increasing economic development in States and the need to mitigate greenhouse gas emissions, has resulted in a comeback of uranium mining after a two decade slump. Data collected by the Agency and the OECD/NEA indicated a 3.5% increase, since 2007, in identified conventional uranium resources recoverable at a cost of less than $130/kg U. This was due mainly to increases reported by Australia, Canada and Namibia. When data from 2009 are complete, it is expected that they will show an increase in uranium production to 49 000 tonnes of uranium, a 12% increase over 2008. Australia, Canada and Kazakhstan accounted for almost 60% of world production in 2008 (Fig. 2). These three, together with Namibia, Niger, the Russian Federation, Uzbekistan and the USA, accounted for 93% of production. At the estimated 2009 rate of consumption, the projected lifetime of the 5.7 megatonnes of uranium of identified conventional resources recoverable at less than $130/kg U is almost 90 years. This compares favourably with reserves for 30–50 years of other commodities (e.g. copper, zinc, oil and natural gas).

Member States continued to request Agency assistance in uranium exploration, resource evaluation, and mine development, planning, safety and regulation. Agency technical cooperation projects provided training and support to a number of developing countries in Africa, Asia and Latin America. In June 2009, the Agency organized an international symposium on 'Uranium Raw Material for the Nuclear Fuel Cycle' (URAM 2009). In addition to discussing developments in the various areas of uranium exploration and production, there was consensus among symposium participants that despite the global financial crisis which started in late 2008, growth in uranium production industries continues to be strong, including in countries that are relatively new to the industry and interested in Agency assistance.

Assurances of Fuel Supply

The establishment of low enriched uranium (LEU) reserves under the Agency's auspices, envisaged to assure States of a supply of LEU for their power reactors in case they experience disruptions for non-technical or non-commercial reasons, has been the subject of discussions. In June, the Director General provided two reports to the Agency's Board of Governors on

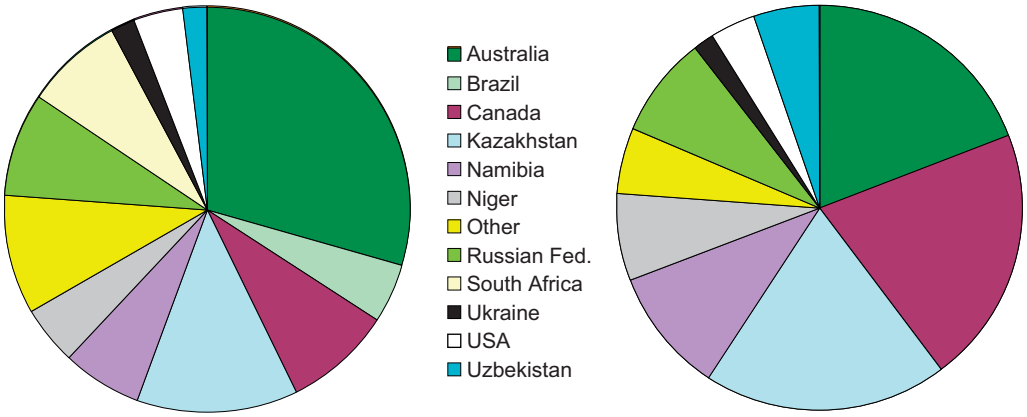

FIG. 2. Geographical distribution of identified conventional uranium resources recoverable at a cost of less than $130/kg U (left) and of uranium production in 2008 (right).

Assurance of Supply: Proposal for the Establishment of an IAEA Low Enriched Uranium (LEU) Bank and *Assurance of Supply: Russian Federation Initiative to Establish a Reserve of Low Enriched Uranium (LEU) for the Supply of LEU to the IAEA for its Member States*. In addition, a report was issued on the German proposal to set up a Multilateral Enrichment Sanctuary Project (MESP), with Agency involvement. Discussions continued on the possible establishment of an Agency LEU reserve. In March, the total pledges and contributions from Member States made in response to a 2006 offer by the Nuclear Threat Initiative (NTI) of $50 million for the setting up of an Agency LEU bank surpassed $100 million.

In November, the Board authorized the Director General to sign an agreement with the Russian Federation to establish a reserve of 120 tonnes of LEU in that country for the use of Member States. The LEU would be made available at the prevailing market price, through the Agency at the Director General's behest, to a country experiencing a non-commercial supply disruption, based on the criteria approved by the Board.

"In December, the Agency organized an international conference in Kyoto on 'Fast Reactors and Related Fuel Cycles: Challenges and Opportunities', hosted by the Japan Atomic Energy Agency."

Innovation

Technological developments for new plants focus on improved plant economics and construction times. Some countries are working on new small and medium sized reactors suitable for smaller grids, incremental investments and transportability. Longer term design and construction activities are under way for fast reactors and high temperature gas cooled reactors.

In December, the Agency organized an international conference in Kyoto on 'Fast Reactors and Related Fuel Cycles: Challenges and Opportunities', hosted by the Japan Atomic Energy Agency. The conference emphasized that the research, industrial and academic areas are expressing renewed interest in technology development for fast reactors and associated fuel cycles.

The results reported in such areas as fuel and materials development, safety, advanced simulation, component and system design, and coolant technology were encouraging. Open issues were identified and possible R&D programmes were outlined to resolve them. The current focus is on the commissioning of experimental fast reactors, including the Chinese experimental fast reactor in 2010, the restart of the industrial prototype Monju in Japan in 2010, the completion of the 500 MW(e) prototype fast breeder reactor in India, the 800 MW(e) BN-800 in the Russian Federation, and further construction projects in France, India, Japan, the Republic of Korea and the Russian Federation. International collaboration is important in harmonizing concepts, and the Agency's Technical Working Group on Fast Reactors continues to be an important part of such collaboration among Member States.

The Agency brings countries together to promote collaboration through its International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and various Technical Working Groups, which cover all reactor categories. It also formulates long term scenarios to help coordinate expectations about how innovative efforts, both technological and institutional, might dovetail most productively. In 2009, the Agency prepared a study on *Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century: Studies of Nuclear Capacity Growth and Material Flow*. More detailed analysis is being developed in an ongoing INPRO collaborative project on *Global Architecture of Innovative Nuclear Systems Based on Thermal and Fast Reactors Including Closed Fuel Cycles.*

Nuclear Fusion

A major development in the area of nuclear fusion was the completion in March of site preparations for the International Thermonuclear Experimental Reactor (ITER). In addition, procurement arrangements were signed for facilities worth approximately €1.5 billion, about a third of the total anticipated procurements. Construction of the National Ignition Facility in the USA was completed, and its inauguration took place in May.

Agency activities related to fusion focus on improving international collaboration within the plasma physics and fusion community, and providing a forum for cooperation and coordination. For example, the International Fusion Research Council (an advisory committee to the Agency) and the Fusion Power Coordinating Committee of the International Energy Agency held a joint meeting during the year. In addition, the Agency organized

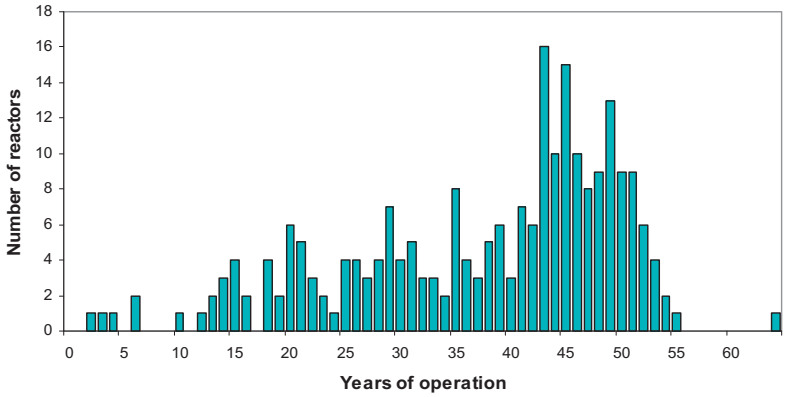

FIG. 3. Age distribution of operating research reactors worldwide.

technical meetings on nuclear fusion topics that were attended by over 450 experts. Through their Cooperation Agreement, the Agency and the ITER Organization began planning international cooperation on training, personnel exchanges, conferences and publications on fusion components and installations. The involvement of young fusion and plasma physicists, with Agency support, in joint experiments and in publishing papers on fusion continued, with a range of scientific experiments organized in May in Brazil.

Research Reactors

Fifty per cent of all operating research reactors are now over 40 years old (Fig. 3). The Agency provides assistance related to research reactor ageing, modernization and refurbishment, and maintains a database to share experience related to research reactor ageing. As older research reactors are retired and replaced by fewer, more multipurpose reactors, greater international cooperation will be required to ensure broad access to these facilities and their efficient use. Progress was made, with Agency support, in the development of cooperative networks in the Mediterranean, Eastern Europe, Caribbean and Central Asian regions. With growing interest in nuclear energy, more than 20 Member States have requested Agency advice regarding the possibility of building new research reactors. In May, the Eastern European Research Reactor Initiative coalition, supported by the Agency, launched a group fellowship training course to assist Member States interested in starting a first research reactor project.

Applications of Nuclear Technology

The Agency helps Member States address a range of development challenges, such as food and water scarcity and inadequate health care. Its programmes seek to reinforce existing partnerships and build new ones, enhance knowledge and networks, and disseminate the application of nuclear technologies in human health, food security, water and the environment.

Food and Agriculture

Nuclear techniques applied to food and agriculture are key tools to address the effects of climate change on regional and global food security in the next decade. The application of nuclear technology in plant breeding, food irradiation, animal health and pest control is of increasing significance in contributing to socioeconomic development (Fig. 4). For example, early and rapid nuclear and nuclear related molecular diagnostic technologies developed by the Agency were used to diagnose avian influenza, Influenza A H1N1 (swine flu) and Rift Valley fever, limiting the impact of these diseases on animal and public health. In South Africa, a variety of grain used as cereal with edible leaves and two cowpea mutant varieties, developed through mutation breeding with traits for tolerance to drought, are contributing to food security in drought prone and marginal lands.

"... early and rapid nuclear and nuclear related molecular diagnostic technologies developed by the Agency were used to diagnose avian influenza, Influenza A H1N1 (swine flu) and Rift Valley fever ..."

In recent years, more than 90 countries have increased their capacity to apply quality controlled analytical techniques to monitor and control

FIG. 4. Areas considered fruit fly free or with low prevalence of these insect pests obtain a special status for vegetable and fruit exports, thus generating employment and export revenues.

chemical residues in food and the environment through technology transfer, thereby helping to protect consumer health and to meet food safety requirements to increase international trade. For example, counterparts of a technical cooperation project in Nicaragua reported that the strengthening of the national residues laboratory in the Ministry of Agriculture and Forestry and the introduction of new analytical techniques, including a radioassay developed in a CRP, had increased the export of meat, shrimp, peanuts and honey, thereby helping the country to increase its foreign currency earnings.

The Agency continued to support requests from Member States to develop the sterile insect technique (SIT) for the control of different insect pests, and to provide technical support to projects in Africa, Asia and Latin America. In February, the Government of Mexico announced the eradication of the invasive cactus moth (*Cactoblastis cactorum*) in the Mexican Caribbean, which is a serious threat to all prickly pear cactus species.

With just 7% of Tajikistan's land being suitable for agriculture, soil erosion and land degradation represent a major threat to soil resources as well as to the capacity of the land to retain water from rainfall or irrigation for sustainable agricultural production. A technical cooperation project utilized nuclear techniques to measure the extent of such erosion and to assess the relative effectiveness of different soil conservation measures in controlling erosion under various agro-ecological conditions and land use systems.

Human Health

Medical physicists fulfil an essential role in the safe and effective use of radiation in medicine, most commonly in cancer treatment and diagnostic imaging. In response to a critical shortage of medical physicists in Africa, Asia and Latin America, the Agency launched a new initiative to strengthen medical physics in radiation medicine through an international collaborative effort with relevant international organizations and professional societies. The first coordination meeting of this initiative was held in Vienna, grouping medical physics experts to review the roles and responsibilities of medical physicists in radiation medicine, clinical education requirements and optimum staffing levels for treatment centres and hospitals.

"... the Agency launched a new initiative to strengthen medical physics in radiation medicine through an international collaborative effort with relevant international organizations and professional societies."

In a related development, the Agency convened an international conference on 'Advances in Radiation Oncology (ICARO)' in April in Vienna, gathering experts in the field of radiation oncology and imaging from both developed and developing countries. The meeting provided a forum for discussion of recent technological and conceptual advances in this discipline from the perspective of low and middle income countries. In addition, there was agreement on the urgent need for

manufacturers to produce less costly, yet robust, radiation oncology equipment for use in countries with limited resources.

Partnerships for the Development of Comprehensive Cancer Control Programmes

The incidence of cancer is growing rapidly in developing countries — by 2020 over 75 million people in low and middle income countries will have been diagnosed with this disease. Responding to the growing need for new capacity in cancer prevention, diagnosis, treatment and palliative care requires collective effort and close coordination. The Programme of Action for Cancer Therapy (PACT) is leading the Agency's response to the cancer crisis and is helping to strengthen global coordination. Following years of close collaboration, in February the Agency launched a Joint Programme for Cancer Control with WHO to enhance the support provided to developing countries.

"... the Agency is working to establish 'research reactor coalitions' for radioisotope production."

The number of PACT Model Demonstration Sites (PMDSs) grew to seven, with Ghana joining Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen. The PMDSs provide opportunities for Member States to make contributions, as evidenced in 2009 by India's donation through PACT of a 'Bhabhatron' radiotherapy unit to Vietnam (Fig. 5). This unit was installed in a hospital in Can Tho Province, a region of Vietnam that previously had no access to such equipment. In addition, multi-partner needs assessment missions — called 'imPACT reviews' — were conducted by the Agency in Madagascar, Mongolia, the Republic of Moldova and Uganda to provide advice to national authorities building comprehensive cancer control plans.

To address the drastic shortage of cancer control professionals in developing countries, the Agency launched the PACT Regional Cancer Training Networks and the Virtual University for Cancer Control and Regional Training Network (VUCCnet) in Africa. The initiative will increase training opportunities through the use of regional hubs for education and mentorship, and provide a web based portal for low cost content delivery. The first phase of the VUCCnet initiative was made possible through an innovative private sector partnership and a $750 000 pledge from the USA.

Securing the Supply of Medical Isotopes

Multiple, independent shutdowns and outage extensions of aged research reactors have led to significant shortages worldwide of molybdenum-99, a key precursor radionuclide for medical diagnoses. In response to international calls for securing reliable supplies, the Agency is involved in several initiatives. In order to expand the number of research reactors involved in the production of molybdenum-99, and to improve the future reliability of supply, the Agency is working to establish 'research reactor coalitions' for radioisotope production. The first such coalition, the Eurasia Isotope Coalition, was established in

FIG. 5. The Bhabhatron radiotherapy unit donated by India as installed in a local hospital in Can Tho Province, Vietnam.

2009. In addition, a CRP related to the production of molybdenum-99 using LEU targets or neutron activation has prompted some of the participating countries, such as Poland and Romania, to offer irradiation services and to explore the feasibility of full scale production. The Agency organized a workshop on the 'Assessment of Options for Enhancing Molybdenum-99 Production and Availability' in Warsaw.

Water Resources

More than one hundred ministers attending the 5th World Water Forum in March 2009 in Istanbul made commitments to strengthen scientific research and education for understanding natural hydrological processes and impacts of global changes on water resources. The third *United Nations World Water Development Report: Water in a Changing World* was released at the Forum. The report highlighted the need for scientific information on the world's water resources and how they are changing in response to external influences such as climate change and water and land use. It also advocates greater attention and more resources for monitoring, observations and assessments of the world's water resources.

"... partners in a CRP developed new tools for quantifying the amount of groundwater in river flow — an important indicator of changes in the water cycle due to climate."

The Agency contributed to enhancing Member State capabilities for using isotopes to assess and manage water resources. The use of laser spectroscopy machines — allowing easier isotope measurements at low cost — was expanded to 22 Member States, with assistance provided through the Agency's technical cooperation programme. To assist in training, the Agency produced an audiovisual tool for the installation, operation and data analysis of the laser analyser. Using this tool, and following initial training provided at Headquarters, counterparts installed and operated the laser machines without further expert assistance from the Agency.

Following the publication of atlases in 2007 on Africa and in 2008 on Asia and the Pacific, a third atlas of isotope hydrology was completed with data from 23 countries in North and South America, allowing Member States to use the information for local and regional studies. In addition, geographical coverage of the Agency's Global Network of Isotopes in Precipitation was expanded with new monitoring stations, and data access through the Internet was improved. Finally, partners in a CRP developed new tools for quantifying the amount of groundwater in river flow — an important indicator of changes in the water cycle due to climate.

Environment

People around the world are experiencing the impact of climate change, including droughts, floods and storms, as well as reduced stocks of fish and lower quality of marine ecosystems. In this regard, the Agency used isotope studies and numerical models to better understand and project how ocean acidification will alter marine resources in the 21st century. For example, based on the projected levels of high carbon dioxide and low pH, a series of applied radioecological studies were conducted using calcium-45 and other isotopes to investigate the effects of ocean acidification on commercially important organisms such as fish and molluscs and key species in marine food webs in polar and temperate waters. The results of these studies facilitated a *Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity* — the first of its kind — which was prepared for the United Nations Climate Change Conference in Copenhagen in December 2009.

Several regional and interregional training courses were held at IAEA-MEL in Monaco, at the Agency's Laboratories, Seibersdorf, and in partner laboratories in Member States. Of particular significance were courses devoted to supporting the UNEP Regional Seas Programme, part of an inter-agency effort to implement international conventions.

Nuclear Safety and Security

Nuclear Safety

Current Status of Nuclear Safety

In 2009, the safety performance of the nuclear industry remained at a high level. Various safety performance indicators, such as those related to unplanned reactor shutdowns, safety equipment availability, radiation exposures of workers, radioactive waste management and radioactive releases to the environment, have shown steady improvement over the past two decades, with some

levelling off in recent years. To avoid complacency and to continuously improve and strengthen the existing global nuclear safety regime, an Agency conference on 'Effective Nuclear Regulatory Systems' was held in Cape Town, in December. The conference brought together head regulators from around the world to help improve the regulation of global nuclear safety. International feedback from various conferences and symposia continues to be used to further improve the Agency's safety standards, peer reviews and advisory services.

Strengthening of Global and Regional Safety Networks

A significant development during the year was the creation by the European Union of a common legal framework for nuclear safety, based on the Agency's main safety standards for nuclear installations and obligations under the Convention on Nuclear Safety. The European Union is the first major regional body to adopt a binding legal framework on nuclear safety.

The European Union Directive which applies Agency safety standards to nuclear installations envisages that Member States will arrange for periodic self-assessment of their national framework and competent regulatory authorities at least every ten years and will invite an international peer review of relevant segments of their national framework and/or authorities, with the aim of continuously improving nuclear safety.

"A significant development during the year was the creation by the European Union of a common legal framework for nuclear safety, based on the Agency's main safety standards ..."

New and Expanding Nuclear Power Programmes

International cooperative efforts in support of new and expanding nuclear power programmes continued to focus on a number of key issues: national safety infrastructure development; safety and security synergy; safety responsibilities of the various participants in a nuclear power programme; and use of research reactors as a preliminary phase in embarking on nuclear power.

Agency efforts concentrated on supporting those countries expanding their nuclear programmes, as well as on assisting the increasing number of countries planning to introduce nuclear power into their energy mix. This was considered to be especially important to address the challenge of nuclear programme development outpacing safety infrastructure development and capacity requirements. A key activity, however, was the preparation of a guide to assist in establishing a safety infrastructure, in accordance with the Agency's safety standards, for countries preparing to introduce nuclear power. It contains a 'road map' of safety related actions to be taken to achieve a high level of safety during the lifetime of a nuclear power plant. The Agency also focused greater attention on international peer reviews requested by Member States seeking to improve their regulatory bodies and nuclear facilities in areas such as regulatory performance, safety culture, operational safety, safety assessment and operational feedback.

Capacity Building

Capacity building is part of an integrated approach to develop technological, scientific and managerial competencies as well as human, organizational and institutional capabilities. This is a major challenge for countries embarking on nuclear power for the first time as well as for countries 'experienced' in using nuclear power. In this context, global and regional information networks for sharing knowledge and expertise provide a platform to support capacity building efforts. Specifically, the Global Nuclear Safety and Security Network, the International Regulatory Network, the Response Assistance Network, the Asian Nuclear Safety Network, the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO) and the recently established Forum of Nuclear Regulatory Bodies in Africa are being used by Member States to enhance their capabilities for information sharing. For example, data from FORO were used in an Agency technical cooperation training course held in March 2009 in Santiago, Chile. As a result of this initiative, 12 countries of the region are implementing an action plan on strengthening safety assessment in radiotherapy, both in hospitals and at the regulatory inspection level.

Spent Fuel and Radioactive Waste Management and Decommissioning

Most of the 10 500 tonnes of spent fuel generated annually continues to be put in long term interim storage. Only about 20% is reprocessed, with the

fissile material being recycled. Experience with both wet and dry long term storage continues to be good, and the Agency is helping to ensure that this experience is shared, for example through a CRP on spent fuel performance assessment.

Completion of the decommissioning of the Rancho Seco nuclear power reactor in the USA brought the number of fully dismantled power reactors around the world to 15. Fifty-one shutdown reactors were in the process of being dismantled, 48 were being kept in a safe enclosure mode, 3 were entombed and, for 6 more, decommissioning strategies had not yet been specified. To share experience gained from past and current decommissioning projects with countries in need of decommissioning knowledge, the Agency coordinates the International Decommissioning Network. Through this network, and the Research Reactor Decommissioning Demonstration Project, it provides practical examples and demonstration exercises. In this regard, the following were held in 2009: a training course on decommissioning, a workshop on small reactor dismantling, a course on decommissioning multiple facility sites, and meetings on cost estimation and on dismantling and decontamination technologies.

"The Agency launched an international LLW disposal network (DISPONET) in 2009 ..."

Although significant progress has been made by Member States in managing their radioactive waste and spent fuel safely, efforts are still needed to develop national strategies up to and including disposal, and to strengthen the national infrastructure accordingly. The storage and disposal of low level waste (LLW) is a well established practice in countries with a nuclear energy programme. The Agency launched an international LLW disposal network (DISPONET) in 2009 to facilitate the sharing of experience among operators and to coordinate support to Member States with less advanced programmes.

The disposal of spent nuclear fuel and high level waste (HLW), while at a mature stage of conceptual development, remains to be implemented. The Swedish Nuclear Fuel and Waste Management Company (SKB) selected Östhammar as the site for a final spent fuel geological repository, following a selection process lasting nearly 20 years. SKB plans to apply for a construction licence in 2010, with operation targeted for 2023. Site investigations continued for repositories at Olkiluoto, in Finland, and near the town of Bure in France, with operation targeted for 2020 and 2025, respectively. The US Government decided to terminate its development of an HLW permanent repository at Yucca Mountain, Nevada, while continuing the licensing process. It has established a commission to evaluate alternatives.

In countries without nuclear power programmes, complete life cycle management of disused, sealed radioactive sources has never been considered systematically, as many are still faced with finding a solution for the disposal. In 2009, several international meetings discussed long term management strategies for disused radioactive sources. These issues were also identified during the third review meeting in May of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Remediation of Uranium Mining Legacy Sites

The Agency is involved in remediation of legacy sites resulting from nuclear weapons testing, nuclear accidents and poor practices, as well as the cleanup of abandoned facilities. Particular effort was aimed at the remediation of uranium mining and milling legacy sites in the countries of Central Asia, where there are many old uranium mines with residues left behind from past activities. At an Agency conference held in Astana, Kazakhstan, in May, the participants agreed on a strategy for avoiding future legacy sites through proper life cycle planning and good operating practices, as well as through the promotion of an environmental protection culture among mining companies and by establishing appropriate regulations.

Incident and Emergency Preparedness

The ability to adequately respond to a nuclear or radiological emergency remains a central element of international nuclear safety. While Member States are working with the Secretariat to improve local, national, regional and international preparedness, many do not meet international safety requirements for emergency preparedness and response. Consequently, a number of Member States worked during the year to improve the legislative and regulatory underpinnings of their emergency systems, and tested their preparedness through exercises based on a wide range of scenarios. Ten Member States informed the Agency that they had carried out and/or invited the Agency to observe

national exercises intended to determine the strength of their response systems.

The Agency receives information on nuclear and radiation related incidents and emergencies around the world through its different official reporting channels and by monitoring the media. Over the course of the year it was informed, or became aware, of 211 events involving, or suspected to involve, ionizing radiation. In the majority of these events, it was determined that no Agency action was required. In 22 events the Agency took action, such as authenticating and verifying information with national competent authorities, exchanging official information or offering the Agency's services.

Civil Liability for Nuclear Damage

The importance of having effective civil liability mechanisms in place to make sure there is no harm to human health and the environment as well as to insure against economic loss resulting from a nuclear incident continues to receive attention, especially in light of the renewed interest in nuclear power around the world.

"The Agency continued its efforts to promote adherence to the various international legal instruments adopted under its auspices ..."

The Agency continued its efforts to promote adherence to the various international legal instruments adopted under its auspices, in particular with respect to the Convention on Supplementary Compensation for Nuclear Damage (CSC), which currently remains the only such instrument to yet enter into force. In support of these efforts, the Director General sent letters in early 2009 to Member States encouraging them "to give due consideration to adhering to the CSC and thus contributing towards strengthening the global nuclear liability regime".

In parallel, the International Expert Group on Nuclear Liability (INLEX), an advisory body to the Director General that was established in 2003, continues to serve as a central forum on questions related to nuclear liability. INLEX assisted the Agency most notably through the provision of lecturers to Agency outreach workshops which seek to assist Member States in gaining a better understanding of, and promoting adherence to, international nuclear liability instruments.

Safe Transport of Radioactive Material

Denial of shipment in the transport of radioactive material continues to be a growing issue. Communication of the issues and effects to a wide audience, and education and training of key stakeholders, have been identified as primary areas of work in combating denial, and a programme of work was initiated in 2009. A safety concern is that unjustified denial could lead to the development of unsafe practices that are not in line with Agency standards. In this respect, the review of the Agency's *Regulations for the Safe Transport of Radioactive Material* is of particular importance in ensuring that a high level of safety is maintained during transport in a manner that does not place unjustified burdens on industry and regulators in Member States. The harmonized application of effective Agency safety standards in transport provides the essential foundation for a strategy to deal with the denial of shipment, and 2009 saw improvements both in the standards and in the extent of harmonized application in Member States.

Facilitating greater communication between Member States on the safe transport of radioactive material is a priority for the Agency. In this regard, a group of coastal and shipping States and the Agency held discussions aimed at improving mutual understanding, confidence building and communication among all parties.

Nuclear Security

Enhancing Nuclear Security Worldwide

The risk that nuclear or other radioactive material could be used in malicious acts remains high and is regarded as a serious threat to international peace and security. The Agency's nuclear security activities contribute to the establishment of appropriate and effective national systems for nuclear security. In 2009, the Agency's contributions towards global nuclear security included: publication of guidance documents; training of more than 1000 people; development of educational programmes; and missions to advise Member States on nuclear security needs and upgrades.

Advisory Services: Review Status of Advisory Missions

Nuclear security advisory missions continued to be key tools for the assessment of needs — the Agency conducted 14 such missions in 2009.

More than half dealt with physical protection and with legal, regulatory and practical measures for controlling nuclear and other radioactive material. Several additional missions reviewed measures for the detection of illicit nuclear trafficking and response to nuclear security incidents. The Agency also conducted a number of technical visits, which addressed security needs at locations including border crossings, medical facilities, scientific institutes and industrial sites.

Nuclear Security Symposium

The Agency convened an international symposium on nuclear security issues in March–April in Vienna which attracted more than 500 participants from 76 States. The symposium noted the need to: strengthen legal elements of the international nuclear security framework; continue to harmonize efforts in the areas of security, safeguards and safety; and promote participation in initiatives for the exchange of nuclear security information, particularly with regard to lessons learned. It encouraged the strengthening of national efforts to secure nuclear and other radioactive material and associated facilities and transports, which should be complemented by increased efforts at the global level. Specific proposals included the production of model elements of legal frameworks, the extension of risk assessment to sensitive technologies, the improvement of methods of reporting on security incidents, and the creation of nuclear forensic reference data. The Secretariat took account of the symposium's findings and proposals in preparing its 2010–2013 Nuclear Security Plan.

New Nuclear Security Plan

In September, the Board of Governors approved the Agency's Nuclear Security Plan for the period 2010–2013. The plan recognizes that the risk of nuclear and other radioactive material being used in malicious acts remains high and continues to be a serious threat. It also confirms that the responsibility for nuclear security rests entirely with each State, and that appropriate and effective national systems for nuclear security are vital in facilitating the peaceful use of nuclear energy and enhancing global efforts to combat nuclear terrorism. In preparing the new plan, the Agency took into account a number of factors that included the lessons learned from the implementation of previous plans and the international instruments relevant to nuclear security. The new plan will enhance the Secretariat's capability to assist States in establishing and providing long term, sustained improvements to nuclear security.

The Agency's Technical Cooperation Programme

The Agency's technical cooperation programme seeks to enhance human and institutional capacity in Member States, so that they can safely utilize nuclear technologies to address major challenges related to chronic hunger, disease, water shortages, lack of reliable energy and environmental degradation. In this way, the Agency contributes to national, regional and international development. The programme also goes beyond these development priorities to address issues for the global good, such as safety, and transboundary issues. Today, technical cooperation projects are under way in 125 countries and territories.[2]

"The Agency's technical cooperation programme seeks to enhance human and institutional capacity in Member States, so that they can safely utilize nuclear technologies to address major challenges related to chronic hunger, disease, water shortages, lack of reliable energy and environmental degradation."

The Technical Cooperation Programme in 2009

Activities in the Africa region continued to focus on building human and institutional capacity in the use of nuclear applications to achieve development goals such as increased food security and better nutrition and health services, particularly in developing countries. In Asia and the Pacific, the emphasis was on strengthening institutional capacity for applications in health, agriculture and energy, with a particular focus on support for newcomers to nuclear power. In Europe, projects to maintain safety and security standards in older nuclear power plants, and to mitigate the environmental degradation caused by uranium mining and milling, were important areas of activity.

[2] More detailed information on the Agency's technical cooperation programme can be found in the *Technical Cooperation Report for 2009: Report by the Director General*, GC(54)/INF/4.

In Latin America, strategic partnerships continued to be an important means to address the development needs of Member States. Emphasis was placed on strengthening national regulatory frameworks and capacity building for radiation safety. Regional agreements have become key strategic mechanisms to expand cooperation with other partners at the regional and international levels.

Financial Resources

The technical cooperation programme is funded by contributions to the Technical Cooperation Fund (TCF), as well as through extrabudgetary contributions, government cost sharing and contributions in kind. Overall, new resources reached a total of some $112 million in 2009, with approximately $86 million for the TCF (including payments for the previous year to the TCF, assessed programme costs, national participation costs (NPCs)[3] and miscellaneous income), approximately $25 million in extrabudgetary resources, and about $1.5 million representing in-kind contributions. These resources were applied directly to technical cooperation projects.

The rate of attainment[4] for the TCF stood at 94% on pledges, and was approximately 91% on payments at the end of the year, while payment of NPCs totalled $4.3 million. Resources were sufficient to carry out the core technical cooperation programme as planned for 2009. However, some $73 million of 'footnote-a/'[5] project components remained unfunded throughout the year.

"The Agency's verification programme remains at the core of multilateral efforts to curb the proliferation of nuclear weapons."

Disbursements

In 2009, some $85 million was disbursed to 125 countries or territories, of which 26 were least developed countries, reflecting the Agency's ongoing efforts to address the development needs of the world's poorest States. Human health remained the single overriding priority in all regions in the technical cooperation programme, accounting for approximately 21% of the budget. It was followed by nuclear safety at 15% and in third place by food and agriculture at around 14% (Fig. 6).

Safeguards and Verification

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

At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force, based upon the evaluation of all information available to it for that year. For a 'broader conclusion' to be drawn that 'all nuclear material remained in peaceful activities', both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) must be in force, and the Agency must have been able to conduct all necessary verification and evaluation activities. For States that have a CSA in force but without an AP, the Agency does not have sufficient tools to draw credible safeguards conclusions regarding the absence of undeclared nuclear material and activities. For such States, the Agency draws a safeguards conclusion, for a given year, with respect only to whether declared nuclear material remained in peaceful activities.

For those States for which the broader conclusion has been drawn and a State level integrated safeguards approach has been approved, the Secretariat is able to implement integrated safeguards, the optimum combination of all available safeguards measures to achieve maximum

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3 *National participation costs (NPCs):* 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.

4 *Rate of attainment:* 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.

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

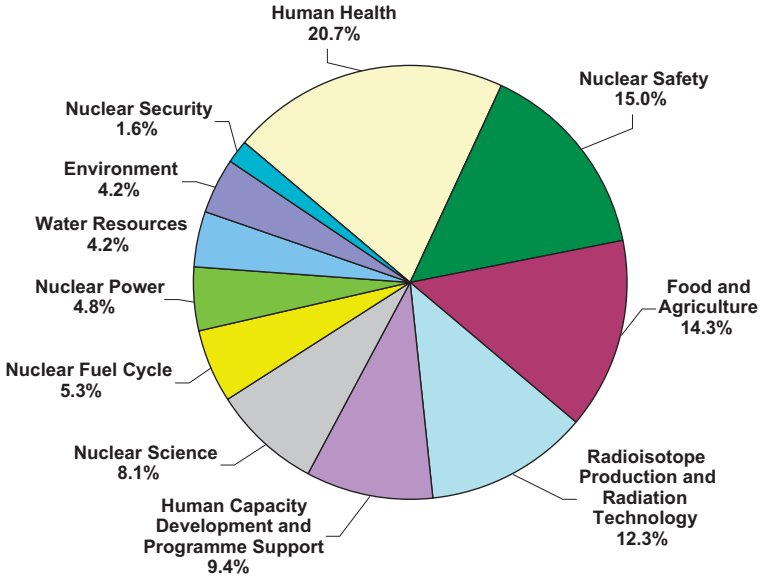


FIG. 6. Distribution of technical cooperation disbursements in 2009 by Agency programme (percentages in this chart may not add up to 100 exactly due to rounding).

effectiveness and efficiency in meeting the Agency's safeguards obligations.

Safeguards Conclusions for 2009

In 2009, safeguards were applied for 170[6] States with safeguards agreements in force with the Agency.[7] Eighty-nine States had both a CSA and an AP in force. For 52 of these States,[8] the Agency concluded that all nuclear material remained in peaceful activities. For the other 37 States, the Agency had not yet completed all the necessary evaluations under their AP in order to conclude that the declared nuclear material remained in peaceful activities. For 73 States with a CSA in force but without an AP, the Agency was only able to draw the conclusion that declared nuclear material remained in peaceful nuclear activities. Integrated safeguards were implemented during 2009 in 44 States.

"In 2009, safeguards were applied for 170 States with safeguards agreements in force with the Agency."

For three States that had safeguards agreements based on INFCIRC/66/Rev.2 in force in 2009, the Secretariat concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities. Safeguards were also implemented with regard to declared nuclear material in selected facilities in four nuclear weapon States under their respective voluntary offer agreements. For these four States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities or had been withdrawn as provided for in the agreements.

The Secretariat could not draw any safeguards conclusions for 22 NPT non-nuclear-weapon States without safeguards agreements in force.

During 2009, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement and relevant United Nations Security Council resolutions in the Islamic Republic of Iran (Iran). The Agency was able to verify the non-diversion of declared nuclear material in Iran in 2009, but as Iran has not provided the information and access that would have allowed the Agency to make progress on a number of outstanding issues, and as Iran has not implemented its AP, the Agency remained unable to draw a conclusion regarding the absence of undeclared nuclear material and activities in Iran. Contrary to the decisions of the Security Council,

6 The 170 States do not include the Democratic People's Republic of Korea, where the Agency did not implement safeguards and, therefore, could not draw any conclusions.

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

8 And Taiwan, China.

Iran did not suspend its uranium enrichment related activities and continued its heavy water related projects. Iran has not been implementing the modified text of its Subsidiary Arrangements on the early provision of design information for its facilities. In October, Iran announced that it was constructing an additional enrichment facility near Qom. Subsequently, Iran announced its intention to build ten new enrichment plants. At its meeting in November, the Board adopted a resolution that, inter alia, urged Iran to comply fully and without delay with its obligations pursuant to Security Council resolutions and the requirements of the Board, to immediately suspend construction of the Qom facility, and to resolve all outstanding issues.

During 2009, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement in the Syrian Arab Republic (Syria). The Agency continued its verification activities in relation to the allegations that an installation destroyed by Israel at Dair Alzour in Syria in September 2007 had been a nuclear reactor under construction. Syria has yet to provide a credible explanation for the origin and presence of anthropogenic[9] natural uranium particles found at the Dair Alzour site. Syria has not cooperated with the Agency since 2008 in connection with the unresolved issues related to the Dair Alzour site and the three other locations to which it is allegedly functionally related. In 2009, the Agency found anthropogenic natural uranium particles at the Miniature Neutron Source Reactor (MNSR) near Damascus. Though Syria has provided some information about the experiments carried out at the MNSR and the origin of the particles, it did not cooperate fully with the Agency in providing design information related to the MNSR, which required nuclear material accountancy reports and detailed explanations of experiments carried out with domestically produced yellowcake and previously undeclared commercial uranyl nitrate. Though the Agency was able to verify the non-diversion of declared nuclear material in Syria, the Agency's verification activities in Syria are continuing.

"The IAEA Remote Monitoring Data Centre was strengthened and is now able to monitor the unattended systems installed in nuclear facilities worldwide on a near real-time basis."

Other Verification Activities

At the start of the year, the Agency implemented monitoring and verification measures in the Democratic People's Republic of Korea (DPRK) related to the shutdown of the Yongbyon nuclear facilities and one facility at Taechon. These activities were discontinued at the request of the DPRK, and the Agency's inspectors left the DPRK in April 2009 after its Government ceased all cooperation with the Agency. Since that date, the Agency has not been able to carry out any monitoring and verification activities in the country, and thus cannot currently provide any conclusions regarding the DPRK's nuclear activities.

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'. Outreach events in 2009 included a briefing on the sidelines of the third session of the Preparatory Committee for the 2010 NPT Review Conference and an inter-regional seminar in the United Republic of Tanzania for States with limited nuclear material and activities.

In 2009, CSAs entered into force for eight States and APs for six States. Two States acceded to the safeguards agreement between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, as well as the AP thereto. Small quantities protocols were amended to reflect the revised text with five States.

Strengthening Safeguards

The Agency continued to develop and implement more effective and efficient approaches to verification, including through the development of information driven safeguards. The IAEA Remote Monitoring Data Centre was strengthened and is now able to monitor the unattended systems installed in nuclear facilities worldwide on a near real-time basis. In 2009, the Agency took advantage of new, higher resolution commercial satellite sensors to improve its capabilities for monitoring nuclear sites and facilities worldwide.

The Secretariat continued to work with State systems of accounting for and control of nuclear

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

material (SSACs) on safeguards implementation issues, such as the quality of operator systems for the measurement of nuclear material, the timeliness and accuracy of State reports and declarations, and support for the Agency's verification activities, including through training and advisory missions.

The Novel Technology Project continued to identify and develop advanced technologies capable of detecting undeclared nuclear activities. Enhancement of the capabilities of the safeguards analytical services — the ECAS project — is progressing as planned.

The new 'Research and Development Programme for Nuclear Verification 2010–2011' was agreed by Member States. It comprises 24 projects in such areas as verification technology development, safeguards concepts, and information processing and analysis. The increased training requirements have led to updating of the Agency's training curriculum.

The Agency is preparing to safeguard new types of facilities in the future. These activities will include not only evaluating safeguards approaches for specific facility types, but also assessing the proliferation resistance of overall nuclear energy systems and the implementation of safeguards early in the design stages of a facility.

"The full implementation of AIPS represents the largest change management project the Agency has ever undertaken ..."

Management Issues

Agency-wide Information System for Programme Support

Full funding was secured in August for the first of four phases of the Agency's enterprise resource planning system (known as AIPS — Agency-wide Information System for Programme Support). Work then started immediately on implementation. The first phase will cover finance, procurement, programme and project management, and transportation, and is scheduled to 'go live' in early 2011. The completion of the first phase will enable the Agency to introduce the International Public Sector Accounting Standards in 2011, as approved by the Board of Governors. The full implementation of AIPS represents the largest change management project the Agency has ever undertaken, involving the re-engineering of all related business processes to meet best international practices. Considerable efficiency gains are foreseen.

Appointment of the Director General

Mohamed ElBaradei retired at the end of November as Director General of the Agency after 12 years of service. At its 53rd regular session, the General Conference approved by acclamation the Board of Governor's appointment of Yukiya Amano as the new Director General.

Conclusion

The role that the Agency played in 2009 in helping to support global development objectives continues to conform to Article II of its Statute, namely to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". In this context, several principles central to the Agency's mission were reinforced during the year:

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

For the Secretariat and Member States to continue making progress in these areas, active partnership is indispensable. The Agency is committed to reinforcing this partnership.

Technology

Nuclear Power

Objective

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

Launching Nuclear Power Programmes

More than 60 countries — mostly in the developing world — have informed the Agency that they might be interested in launching nuclear power programmes. In 2009, 58 Member States participated in regional or national technical cooperation projects related to the introduction of nuclear power. Of these States, 17 were actively preparing national nuclear power programmes. Iran was constructing its first nuclear power plant, and the United Arab Emirates completed a bidding process for its first nuclear power plant. In December, it selected the bid by a consortium led by the Korea Electric Power Corporation and the Emirates Nuclear Energy Corporation. The increased interest among Member States led to a threefold increase in technical cooperation projects related to nuclear power in the Agency's 2009–2011 technical cooperation cycle. Agency assistance to countries launching nuclear power programmes includes: technical guidance and reference documents; the dissemination of experience, new knowledge and best practices; direct training and computer packages for distance learning; and peer reviews and other expert advisory missions.

"More than 60 countries — mostly in the developing world — have informed the Agency that they might be interested in launching nuclear power programmes."

In 2009, the Agency launched a new Integrated Nuclear Infrastructure Review (INIR) service to examine national infrastructure needs based on the 'milestones' it has developed to guide Member States as they embark on a nuclear power programme.[1] The first three INIR missions visited Jordan, Indonesia and Vietnam. Opportunities for international cooperation between newcomer countries and the vendor community were identified in an Agency workshop in November, and new publications were issued on financing nuclear power plants and on the responsibilities and capabilities of owners and operators, and of organizations, in implementing new nuclear power programmes.

Engineering Support for Operation, Maintenance and Plant Life Management

The Agency's support for Member States with operating nuclear power plants continues to focus on operational excellence, especially by extending the operational life of such plants through the replacement of heavy components. Many Member States give high priority to long term operation of reactors beyond the 30–40 years originally anticipated. Out of a total of 437 nuclear power reactors in operation at the end of 2009, 339 had been in operation for more than 20 years.

Two CRPs related to the integrity of reactor pressure vessels were completed in 2009 and their final reports published: *Pressurized Thermal Shock in Nuclear Power Plants: Good Practices for Assessment* (IAEA-TECDOC-1627) and *Master Curve Approach to Monitor Fracture Toughness of Reactor Pressure Vessels in Nuclear Power Plants* (IAEA-TECDOC-1631). The first CRP concluded that under certain well specified conditions, different national codes for assessing pressurized thermal shock produced consistent results. The factors that most influenced the assessment results were the size, shape, location and orientation of flaws in the material, thermohydraulic assumptions and material toughness. Less influential factors were the vessel steel stress-strain curve, fatigue crack growth, and the profile of weld

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

FIG. 1. Construction of water cooled reactors (2 × 917 MW(e)) at Kundankulam, in India.

residual stresses. The second CRP confirmed the applicability of the master curve approach under most conditions, identified exceptional conditions and recommended adjustments, and identified biases in toughness tests related to the size and geometry of the specimens tested. The Agency also published *Integrity of Reactor Pressure Vessels in Nuclear Power Plants: Assessment of Irradiation Embrittlement Effects in Reactor Pressure Vessel Steels* (IAEA Nuclear Energy Series NP-T-3.11).

Nearly all power reactors in operation and under construction are water cooled reactors (Fig. 1), and in October the Agency convened a conference on 'Opportunities and Challenges for Water Cooled Reactors in the 21st Century'. The conference attracted 270 participants from 54 Member States, nearly twice the number of countries with operating nuclear power plants. The conference participants discussed projections for the continued expanding demand for water cooled reactors and the central role they will play in the 21st century. It provided an opportunity for participants to share lessons learned from operational and regulatory experience so as to improve the design, operation and safety of the expanding fleet of water cooled reactors. The participants also discussed prospects for innovative applications of water cooled reactors. The conference identified the need for additional efforts to develop advanced materials and reliable components for longer plant lifetimes and more demanding conditions, to clarify the optimal balance between active and passive safety systems, to make more effective use of alternative fuels and advanced fuel designs, and to attain higher conversion rates.

The Agency established a new review mission — Independent Engineering Review of I&C Systems (IERICS) — to peer review design documents, prototype systems, and I&C systems already deployed in operating nuclear power plants. The first three IERICS missions will take place in 2010.

"The Agency established a new review mission — Independent Engineering Review of I&C Systems (IERICS) — to peer review design documents, prototype systems, and I&C systems already deployed in operating nuclear power plants."

The Agency also established a new international network of instrumentation and control (I&C) experts, the Network of Excellence for Supporting the Use of I&C Technologies for the Safe and Effective Operation of Nuclear Power Plants (NE-ICT). In related work, the Agency completed two publications in the area of I&C modernization: *Implementing Digital Instrumentation and Control Systems in the Modernization of Nuclear Power Plants* (IAEA Nuclear Energy Series No. NP-T-1.4) and *Protecting against Common Cause Failures in Digital I&C Systems of Nuclear Power Plants* (IAEA Nuclear Energy Series No. NP-T-1.5).

TABLE 1. NUCLEAR POWER REACTORS IN OPERATION AND UNDER CONSTRUCTION IN THE WORLD (AS OF 1 JANUARY 2010)[a]

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2008		Total operating experience through 2009	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW·h	% of total	Years	Months
Argentina	2	935	1	692	6.9	6.2	62	7
Armenia	1	376			2.3	39.4	35	8
Belgium	7	5 863			43.4	53.8	233	7
Brazil	2	1 766			13.2	3.1	37	3
Bulgaria	2	1 906	2	1 906	14.7	32.9	147	3
Canada	18	12 577			88.3	14.8	582	2
China	11	8 438	20	19 920	65.3	2.2	99	3
Czech Republic	6	3 678			25.0	32.5	110	10
Finland	4	2 696	1	1 600	22.1	29.7	123	4
France	59	63 260	1	1 600	419.8	76.2	1 700	2
Germany	17	20 470			140.9	28.8	751	5
Hungary	4	1 859			13.9	37.2	98	2
India	18	3 984	5	2 708	13.2	2.0	318	4
Iran, Islamic Republic of			1	915				
Japan	54	46 823	1	1 325	241.3	24.9	1 439	5
Korea, Republic of	20	17 647	6	6 520	144.3	35.6	339	8
Mexico	2	1 300			9.4	4.0	35	11
Netherlands	1	482			3.9	3.8	65	0
Pakistan	2	425	1	300	1.7	1.9	47	10
Romania	2	1 300			10.3	17.5	15	11
Russian Federation	31	21 743	9	6 894	152.1	16.9	994	4
Slovakia	4	1 711	2	810	15.5	56.4	132	7
Slovenia	1	666			6.0	41.7	28	3
South Africa	2	1 800			12.8	5.3	50	3
Spain	8	7 450			56.5	18.3	269	6
Sweden	10	8 958			61.3	42.0	372	6
Switzerland	5	3 238			26.3	39.2	173	10
Ukraine	15	13 107	2	1 900	84.5	47.4	368	6
United Kingdom	19	10 097			48.2	13.5	1 457	8
United States of America	104	100 683	1	1 165	806.7	19.7	3 499	9
Total[b, c]	437	370 187	55	50 855	2 597.8	14	13 911	3

[a] Data are from the Power Reactor Information System.

[b] The total includes the following data on Taiwan, China:

— 6 units, 4949 MW(e) in operation; 2 units, 2600 MW(e) under construction.

— 39.3 TW·h of nuclear electricity generation, representing 17.5% of the total electricity generated there.

— Total operating experience at the end of 2009: 170 years, 1 month.

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

In addition to publications, the Agency also disseminates information on nuclear power reactors through its web site. For reactor operations, a key information source is the Power Reactor Information System (*http://www.iaea.org/pris*), which is kept up to date by national contributors from all countries with reactors that are under construction, in operation or shut down (Table 1).

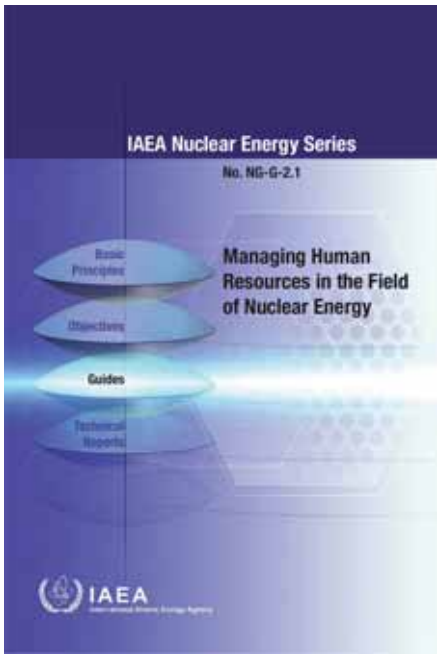


FIG. 2. The Agency published a new guide on the essential steps in managing the supply of a competent workforce for nuclear power programmes.

Human Resource Management

With increased interest in nuclear power, concerns have been expressed about possible shortages of individuals with the necessary skills. The Agency helps to analyse trends and needs, facilitates information sharing, provides training, and publishes technical guidance and reference material (Fig. 2). In 2009, the Agency organized, with support from the US Department of Energy, an interregional training course on leadership and management of nuclear power programmes in countries introducing nuclear power. It also held regional workshops in Latin America and Europe on human resources for new nuclear power programmes, and national workshops in Belarus, Chile, Egypt, Ghana, Thailand and Vietnam. It provided assistance on staff training at nuclear power plants under continuing technical cooperation projects, and convened a meeting in Vienna on simulators, advanced training tools and technologies for the nuclear industry, with a special session on the development of training systems for countries introducing nuclear power. It also published a new guide, *Managing Human Resources in the Field of Nuclear Energy* (IAEA Nuclear Energy Series No. NG-G-2.1).

"With increased interest in nuclear power, concerns have been expressed about possible shortages of individuals with the necessary skills."

Nuclear Reactor Technology Development

The Agency seeks to stimulate innovation in nuclear power through activities in four areas:

- Light water, heavy water, gas cooled and fast reactors;
- Small and medium sized reactors (SMRs);
- Non-electric applications, such as hydrogen generation and desalination using nuclear power;
- The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO).

In addition to the international conference mentioned on page 20, the Agency organized a number of meetings, workshops and courses dealing with water cooled reactors. For example, a technical meeting on improved pellets and advanced fuel designs reviewed the status of developments in fuel pellet materials as well as recent improvements in fuel rod designs for advanced cooled power reactors. A two week workshop on 'PC Based Simulators for Education' was held at the ICTP in Trieste, Italy, to demonstrate the Agency's simulators and advise participants on their best use as a training and educational tool. In June, the University of Pisa hosted an Agency course on Natural Circulation in Nuclear Power Plants.

The Agency published *Passive Safety Systems and Natural Circulation in Water Cooled Nuclear Power Plants* (IAEA-TECDOC-1624), which provides insights into system design, operation and reliability. The report was the result of a CRP on natural circulation phenomena, modelling and reliability of passive systems that brought together 16 institutes from 13 Member States. The Agency also published *Intercomparison of Techniques for Inspection and Diagnostics of Heavy Water Reactor Pressure Tubes: Determination of Hydrogen Concentration and Blister Characterization* (IAEA-TECDOC-1609), which presents the most effective HWR pressure tube inspection and diagnostic methods, and identifies further development needs.

In the area of gas cooled reactors, the Agency started a new CRP on Improved Understanding of the Creep Phenomenon for Irradiated Nuclear Graphite. The objective is to develop a universally accepted graphite creep model, based on experimental data, to address both regulatory

issues on life extensions for advanced gas cooled reactors in the United Kingdom and graphite qualification issues for the new high temperature gas cooled reactor (HTGR) programmes in China, South Africa and the USA. To identify available data and knowledge gaps related to these new HTGR programmes, the Agency organized a technical meeting, hosted by the Jülich Research Centre in Germany, on the performance of past HTGR programmes and test facilities. This meeting identified extensive data on the performance of past HTGRs.

In the area of fast reactors, the Agency organized an international conference in Kyoto on 'Fast Reactors and Related Fuel Cycles: Challenges and Opportunities', hosted by the Japan Atomic Energy Agency. In addition to the scientific presentations, a 'Young Generation Event' was held, underlining the fact that technology development for fast reactors and associated fuel cycles is once again receiving attention in research, and industrial and academic organizations. The participants identified a number of issues, and plans for R&D programmes to resolve them were outlined. The current focus is on the commissioning of experimental fast reactors, including the Chinese experimental fast reactor in 2010, the restart of the Monju industrial prototype in Japan in 2010, the completion of the 500 MW(e) prototype fast breeder reactor in India and the 800 MW(e) BN-800 in the Russian Federation, as well as other construction projects in France, India, Japan, the Republic of Korea and the Russian Federation.

"... ADSs have the potential to reduce the amount and toxicity of high level nuclear waste generated by power production ..."

The Agency also organized a topical meeting, in cooperation with the American Nuclear Society, on accelerator applications, including nuclear materials research, accelerator technology and accelerator driven systems (ADSs) utilizing and transmuting minor actinides and long lived fission products. Participants agreed that ADSs have the potential to reduce the amount and toxicity of high level nuclear waste generated by power production and that the Agency should both play a significant role in progress towards an ADS demonstration plant and continue to coordinate research on ADS related nuclear data, cross-section measurements, codes and data validation, materials development and coolant technology.

Publications completed in 2009 on fast reactors included: *Advanced Reactor Technology Options for Utilization and Transmutation of Actinides in Spent Nuclear Fuel* (IAEA-TECDOC-1626); *Decommissioning of Fast Reactors after Sodium Draining* (IAEA-TECDOC-1633); and *BN-600 Hybrid Core Benchmark Analyses* (IAEA-TECDOC-1623). The last publication reports the results of a CRP on updated codes and methods to reduce the calculational uncertainties of liquid metal fast reactor reactivity effects.

In the area of small and medium sized reactors, the Agency published *Design Features to Achieve Defence in Depth in Small and Medium Sized Reactors* (IAEA Nuclear Energy Series No. NP-T-2.2).

Non-electric applications of nuclear power continue to be an area of strong interest to Member States. In response, the Agency organized a technical meeting hosted by the Korea Atomic Energy Research Institute, in Daejeon, the Republic of Korea, which emphasized the importance of international collaboration given the high R&D costs for non-electric applications, notably for nuclear hydrogen production. The meeting recommended that existing nuclear facilities related to non-electric applications should be made available for international cooperation and that more attention be given to coupling and safety issues associated with non-electric applications. It encouraged the Agency to develop new standards on these issues. The Agency also organized a workshop on the technology and performance of desalination systems, which trained participants in carrying out technology and performance evaluations of energy sources and water desalination systems, including those coupling various sources of energy, such as combined cycles, gas turbines, fossil and nuclear reactors, with different desalination processes. The course also trained participants in the use of the Agency's Desalination Economic Evaluation Program (DEEP).

The Agency began a CRP on new technologies for seawater desalination using nuclear energy. The CRP will investigate the potential to harness waste heat in nuclear power plants using heat pipe technologies.

Environmental Impact Assessment of Nuclear Desalination (IAEA-TECDOC-1642) was completed in 2009. It provides an overview of the nature and magnitude of the environmental impacts of nuclear desalination, detailing experimental data and the experience gained in operating nuclear desalination projects, and highlighting risks perceived by the public.

The Agency released a 'toolkit' on nuclear desalination. The toolkit, intended for Member

States considering nuclear power for seawater desalination, provides access to information on DEEP, Agency publications on nuclear desalination, Agency activities in the field, the work of the Technical Working Group on Nuclear Desalination, options for seawater desalination and launching a nuclear desalination programme.

Another computer code, the Hydrogen Economic Evaluation Program (HEEP), was released to evaluate the economic aspects of hydrogen production using nuclear energy. An Agency technical meeting, hosted by the Bhabha Atomic Research Centre in India, concluded that hydrogen will be an important commodity for Member States, and the hydrogen generated using nuclear energy offers much lower greenhouse gas emissions than that generated from fossil fuels.

"Since its establishment in 2001, INPRO has grown to 31 members, representing 75% of the world's GDP and 65% of the world's population."

INPRO provides a forum for technology holders and users to jointly consider innovation. Since its establishment in 2001, INPRO has grown to 31 members, representing 75% of the world's GDP and 65% of the world's population. Since 2001, 38 cost free experts from 16 Member States have contributed to INPRO's work. In 2009, INPRO's activities were consolidated into five new substantive areas: nuclear energy system assessments (NESAs) using the INPRO methodology; global vision, scenarios and pathways to sustainable nuclear development; innovations in nuclear technology; innovations in institutional arrangements; and the INPRO dialogue forum on nuclear energy innovations.

New guidance was made available to Member States in *Lessons Learned from Nuclear Energy System Assessments (NESA) Using the INPRO Methodology* (IAEA-TECDOC-1636) and a brochure on *IAEA Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments*. The latter describes an integrated way of using Agency tools in support of both *energy* and *nuclear energy* planning. In 2009, Belarus started a new NESA for the first two nuclear power plants to be built by 2016 and 2018 and the associated waste management issues.

An Agency study, within the framework of INPRO, on *Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century* was concluded in 2009. It analyses the perspective for long term sustainable nuclear energy development based on scientific and technical calculations of possible growth scenarios. The study also details the links between industrial capacity, resources, and flows of nuclear fuel and other nuclear material between regions.

Sustainable expansion of nuclear power will require both technical and institutional innovations. In 2009, the Agency published *Status and Trends of Nuclear Technologies* (IAEA-TECDOC-1622), which provides an overview of the history, present situation and future perspectives of nuclear fuel cycle technologies. Also in 2009, a key study on *Legal and Institutional Issues of Transportable Nuclear Power Plants* was concluded. Such power plants are of particular interest for areas with limited infrastructure, countries with small electric grids, and remote or isolated islands.

Nuclear Fuel Cycle and Materials Technologies

Objective

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

Uranium Production Cycle and the Environment

The resurgence in the global uranium production industry continued in 2009, with new uranium mines opening in Kazakhstan and Malawi and several production centres — in Australia, Brazil, Namibia and the Russian Federation — looking to maximize output from their existing facilities and/or expand production. Exploration activity was reduced in some quarters, as many smaller companies ceased operating when financing became difficult to obtain as a consequence of the global financial crisis. However, some exploration areas saw little reduction of activity. In Namibia, for example, there were significant finds, and resource development work continued unabated.

Member State interest in uranium production continued to increase, with particularly strong interest in related technical cooperation projects from a number of developing countries. Many of these countries are now looking at nuclear power as an integral part of their energy plans, and in several cases the desire to use domestic energy resources has led to a significant increase in requests for training and support in the areas of uranium exploration, resource evaluation and development planning, and mine development planning and regulation. The Agency provided training in all aspects of uranium production to Member States in Africa, Asia and Latin America.

The Agency also published *Establishment of Uranium Mining and Processing Operations in the Context of Sustainable Development* (IAEA Nuclear Energy Series No. NF-T-1.1). Within the context of the four cornerstones of sustainability — environment, social issues, economics and governance — the report focuses on legacy issues and the timescales over which uranium mining and processing operations should be considered sustainable.

In June, the Agency organized a symposium entitled 'Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues' (URAM-2009) in Vienna. The meeting concluded that despite the ongoing global financial crisis, growth in the uranium production industry continues to be strong, including in countries that are relatively new to the industry and interested in Agency assistance.

"The meeting concluded that despite the ongoing global financial crisis, growth in the uranium production industry continues to be strong ..."

Nuclear Power Reactor Fuel Engineering

Two CRPs were completed in 2009. The first, on optimization of water chemistry to ensure reliable water reactor fuel performance at high burnup and in ageing plants, investigated the causes and consequences of corrosion product deposition on fuel and the techniques available to water chemists to control such deposition. It provided information on current best practices and covered issues of concern for all major nuclear power plant types. The second CRP, on delayed hydride cracking of zirconium alloy cladding, included round robin testing that generated comprehensive experimental data on cracking velocities in Zircaloy-4 PWR, BWR, WWER and CANDU/PHWR cladding and led to the transfer of experimental methods from the host laboratory, Studsvik Nuclear AB in Sweden, to the project participants.

The Agency also convened a topical meeting in Vienna on 'Nuclear Research Applications and Utilization of Accelerators', as well as a technical meeting in Buenos Aires, to consider PHWR fuel experience and manufacturing technologies and to support efforts to improve fuel behaviour. The participants at the Buenos Aires meeting concluded

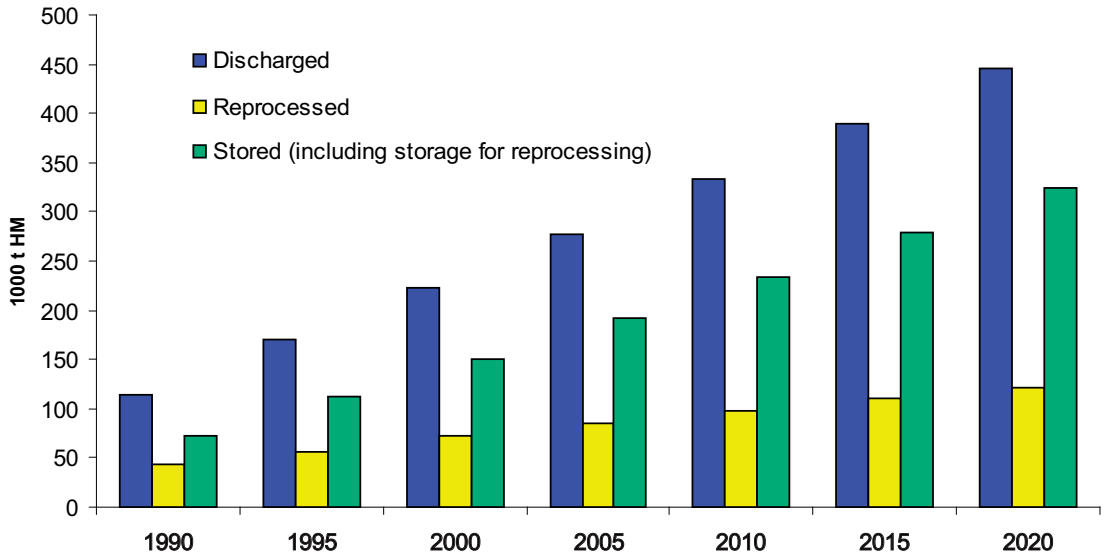


FIG. 1. Projections for the total amount of spent fuel in storage show an increase until 2020.

that although current PHWR fuel has proved to be extremely reliable, more work was needed to understand fuel performance at extended values of burnup and to develop advanced fuel designs.

Other technical meetings were held in Villigen, Switzerland, on advanced fuel pellet materials and fuel rod designs for water cooled reactors, and in Vienna as part of a CRP on the use of accelerator techniques and theoretical modelling to develop radiation resistant materials.

Spent Fuel Management

The implementation of safe and effective strategies for spent fuel management continues to be a high priority. Currently, only about 20% of discharged fuel is reprocessed, and the development of disposal facilities for spent fuel or high level waste has been delayed in many countries, with no repository scheduled to start operation before 2020. Under these circumstances, many countries have adopted the approach of long term storage of spent fuel for 100 years or longer, and the reports and activities of the Agency reflect the need for long term spent fuel storage (Figs 1 and 2).

The Agency completed a CRP on Spent Fuel Performance Assessment and Research (SPAR-II), which evaluated the performance of spent fuel in wet and dry storage and concluded that current storage technology can accommodate the trend towards extended storage times. The Agency also published reports on the *Management of Damaged Spent Nuclear Fuel* (IAEA Nuclear Energy Series No. NF-T-3.6) and *Costing of Spent Nuclear Fuel Storage* (IAEA Nuclear Energy Series No. NF-T-3.5). Together with the OECD/NEA, the Agency organized an international workshop on burnup credit application, to provide more realistic safety margins in criticality calculations while reducing the cost of spent fuel management.

FIG. 2. Dry storage casks at the Wolsong nuclear power plant site in the Republic of Korea.

Topical Advanced Fuel Cycle Issues

The sustainable development of nuclear energy requires the efficient use of fissile and fertile resources.[1] However, today's commercial

[1] In a nuclear reactor, fissile material undergoes fission by thermal neutrons producing energy, whereas fertile material absorbs neutrons and is converted into fissile material.

thermal reactors utilize less than 1% of uranium resources. Resource utilization can be improved by reprocessing the spent fuel and recycling the plutonium and uranium from reprocessing operations into fresh reactor fuel. Various aspects of such scenarios were examined in two closely related publications. One, entitled *Use of Reprocessed Uranium* (IAEA-TECDOC-CD-1630), covers the technical issues, while the other, *Use of Reprocessed Uranium: Challenges and Options* (IAEA Nuclear Energy Series No. NF-T-4.4), covers economic issues and long term prospects for the use of reprocessed uranium for nuclear energy generation.

The persistent toxicity of some of the radionuclides (such as minor actinides) in discharged nuclear fuel is a major obstacle to achieving wide public acceptance of the disposal of spent fuel or high level waste. Several Member States have alternative reprocessing technologies and advanced partitioning processes to improve the management of minor actinides. Many of these processes aim to recover minor actinides and other long lived fission products to transmute them in fast reactors. The Agency has initiated substantial work in the area of partitioning and transmutation as a part of advanced fuel cycle activities and, in 2009, completed a CRP on process losses in separation processes in partitioning and transmutation systems to minimize the long term environmental impact. The CRP showed that after the removal of both plutonium and minor actinides through partitioning and transmutation, the radiotoxicity of high level waste will fall to the level of natural uranium ore within 500 years.

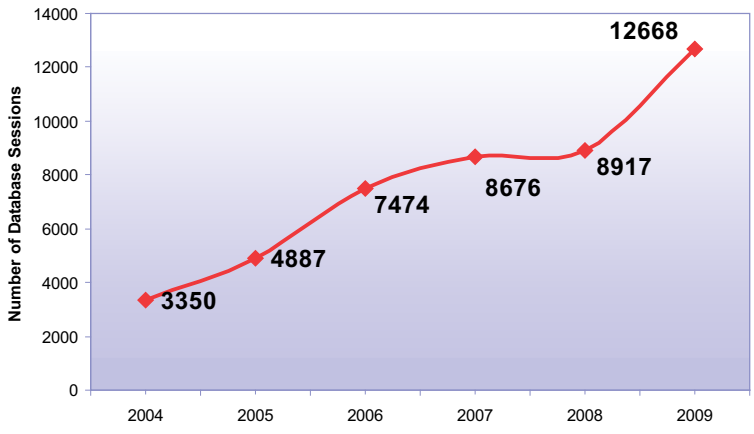


FIG. 3. Increase in the use of iNFCIS in 2009.

Significant efforts are under way in several Member States to develop high temperature gas cooled reactors (HTGRs) for process heat, hydrogen production and electricity generation. HTGRs have already demonstrated their high temperature capabilities by attaining reactor outlet coolant temperatures of up to 950°C, and are being further developed for their high temperature capabilities and enhanced safety features. In addition to their prospective use for heat, hydrogen and electricity production, HTGRs could also be used for burning plutonium and minor actinides. Finally, the Agency published *Status and Prospects for Gas Cooled Reactor Fuels* (IAEA-TECDOC-CD-1614).

"The Agency has initiated substantial work in the area of partitioning and transmutation as a part of advanced fuel cycle activities ..."

Integrated Nuclear Fuel Cycle Information System

Reliable and accurate data on worldwide nuclear fuel cycle activities are extremely important to the nuclear community for national policy making, international cooperation and studies pertaining to sustainable global energy development. Such data are available through the Agency's Integrated Nuclear Fuel Cycle Information System (iNFCIS) (*http://www-nfcis.iaea.org/*), which provides information on global nuclear fuel cycle activities. The on-line databases include the Nuclear Fuel Cycle Information System, World Distribution of Uranium Deposits and the Post Irradiation Examination Facilities Database. In 2009, the Minor Actinide Property Database was also made available after expert review and intensive testing.

In 2009, iNFCIS saw a sharp increase in usage of over 40% compared with 2008, reflecting increased demand by experts, researchers and the general public (Fig. 3). Publications issued during the year based on iNFCIS data included *Nuclear Fuel Cycle Information System: A Directory of Nuclear Fuel Cycle Facilities — 2009 Edition* (IAEA-TECDOC-1613) and *World Distribution of Uranium Deposits (UDEPO) with Uranium Deposit Classification — 2009 Edition* (IAEA-TECDOC-1629).

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.

Energy Modelling, Databanks and Capacity Building

The Agency revised upwards its annual projections for the future of nuclear power. The 2009 update for the low projection anticipated an installed global nuclear power capacity of 511 GW(e) in 2030, a 40% increase over the 370 GW(e) installed in 2009. The high projection anticipated 807 GW(e), more than a doubling of the current level. The revised projections for 2030 were 8% higher than the projections made in 2008.

"Demand remains strong for the Agency's support in analysing different national and regional energy systems and energy strategies."

The upward shift in the projections was greatest for the Far East. Modest downward shifts in the projections were made for North America and for Southeast Asia and the Pacific. For all other regions there was a generally modest upward shift, with the exception of a higher upward shift in the high projection for the Middle East and South Asia. The variation across regions reflected, in part, the financial crisis that began in late 2008, which had different impacts in different regions.

The low and high projections were developed by international experts assembled by the Agency. The general upward revision in both projections reflected, first, the judgement of the experts that the medium and long term factors driving rising expectations for nuclear power — good performance and safety, projected energy demand growth, and concerns about global warming, energy supply security, and high and volatile fossil fuel prices — had not changed substantially. Second, the upward revision reflected their judgement that the commitments of governments, utilities and vendors to their announced plans, and the investments already made in those plans, had become firmer than in the preceding year.

Demand remains strong for the Agency's support in analysing different national and regional energy systems and energy strategies. The Agency develops and transfers to interested Member States analytical tools for energy assessments and trains energy experts to help build local analytical capacity to chart energy strategies consistent with national development objectives. Increasingly, Member States are applying these tools to analyse cost effective options for reducing greenhouse gas (GHG) emissions, and those interested in nuclear energy are using them to explore the feasibility of adding nuclear power to their energy systems. By the end of 2009, these analytical tools had been distributed to more than 120 Member States and eight international or regional organizations.

Over the year, more than 500 energy analysts were trained in 28 courses, mostly organized through Agency technical cooperation projects. National energy assessments were supported in more than 70 countries through 44 national and regional technical cooperation projects. Fifty of these countries explored a possible role for nuclear power in their national energy assessments.

Energy Economic Environment (3E) Analysis

In line with its mandate to provide objective and up to date information about nuclear power, the Agency contributes to international studies and deliberations that provide the context within which nuclear power is assessed and compared with other sources of energy.

At the 15th Session of the Conference of the Parties (COP-15) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Copenhagen, Denmark, the Agency maintained an

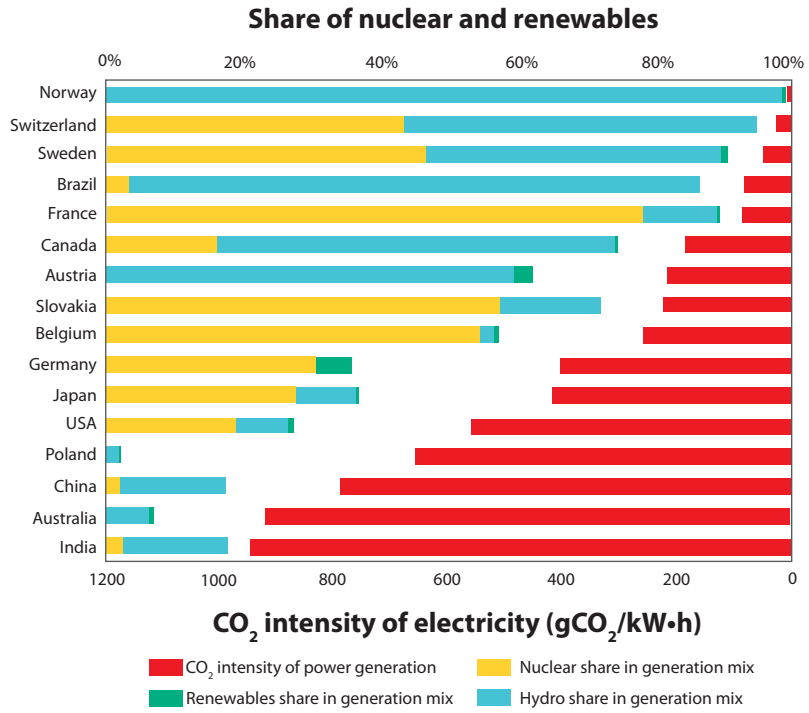


FIG. 1. Intensity of carbon dioxide and the shares of non-fossil sources in the electricity sector of selected countries. (Source: Agency calculations based on IEA data.)

information centre. Agency publications distributed at the centre included a brochure, *Climate Change and the Atom*, describing the Agency's activities related to the issue of climate change, and *Climate Change and Nuclear Power 2009*, which provides updated information on all aspects of nuclear power in the context of current climate change concerns and presents national perspectives from a number of countries (Fig. 1).

As more countries began to explore establishing nuclear power programmes, demand increased for in-depth assessments of the associated economic, social, policy and technical issues. The Agency therefore began a project on developing indicators for comprehensive nuclear energy development aimed at countries considering the introduction of nuclear power. The project builds on previous Agency work on energy indicators for sustainable development. A series of meetings in 2009 provided a preliminary evaluation of an extensive list of possible indicators and developed a concise selection of indicators for testing by Member States and the Secretariat. The results of initial testing completed in 2009 will be the basis for the next phase of the project.

Public acceptance and stakeholder involvement have been given high priority by many countries considering the introduction of nuclear power. The Agency conducted two public information seminars, in China and Malaysia, on the benefits and risks of nuclear energy. The seminars included sessions on experience around the world and lessons learned in communicating about nuclear energy with the general public.

The Agency also completed a CRP on GHG mitigation strategies and energy options, which evaluated the impacts on the energy sectors of 13 participating countries of different possible 'post-Kyoto' international agreements for limiting GHG emissions and mitigating climate change impacts. The results show that the range of possible post-Kyoto agreements — given the findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, the GHG reduction targets of the European Union and the Bali Action Plan — would create serious challenges for energy sectors in both developed and developing countries, but would simultaneously offer new opportunities for the development and deployment of low carbon energy technologies, including nuclear power.

"The Agency conducted two public information seminars, in China and Malaysia, on the benefits and risks of nuclear energy."

'Energy for Development' was the title of the 2009 Scientific Forum held during the General

Conference. The forum covered energy access, energy security, international assistance, the drivers of energy demand, energy efficiency, low carbon technologies, the impacts of biofuels on food security, and the effects of changing demography and long lived infrastructure such as buildings and roads. The concluding session discussed improving international assistance through an expanded role for UN-Energy, by building on the Vienna Energy Conference 2009, or by expanding the Energy Charter Treaty. For example, the Energy Charter Treaty could be expanded to Africa, to help aggregate small markets and establish conditions attractive to investors.

Nuclear Knowledge Management

In 2009, the Agency conducted knowledge management assistance visits to Atomic Energy of Canada Limited, to the Nuclear Power Production and Development Company in the Islamic Republic of Iran, and to the national nuclear power organization in Slovakia, as well as to educational organizations in Malaysia and in Montenegro. Such visits provide assistance, education and advice on best practices and strategies in knowledge management; they also reinforce existing strengths and offer recommendations on possible improvements.

"The Agency also conducts training courses on nuclear knowledge management to reach broader audiences, and supports networks that disseminate information in this area."

The Agency publishes guidance and reference documents on the collection and preservation of nuclear knowledge and expertise. In 2009, it published *Development of Knowledge Portals for Nuclear Power Plants* (IAEA Nuclear Energy Series No. NG-T-6.2), which proposes guidelines for the development of such portals, covering their main design principles and typical content.

The Agency also conducts training courses on nuclear knowledge management to reach broader audiences, and supports networks that disseminate information in this area. A regional training course was organized in the United Arab Emirates on operating the web portal and cyber platform of the Asian Network for Education in Nuclear Technology (ANENT) (*http://www.anent-iaea.org*). Other workshops on knowledge management were hosted by Germany and Malaysia. In cooperation with the ICTP, the European Commission and the World Nuclear University, the Agency conducted the 2009 School of Nuclear Knowledge Management at the ICTP.

International Nuclear Information System and the IAEA Library

The International Nuclear Information System (INIS) and the IAEA Library provide access to over 3.5 million bibliographic references and 300 000 full text documents, as well as print and audiovisual material. This pool of information was enlarged even further through the International Nuclear Library Network, which has 32 participating nuclear libraries.

In 2009, there were over 1000 visitors per month to the IAEA Library. Usage statistics showed that there has been a shift from a product to a training orientation: requests for customized training sessions quadrupled, individual information coaching visits doubled and the number of research queries increased by 58%.

Free access to INIS via the Internet was added in 2009, which increased the average number of INIS searches from 7000 per month at the beginning of the year to 70 000 in December.

Nuclear Science

Objective

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

Atomic and Nuclear Data

The Agency maintains extensive nuclear, atomic and molecular databases that are available to all Member States through on-line and traditional services. The number of International Nuclear Data Committee (INDC) reports on the web has risen from about 1500 in 2008 to more than 1800 in 2009, and important archival material, including the files of standards previously used, has also been made available on-line. There was a significant increase of approximately 12% in the use of on-line sites in 2009.

International collaboration and the development of application specific databases remain at the forefront of the Agency's work, as demonstrated by the prompt adoption by the nuclear industry and research centres of the Agency's contributions, including contributions to the Joint Evaluated Fission and Fusion (JEFF) project for the safe operation of existing reactors and assessment and planning of new reactor concepts, and to a new version of the International Reactor Dosimetry File (IRDF).

At a technical meeting held in Vienna, 22 participants from 15 Member States reviewed the generation of nuclear data using research reactors. The meeting brought together nuclear data experts and reactor managers with the goal of encouraging closer interaction to strengthen the role of research reactors in the provision of nuclear data for a range of applications. Specifically, the discussions focused on the use of research reactors for fission and capture cross-section and decay data measurements, and also for integral experiments to benchmark evaluated data libraries. A significant feature of evaluated databases is that they present non-predictive information and can display complex correlations interactively (Fig. 1). This is important in the analysis of the safety and efficiency of nuclear power plants.

A new graphical interface and retrieval tool for the Evaluated Nuclear Structure Data File (ENSDF) was released in 2009. Known as the 'Live Chart of Nuclides', the tool provides detailed information on nuclide properties.

An important aspect of the Agency's work is to ensure the consistent use of nuclear reaction model codes. In 2009, a report was published covering the past 15 years of work of the Reference Input Parameter Library (RIPL). A new centralized portal for all medical related nuclear data was created and is available at *http://www-nds.iaea.org/medportal/*.

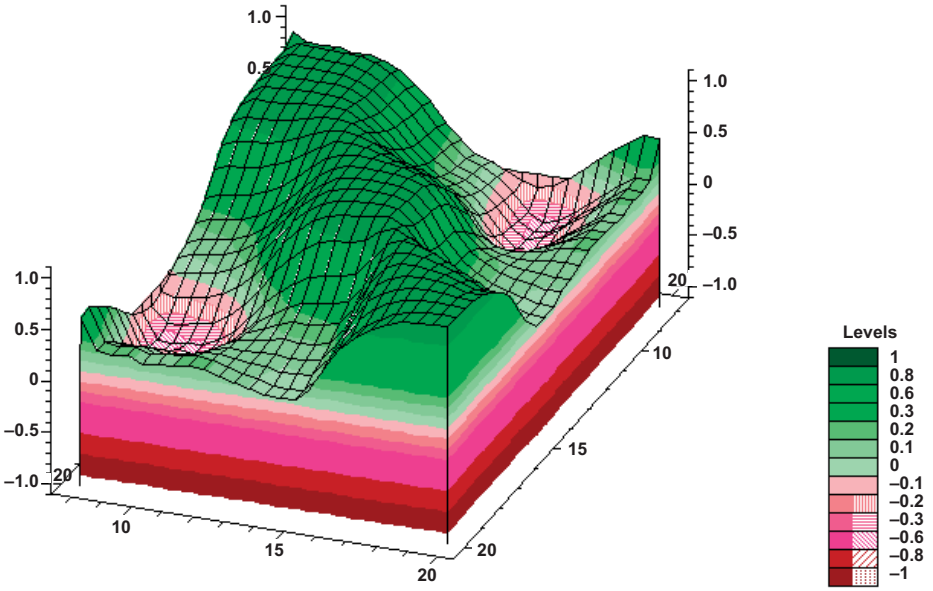


FIG. 1. The correlation matrix for the iridium-193 (n, 2n) iridium-192 reaction showing how cross-section data at different energies are linked.

As part of the Agency's work on atomic and molecular data in support of fusion research, a new CRP was begun, aimed at generating data on excitation, ionization, recombination and heavy particle collision processes for ions and molecules of light elements, which are the dominant impurity species in fusion devices. A new standard for exchange of atomic, molecular and particle–surface interaction data is also being developed.

Research Reactors

Agency activities in the area of research reactors focused on the challenges of underutilization, ageing/modernization, and the presence of fresh or spent high enriched uranium (HEU) fuel, as well as on issues of safety and security, and on plans by some Member States to build new research reactors. In this connection, more than 20 Member States have approached the Agency regarding the possible construction of new research reactors. In 2009, Agency assistance included the preparation of feasibility studies for Azerbaijan, Jordan, Sudan and the Gulf Cooperation Council (GCC).

The Eastern European Research Reactor Initiative (EERRI), supported by the Agency, organized a group fellowship training course to assist Member States interested in initiating research reactor projects. The course provided training on planning, evaluation, development, construction, commissioning, utilization, operation and maintenance.

Agency supported coalitions and networks of research reactors continued to enhance cooperation among research reactor facility managers, including existing and potential users and other stakeholders. A number of such networks (Table 1) shared research reactor facilities and competencies and collectively offered services to regional and international users, and secured entrepreneurial interest and support for upgrading existing or developing new facilities and improving access to countries without research reactors. During the 6th African Regional Conference on Research Reactor Utilization and Safety, held in Abuja, Nigeria, in November, the African Regional Research Reactor Safety Committee was officially formed and the African Research Reactor Network was initiated.

"Agency supported coalitions and networks of research reactors continued to enhance cooperation among research reactor facility managers, including existing and potential users and other stakeholders."

The Agency supports materials studies for the energy sector using research reactors through CRPs.

TABLE 1. PARTICIPATION OF MEMBER STATES IN RESEARCH REACTOR COALITIONS AND NETWORKS SUPPORTED BY THE AGENCY

Coalition/network	Member States
African Research Reactor Network	Algeria, Democratic Republic of the Congo, Egypt, Ghana, Kenya, Libyan Arab Jamahiriya, Morocco, Niger, Nigeria, South Africa, Sudan, Tunisia, Zambia
Baltic Research Reactor Network	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russian Federation, Sweden
Caribbean Research Reactor Coalition	Colombia, Jamaica, Mexico
Eurasia Research Reactor Coalition	Czech Republic, Hungary, Kazakhstan, Ukraine, USA, Uzbekistan
Eastern European Research Reactor Initiative	Austria, Czech Republic, Hungary, Poland, Romania, Serbia, Slovenia

Two new CRPs were launched in 2009, one on the application of the large sample neutron activation analysis technique for inhomogeneous bulk archaeological samples and large objects, and the other on characterization and testing of materials of relevance to the nuclear energy sector using neutron beams.

An improved version of the Research Reactor Database (*http://www.iaea.org/worldatom/rrdb/*) showing classification of operational research reactors by geographical distribution, category, features, utilization and applications was circulated to selected users and stakeholders for review and evaluation. The new design will be made available on the web to support the development of strategies for capacity building and effective utilization and management of research reactors on a national, regional and international basis.

Addressing the Shortage of Molybdenum-99 Supplies

Shutdowns and outage extensions of aged research reactors have significantly reduced global molybdenum-99 supplies since the end of 2007. In

response, the Agency has been engaged in several initiatives, such as the Eurasia Research Reactor Coalition, set up to expand the number of research reactors involved in molybdenum-99 production. Some of the participating teams (for example, from Poland and Romania) in an ongoing CRP related to the production of molybdenum-99 using low enriched uranium (LEU) targets or neutron activation have offered to provide irradiation services or initiate full scale production of molybdenum-99. A workshop on the assessment of options for enhancing molydenum-99 production and availability, held in Warsaw in September, and a panel discussion on the reliability of medical isotopes produced in research reactors, held during the Agency's General Conference, highlighted the various issues and challenges to be addressed and the options under consideration by some Member States.

The Agency participated in a number of international meetings and related events aimed at enhancing the reliability of molybdenum-99 supply and sourcing, including an OECD/NEA workshop on the security of supply of medical radioisotopes (held in January 2009), meetings of the OECD/NEA High-level Group on the Security of Supply of Medical Radioisotopes (held in June and December), and a meeting of the Association of Imaging Producers and Equipment Suppliers (in September).

Research Reactor Operation and Maintenance

Information on ageing related operating experience from research reactors around the world was collected in a database that is available to research reactor operators (*http://www.iaea.org/OurWork/ST/NE/NEFW/rrg_operation.html*). The Agency also held a technical meeting to share experience in the management of ageing of research reactors.

The Agency published *Research Reactor Modernization and Refurbishment* (IAEA-TECDOC-1625), which includes descriptions of the modernization and refurbishment projects implemented at different research reactors. Written for management teams and stakeholders, the report assumes that individual facilities have developed a five to ten year strategic plan that takes into consideration customer and market trends.

Research Reactor Fuel

Agency support continued for Member States participating in international programmes to return research reactor fuel to its country of origin. As part of the Russian Research Reactor Fuel Return (RRRFR) programme, 18.9 kg of fresh HEU fuel was moved from Hungary to the Russian Federation under a contract arranged by the Agency. The Agency also assisted in the repatriation to the Russian Federation of spent HEU fuel from Kazakhstan, the Libyan Arab Jamahiriya, Poland and Romania.

An Agency publication, *Good Practices for Qualification of High Density Low Enriched Uranium Research Reactor Fuels* (IAEA Nuclear Energy Series No. NF-T-5.2), provides guidance on ensuring acceptable performance of high density LEU fuels in a wide variety of research and isotope production reactors to fuel developers, reactor operators planning to use a new fuel, and regulatory bodies considering issuing licences allowing specific reactors to use a new fuel.

"The Agency also assisted in the repatriation to the Russian Federation of spent HEU fuel from Kazakhstan, the Libyan Arab Jamahiriya, Poland and Romania."

A technical cooperation project on repatriating spent fuel from the RA research reactor at the Vinča Institute in Serbia continues on schedule. During the General Conference in September, delegates from the Russian Federation and Serbia signed the Foreign Trade Contract, a precondition for the spent fuel's envisioned repatriation to the Russian Federation. A further milestone was the initiation of spent fuel repackaging activities. All of the spent fuel will be transported to the Russian Federation in one shipment in 2010.

Accelerators for Materials Science and Analytical Applications

A topical meeting on 'Nuclear Research Applications and Utilization of Accelerators', held in collaboration with the American Nuclear Society, discussed new trends in this area. The meeting highlighted the importance of continued research into the applications of accelerators for the further development of nuclear power, such as structural materials development and partitioning and transmutation, as well as the role of accelerators into nuclear education, biomedical applications, environmental science and cultural heritage. The participants noted the growing number of practical

applications of accelerators, for example as an analytical tool for environmental issues as well as in industrial practices. The growing interest among developing countries in the adoption of such techniques was also noted.

A series of topical meetings was held by the Agency in 2009 to promote knowledge transfer and networking. In addition, the meetings focused on building capacity in the area of structural materials for fusion and fission applications, high intensity neutron sources, cold neutron sources, synchrotron radiation and utilization of exotic beams.

A new CRP on the application of nuclear methods in microstructural characterization and performance testing of materials for hydrogen fuel cell and storage technologies was launched. Along with another ongoing CRP on Accelerator Simulation and Theoretical Modelling of Radiation Effects (SMORE), the new CRP is focused on addressing materials science issues and developing nuclear technologies to support new energy sources, both nuclear and non-nuclear.

In continuing to strengthen collaboration with other international organizations in 2009, meetings were held with the Joint Research Centre of the European Commission, the IEA and the OECD/NEA. The subjects addressed included advances in materials for fission and fusion reactor systems as well as for hydrogen based energy sources.

A new report on *Ion Beam Applications in Surface and Bulk Modification of Insulators* (IAEA-TECDOC-1607) was published.

Nuclear Instrumentation and Spectrometry

A CRP on the development of harmonized quality assurance (QA)/quality control (QC) procedures for the maintenance and repair of nuclear instruments was completed in 2009. Seven sets of QA/QC procedures for calibration and maintenance of nuclear instrumentation were developed and four low cost instruments were made available to users in Member States.

The Agency's training programme for building first line maintenance capacity in nuclear instrumentation was modified to better respond to the needs of Member State laboratories. Innovative methods for maintenance — such as using digital signal processing and modern communication tools, including the Internet, for remote diagnostics — and guidelines for modernization of nuclear instruments applied in the fields of food and agriculture and environmental quality management were assessed. The publication, *Signal Processing and Electronics for Nuclear Spectrometry* (IAEA-TECDOC-1634), detailed operational experience in this area and highlighted the latest

"The Agency's training programme for building first line maintenance capacity in nuclear instrumentation was modified to better respond to the needs of Member State laboratories."

FIG. 2. A participant in the fellowship training programme in the X ray fluorescence laboratory at the Agency's Laboratories, Seibersdorf.

developments in this field. Information on establishing and supporting a quality management system in nuclear instrumentation laboratories was made available to Member States. Ten regional and three national training courses were organized under technical cooperation projects related to nuclear instrumentation support, and 23 participants were trained at the Agency's Laboratories, Seibersdorf, under group and individual fellowship training programmes (Fig. 2).

A CRP on unification of nuclear spectrometries that ended in 2009 led to improved analytical practices through a combination of related techniques and by integrating multifunctional instruments. A new CRP on microanalytical techniques based on nuclear spectrometry was initiated with the objective of deploying these techniques for environmental monitoring and materials studies. The Agency's support to Member State laboratories in the field of nuclear spectrometry for environmental pollution monitoring, cultural heritage object analysis and other applications included the organization of seven regional training courses and one national course under technical cooperation projects that included X ray spectrometry aspects. In addition, six Fellows were trained in Seibersdorf in methodology and applications.

Nuclear Fusion

Agency activities in nuclear fusion focused on improving international collaboration within the plasma physics and fusion community, for example through a joint meeting of the Agency's International Fusion Research Council and the IEA's Fusion Power Coordinating Committee in February. Further, under the IAEA–ITER cooperation agreement, the Agency and ITER are ensuring reciprocal representation in relevant events for effective exchange of information.

In 2009, over 450 experts attended seven Agency organized technical meetings on nuclear fusion topics. Meeting participants reviewed the latest developments in plasma heating, the theory of particles and plasmas, new designs for possible fusion power plants, and power plant safety (Fig. 3). A joint Agency/European Commission topical meeting on the development of new structural materials for advanced fission and fusion reactor systems reflected the need for a common approach to materials research for these systems.

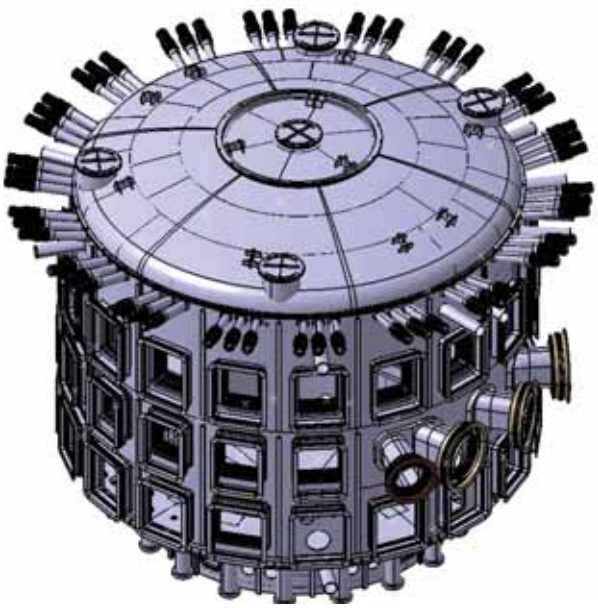


FIG. 3. The ITER cryostat (approximately 30 m in diameter) housing the tokamak passed the conceptual design review stage in November.

Food and Agriculture

Objective

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

Mutation Breeding and Its Impact on Food Security and Poverty Alleviation

The benefits from the widespread adoption and cultivation of better adapted and more productive mutant varieties translate into billions of dollars in additional income to farmers. In 2009, an Agency managed database for officially released mutant varieties was expanded to include 3100 entries on 170 species from 60 countries, covering every continent (*http://mvgs.iaea.org/*). The database provides an important service to producers and research institutions worldwide.

"In 2009, an Agency managed database for officially released mutant varieties was expanded to include 3100 entries on 170 species from 60 countries covering every continent."

Based on Agency support to the national plant breeding programme in Bangladesh, the counterpart was able to release the rice mutant variety BINA Dhan-7 (Fig. 1). It is early maturing and high yielding, and therefore suited to difficult conditions in particular locations, such as in Bangladesh during the pre-monsoon period. This variety can be harvested about one month earlier than other rice varieties, and has similar yield and high quality, enabling farmers to harvest three instead of two crops every year. Forecasts by FAO indicate that this variety may cover about 80% of rice acreage in parts of Bangladesh over the next three years.

In South Africa, one amaranth and two cowpea varieties developed for tolerance to drought, identified earlier and now ready for registration and release as new mutant varieties, represent an especially important resource for low income farmers living in drought prone or marginal lands. This success was achieved under a technical cooperation national project in cooperation with the South African Agricultural Research Council/Vegetable and Ornamental Plant Institute.

One focus of the Agency's activities in this particular area has also been to enhance the use of induced mutations for plant functional genomics and trait identification through reverse genetics. A reverse genetics strategy, known as 'targeting induced local lesions in genomes' (TILLING), improves the efficiency of induced mutations to identify crops with superior traits, and expands knowledge of gene function. In 2009, the Agency developed and distributed a TILLING positive control kit, which can be used as a reference by Member States. This technology was transferred by means of group and individual training, oral presentations and technical support.

FIG. 1. The new mutant rice variety, BINA Dhan-7, is tolerant to drought and has been released in Bangladesh.

FIG. 2. Taking soil samples from the High Pamir Mountains of Tajikistan to assess spatial FRN distribution and hence soil erosion deposition. (Photograph courtesy of Lomonosov Moscow State University, Russian Federation.)

To address the effects of drought and salinity on crops and soil, among the major concerns for Member States, the Agency developed and disseminated enhanced screening and selection techniques to allow plant breeders and scientists to identify a valuable mutant line with the characteristics to produce more, even under adverse conditions. These screening methods stemmed both from the contributions of counterparts and from the Agency's research programme on rice.

"... the Agency developed and disseminated enhanced screening and selection techniques to allow plant breeders and scientists to identify a valuable mutant line with the characteristics to produce more, even under adverse conditions."

Food Security and Sustainable Agriculture in Tajikistan

Only 7% of Tajikistan's land is suitable for agriculture. Furthermore, soil erosion and land degradation represent major threats to sustainable agricultural production. In 2009, the Agency supported Tajikistan in its efforts to use fallout radionuclides (FRNs), such as caesium-137 and beryllium-7, as tracers to obtain quantitative estimates of soil erosion in agricultural landscapes. Soil conservation measures such as strip cropping, mulching, gully rehabilitation, planting of shrubs and trees, planting of windbreak poplars and pasture rotation were found to be effective in reducing the soil erosion rate from 150 tonnes to 8–15 tonnes per hectare per year, and in preventing the loss of valuable plant nutrients and organic carbon from the agricultural topsoil.

Based on the successful use of FRNs in quantifying soil erosion rates, Turkey joined this project and provided training support through its Ministry of Agriculture and Rural Affairs on the use of the geographical information system (GIS) for upscaling the isotopic data obtained for the area-wide control of soil erosion in Central Tajikistan. In addition, the success of this project attracted interest from UNEP, which integrated the project into one of its own projects on sustainable land management in the High Pamir and Pamir–Alai Mountains (Fig. 2). The project addresses the interlinked problems of land degradation and poverty in one of Central Asia's critical mountain regions through the promotion of sustainable land management practices, with the aim of improving the livelihood and economic well-being of smallholder farmers.

Impact of Conservation Agriculture on Soil Quality and Water Use for Crop Productivity

Conservation agriculture (CA) is a farming system that includes minimum soil cultivation, permanent soil cover with crop residues, and the use of legume crops in crop rotations. A CRP completed

FIG. 3. Conservation agriculture for cereal crop in dry lands (in this case north-west Pakistan) to improve crop yield, soil organic carbon, soil nitrogen status and water use efficiency.
(Photograph courtesy of the Nuclear Institute for Food and Agriculture, Peshawar, Pakistan.)

in 2009 addressed the issue of integrated soil, water and nutrient management in CA. The CRP participants, from Argentina, Australia, Brazil, Chile, India, Kenya, Mexico, Morocco, Pakistan, Turkey and Uzbekistan, demonstrated that CA can be implemented if constraints such as soil compaction, low soil fertility and lack of soil organic matter are removed. Using the stable isotopes nitrogen-15 and carbon-13, as well as soil moisture neutron probes, the CRP also provided data on the beneficial effects of CA in improving soil organic matter content, reversing soil fertility degradation and enhancing soil water holding capacity. Crop residues were shown to enhance soil nitrogen fertility (by 50–100%) and nitrogen removal (by 1–100%) from the atmosphere (through biological nitrogen fixation) by vegetable crops (for example, beans, lentils, lupins, peas and soybeans that capture nitrogen from the atmosphere for their growth). They also improved soil water holding capacity by 40% and nitrogen fertilizer use efficiency by a similar extent, which is attributable to the increase in soil quality (soil aggregate stability and soil microbial activity) (Fig. 3). In India, 20–30% more water was available under CA at a critical stage of grain filling. In Australia, 15% more water was available under the same conditions, and the soil sodicity (excessive presence of sodium) was reduced by half after 13 years under CA, as compared with conventional tillage without crop residues.

Sustainable Improvement of Animal Production and Health

The Agency organized an international symposium in June in Vienna to discuss strategies for the sustainable improvement of animal production and health, as well as research needs to increase food security in developing countries. The symposium concluded that more and better quality food would be needed in the future to satisfy global demand. This can only be achieved through the sustainable intensification of livestock production systems through the efficient use of locally available feed resources, adequate management practices and breeding programmes for raising indigenous animals with improved traits, and the development of early and rapid diagnostic tools for the control and prevention of animal and zoonotic diseases.

"The Agency organized an international symposium in June in Vienna to discuss strategies for the sustainable improvement of animal production and health ..."

Methane is a potent greenhouse gas and has a serious impact on climate change; therefore, reducing enteric methane production in cattle is beneficial from an environmental perspective. More than 200 plants and plant extracts comprising browse, multipurpose trees, medicinal plants and spices from Africa, Asia and Latin America

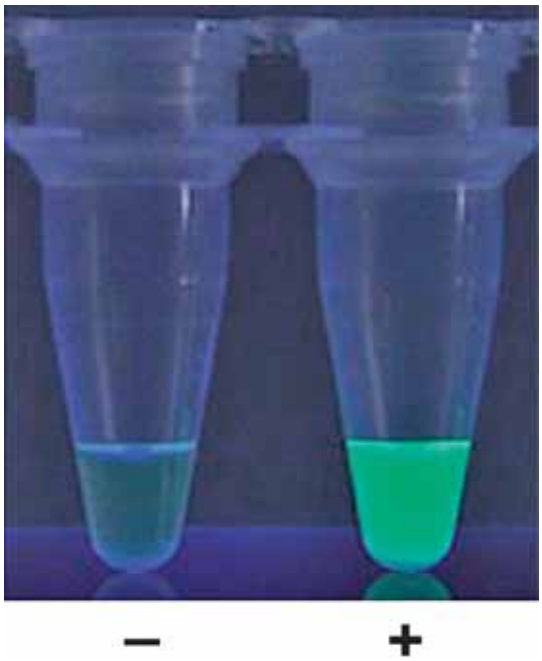


FIG. 4. A fluorometric green dye allows visual interpretation of the loop mediated isothermal amplification (LAMP) test result for the early and rapid detection of transboundary animal diseases such as the highly pathogenic avian influenza (HPAI).

were screened in 2009 for the effects of secondary metabolites using rumen molecular techniques to assess how they might reduce methane produced in the rumen (stomach). Seventeen of the plants and plant extracts inhibited methane production by 10–100% in vitro and by 11–35% in vivo.

In Honduras, the Agency supported a project in 2009 that increased milk yield in high yielding herds and meat productivity by 20%. The project integrated laboratory services to identify and promote the use of higher yielding cattle, to deliver early and rapid disease diagnosis (Fig. 4), and to control programmes and the introduction of improved feeds, feeding and management practices through the integrated use of nuclear techniques.

"In Honduras, the Agency supported a project in 2009 that increased milk yield in high yielding herds and meat productivity by 20%."

The Agency, together with the United States Department of Agriculture, assisted Bangladesh in developing a model for delivering self-sustained veterinary services to smallholder dairy farms. Known as the Community-based Dairy Veterinary Service, this approach is being used in many other parts of Bangladesh.

The selection of cattle for desirable productive traits, disease resistance and tolerance to adverse climatic conditions is mainly being done through phenotypic data. In order to enhance selective breeding practices, however, a greater understanding of the genetic make-up of the different animal breeds is required. The Agency, as part of an international consortium, continues to provide resources for the international bovine genome sequencing project which studies parasite resistant Sheko cattle to help African farmers take advantage of selected gene carriers to improve livestock productivity. Genetic profiling will help cattle breeders select for desirable production traits by mapping DNA sequence variations in bulls. In 2009, the Agency co-authored an article in the journal *Science*[1], providing a unique source of data to stimulate research for modifying the genetic make-up of ruminant livestock.

Sustainable Management of Major Insect Pests

The need to effectively control key insect pests to avoid very significant crop losses often results in the excessive application of pesticides that frequently miss their target and contaminate people, foodstuffs, soil and groundwater. The melon fly,

[1] THE BOVINE HAPMAP CONSORTIUM, Genome-wide survey of SNP variation uncovers the genetic structure of cattle breeds, *Science* **324** (2009) 528–532.

Bactrocera cucurbitae, is the most important insect pest of cucurbit vegetable and fruit crops, causing severe damage in Africa, Asia and in islands of the Indian Ocean and the Pacific Ocean. To suppress this pest, farmers resort to several weekly insecticide cover sprays, which — apart from the many other disadvantages — is a costly practice.

In Mauritius, a pilot project involving 135 small scale cucurbit growers on 110 hectares demonstrated the feasibility of producing high quality cucurbits through effective, environmentally friendly melon fly suppression methods, including use of the sterile insect technique (SIT), which minimized the use of pesticides. Growers were trained through expert support and meetings, and given incentives to ensure full participation in the melon fly suppression campaign. To evaluate the progress of the project, a survey was carried out in 2009 which indicated that the cost of cucurbit production had been reduced through a decrease in the use of pesticides, and melon fly infestation had been reduced to 5%. Up to 85% of growers claimed to have obtained an increase in both the quality and quantity of cucurbits, and 60% reported an increase in their profit. Overall, 97% of growers expressed satisfaction and stated that the melon fly project was beneficial to them. Given the success of this pilot project, growers from other areas in Mauritius have asked to participate. In view of the positive results, the Government of Mauritius has expressed interest in expanding the use of SIT and in the extension of the programme to other cucurbit growing areas.

"In 2009, Agency efforts focused on the more effective management of major Anastrepha *and* Ceratitis *fruit fly pests through the integrated application of SIT ..."*

The presence of major insect pests such as fruit flies is a significant barrier to the export of agricultural commodities from many tropical and subtropical developing countries. In 2009, Agency efforts focused on the more effective management of major *Anastrepha* and *Ceratitis* fruit fly pests through the integrated application of SIT, opening lucrative export markets and bringing investments for the production of fruit and vegetables of over $185 million to Central America in 2009. Currently, all exports of tomatoes and bell peppers from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua originate from the fruit fly low prevalence areas established with the support of the Agency and FAO.

Food Safety and Food Control

Agency collaboration with the European Union's ProSafeBeef Project resulted in the development

FIG. 5. Analysts training in sample preparation for the multiresidue analysis of anthelmintics at the Agency's Laboratories, Seibersdorf.

and validation in 2009 of a multiresidue isotope dilution assay for 38 anthelmintic drugs[2] which is suitable for risk assessment, survey and regulatory application for food safety (Fig. 5). The method was transferred to a partner laboratory in Brazil, which will be used as a training hub to transfer the method to eight countries in a regional technical cooperation project in Latin America. The method was also demonstrated to 22 participants from 20 countries in a train the trainers workshop in October 2009 at the Agency's Laboratories, Seibersdorf, and will be adopted by several partners in a related CRP.

In a technical cooperation project in Nicaragua, Agency counterparts have used nuclear and complementary techniques to improve production, product quality and analytical techniques to control residues of veterinary drugs and hormonal growth promoters in bovine meat exports. They also reported in 2009 that the strengthening of the National Residues Laboratory of the Ministry of Agriculture and Forestry, including the introduction of new analytical techniques and a radioassay developed by the Agency, have helped to increase the export of Nicaragua's meat, shrimp, peanuts and honey.

Food irradiation, which is traditionally used for food preservation and extension of shelf life, has now evolved for post-harvest insect control (quarantine) purposes. Most recently, the Agency ensured the successful adoption of eight irradiation treatments it developed for pests of quarantine importance through the International Plant Protection Convention (IPPC) Commission on Phytosanitary Measures for inclusion in the standard[3].

A CRP that commenced in 2009, on the development of generic irradiation doses for quarantine treatments, will continue the development of other generic and specific doses for pests and pest groups of quarantine importance (29 insect species from 13 arthropod families) for eventual adoption by the IPPC, thereby reducing technical barriers and facilitating international trade in agricultural produce.

[2] These are drugs that destroy or cause the expulsion of parasitic intestinal worms.

[3] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, *International Standard for Phytosanitary Measures, Phytosanitary Treatments for Regulated Pests*, IPPC publication No. 28, FAO, Rome (2009).

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.

Nuclear Techniques to Monitor Nutrition during Early Life

The rapid increase in the prevalence of non-communicable diseases represents a major global health challenge. The impact of nutrition during early life and its role in the development of disease later in life have been emphasized by the association between small size at birth and rapid growth rate during infancy with higher rates of coronary heart disease and type 2 diabetes mellitus. In 2009, the Agency focused on defining 'quality of growth' by assessing body composition during infancy, i.e. body fat versus muscle mass, to better understand its association with health status later in life (Fig. 1).

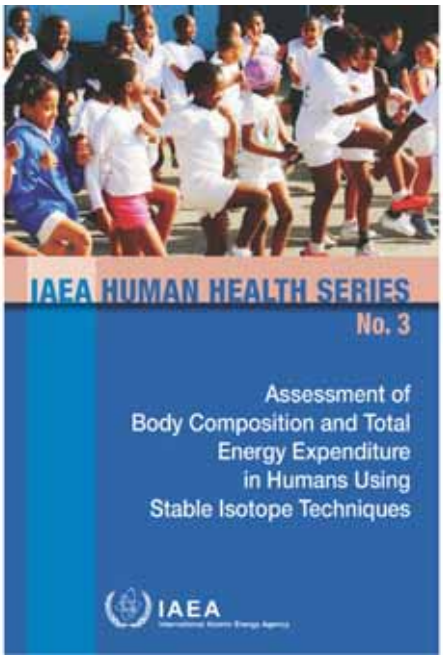


FIG. 1. In 2009, the Agency published its first report on the use of stable isotope techniques in assessing body composition and energy expenditure.

The technically challenging aspects of capturing the dynamic nature of growth during early life and its associated rapid changes in body composition and, in particular, the usefulness of nuclear techniques to assess body composition during infancy were highlighted during a technical meeting held at Headquarters, as well as during the 19th International Congress of Nutrition held in October in Bangkok.

In collaboration with WHO, the Agency launched a new AFRA regional project in Africa on improving infant and young child nutrition and health. Exclusive breastfeeding for six months, followed by the introduction of appropriate complementary foods and continued breastfeeding, as recommended by WHO and UNICEF, are cornerstones of infant nutrition. However, only limited information is available on the quantities of human milk consumed and the time of introduction of other foods into an infant's diet, partly due to the difficulties involved in measuring the intake of human milk (Fig. 2).

"In collaboration with WHO, the Agency launched a new AFRA regional project in Africa on improving infant and young child nutrition and health."

The new regional project will use stable isotope techniques to provide data in 13 countries on the intake of human milk, as well as the time of introduction of complementary foods, in a large group of infants from 3 to 12 months of age. The first coordination meeting was held in Kampala, Uganda, in May, and a training course was organized in Dar es Salaam, United Republic of Tanzania, in August, to develop standardized protocols for use in this project.

Educational Resources in Nuclear Medicine and Diagnostic Radiology

A priority of the Agency is the provision of guidance and educational resources to Member States. One medium is a dedicated human health web site (*http://nucleus.iaea.org/apps/HHW/root/content/MedicalPhysics*), while another is publications on various aspects of clinical practice in nuclear medicine. The Agency is also implementing a programme on Quality Management Audits in Nuclear Medicine Practices (QUANUM).

To support the Agency's training activities, the Research Institute for Asia and the Pacific (RIAP)

FIG. 2. Mothers and infants participating in an Agency supported project on breastfeeding in Burkina Faso. (Photograph courtesy of N. Mokhtar.)

at the University of Sydney, Australia, coordinated a Distance Assisted Training (DAT) programme for nuclear medicine technologists. Initially developed to cover conventional nuclear medicine applications, DAT material was expanded in 2009 to include single photon emission computed tomography (SPECT/CT) and positron emission tomography (PET/CT), and adapted for on-line delivery through a new web site (DATOL) (*http://nucleus.iaea.org/apps/HHW/root/content/Technologists/NuclearMedicine/Educationalresources/DistanceAssistedTrainingforNuclearMedicineTechnologists*).

Following up on previous work, auditing missions were carried out within the framework of the QUANUM programme. The objective of these missions was to conduct a quality assessment of nuclear medicine services in accordance with Agency guidelines. A quality management self-assessment questionnaire was completed by institutes and submitted before the visit of an external audit team with reference to these guidelines, Agency technical publications or other external standard setting bodies. Typically, the audit missions produce a series of recommendations, corrective measures and action plans for the audited facilities. Follow-up missions check the implementation of the plans.

"The objective of these missions was to conduct a quality assessment of nuclear medicine services in accordance with Agency guidelines."

Two publications on quality assurance (QA) were published in 2009: *Quality Assurance for PET and PET/CT Systems* (IAEA Human Health Series No. 1) and *Quality Assurance for SPECT Systems* (IAEA Human Health Series No. 6). These reports provide guidelines for the implementation of quality control programmes related to the combined medical diagnostic modality, using PET and CT technologies. The use of these independent, but complementary, imaging techniques is growing within the fields of diagnostic imaging, oncology, cardiology and neurology, where they allow physicians to locate and diagnose diseases accurately. A third publication, *Clinical Translation of Radiolabelled Monoclonal Antibodies and Peptides* (IAEA Human Health Series No. 8), provides guidance on planning the investigations needed for radiolabelled biological products to be brought into routine use. Within the context of the Agency's nuclear medicine activities, a variety of strategies have evolved for radiolabelling biological products with a view to enhancing diagnosis, palliation and therapy. Currently, more than 350 products aimed at treating over 200 diseases are being tested, including a range of monoclonal antibodies (MAbs) and peptides. However, since very few radiolabelled MAbs or peptide products have reached clinical use, the Agency is conducting two CRPs to test some of these products for clinical implementation.

Radiation Oncology

At an Agency conference on 'Advances in Radiation Oncology' (ICARO), held in April in Vienna, discussion focused on developments in radiation oncology and on needs with respect to education and training. The participants concluded that the demand for training and equipment will increase dramatically in the future. Furthermore, they agreed that finding the right balance between providing services that cover Member State needs and pursuing advanced technologies is a challenge. A side event was organized to encourage 19 companies to make diagnostic and radiotherapy equipment more affordable and technically suitable for developing countries.

Two new CRPs were initiated to contribute to capacity building and the improvement of cancer management in Member States. A CRP on paediatric radiation oncology was started to improve the quality of radiotherapy given to children with cancer in low and middle income countries.

"A CRP on paediatric radiation oncology was started to improve the quality of radiotherapy given to children with cancer in low and middle income countries."

In 2009, the focus on train the trainer activities was strengthened. In addition, distance learning tools were further developed and training materials were provided through the Agency's human health programme web site (*http://www-naweb.iaea/nahu/default.asp*). The distance learning tool in applied sciences of oncology (ASO) for radiation oncologists, radiation therapy technologists (RTTs) and other professionals in radiation medicine is being prepared for release on the Agency's public web site. A pilot course on training RTT trainers was held to test the methodology.

In 2009, the Agency implemented over 120 technical cooperation projects related to radiotherapy capacity building and equipment, and establishing or upgrading radiotherapy centres. In addition, it conducted a number of regional and national training courses. The Agency also carried out audits within the framework of its Quality Assurance Team for Radiation Oncology (QUATRO) service (Fig. 3).

Quality Assurance and Metrology in Radiation Medicine

To support the use of harmonized QA procedures for imaging modalities, the Agency published *Quality Assurance Programme for Screen Film Mammography* (IAEA Human Health Series No. 2); this was in addition to the two QA titles mentioned on page 43. Quality assurance procedures for digital mammography and CT were also developed. The Agency continued its efforts to raise awareness of the need for proper administration of QA procedures as a member of the 'Image Gently Alliance', an initiative of the Alliance for Radiation Safety in Pediatric Imaging, which has the goal of changing medical practices to lower the radiation dose in the imaging of children.

FIG. 3. QUATRO audit in Poznan, Poland.

A CRP on accurate radioactivity measurements in nuclear medicine was completed. One of the achievements of this project was a radioactivity measurement comparison for iodine-131, which is widely used in nuclear medicine practice. The results of the comparison have allowed participating Member States to establish traceability to international standards for this radionuclide.

The IAEA/WHO dosimetry services focus on Member States requiring assistance, through the Agency or WHO, in calibrating their national measurement standards and in verifying the calibration of their radiotherapy beams used to treat cancer patients. During 2009, the Agency calibrated 47 national standards from 21 Member States, 70% of which were for radiotherapy dosimetry. The remaining calibrations concerned radiation protection dosimetry. Ten Member States participated in an Agency organized comparison for radiotherapy dosimetry and all of the results were found to be within the acceptance limits. A similar result was also achieved in a comparison of radiation protection dosimetry involving 25 Member States. This demonstrates the competence of calibration laboratories in Member States to provide quality calibration services.

There is a need in hospitals to periodically check the calibration of the treatment machines to ensure safe and high quality treatment. The IAEA/WHO Postal Dose Audit service provides assurance to participating Member States that radiation beams used in clinics for cancer treatment are properly calibrated. The service has checked the calibration of over 7500 radiotherapy beams. As a result, significant improvements in dosimetry practices have been noted worldwide, especially in the last ten years. In 2009, the calibration of 557 hospital beams was checked, and 15 discrepancies in dosimetry were exposed and resolved, directly leading to an improved quality of patient treatment. The number of beam checks in 2009 exceeded what was planned by more than 10%, mostly due to requests from new facilities, which must have their calibrations verified before patient treatments can begin.

Over the past decade, new treatment modalities have been introduced, many of which tend to utilize small and composite radiation fields. In such cases, the determination of radiation dose is more complex, and there is a growing concern about the lack of standardization in the reference dosimetry used for these new treatment fields. The Agency's response has been to establish a working group, jointly with the American Association of Physicists in Medicine, comprising clinical medical physicists and specialists in dosimetry, to review the current practices and to suggest a harmonized approach.

Programme of Action for Cancer Therapy

The Agency's Programme of Action for Cancer Therapy (PACT) seeks to assist developing countries in integrating radiotherapy into the broader framework of cancer prevention and control. In 2009, the Agency with WHO launched a Joint Programme on Cancer Control to accelerate cancer control programme delivery to Member States. In addition, it signed new partnerships with the Alliance for Cervical Cancer Prevention and with the International Cancer Centre Abuja to fight cancer in Nigeria and neighbouring African countries. In addition to the funds mobilized by the Agency for PACT Model Demonstration Sites (PMDSs), a sum of $300 000 was raised to support cancer control in Uruguay. Donations to PACT in 2009 reached $6.2 million.

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

The PMDSs remain an effective model for interpartner collaboration for cancer control. In 2009, Ghana joined Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen in setting up a PMDS. Through PACT and its partners, the Agency has helped develop national cancer control plans in all seven PMDSs. In Nicaragua, the National Radiotherapy Centre hosted an inauguration ceremony for the launching of the Equinox radiotherapy machine (donated by MDS Nordion/Best Theratronics through the Agency), as well as a treatment planning system and simulator provided through the technical cooperation programme. In Vietnam, following the conclusion of a tripartite agreement in 2008, a Bhabhatron radiotherapy unit donated by India was installed at a regional hospital in Can Tho Province, where patients previously had no access to radiotherapy.

In 2009, the Agency nominated 20 professionals from the PMDSs and other developing countries to attend the US National Cancer Institute (NCI) summer curriculum in cancer prevention. NCI's in-kind contribution to PACT from 2007 to 2009

was $800 000. The Agency also supported the participation of 12 cancer professionals from West Africa in a palliative care workshop in Burkina Faso, and of seven PMDS professionals in the 3rd International Cancer Control Congress, held in November in Como, Italy. It also sponsored the participation of five African experts in radiation therapy in the 7th International Cancer Control Congress of the African Organization for Research and Training in Cancer, held in November in Dar es Salaam, United Republic of Tanzania.

By the end of 2009, the Agency had received requests from 72 Member States for 'imPACT' reviews, a cancer control needs assessment and planning process. In 2009, PACT conducted post-imPACT missions to PMDSs in Nicaragua, the United Republic of Tanzania and Vietnam. Pre-imPACT missions were undertaken in Madagascar, Mongolia, the Republic of Moldova and Uganda. A self-assessment questionnaire and an analytical tool were developed to aid government cancer control planning.

"To help meet the global need for qualified cancer care professionals, in 2009 the Agency launched PACT's Regional Cancer Training Networks and Virtual University for Cancer Control."

To help meet the global need for qualified cancer care professionals, in 2009 the Agency launched PACT's Regional Cancer Training Networks and Virtual University for Cancer Control. Professionals will be trained in their home countries through linked training centres and regional hubs for education and mentorship. With a $750 000 donation from the USA, the first network will be established in Africa, with support from a private sector partnership. The network is scheduled to include newly linked training centres, standardized curricula and a web based portal for low cost content delivery.

As part of its capacity building and awareness initiatives in 2009, the Agency invited 76 policy makers from the African and the Asia–Pacific regions to attend two PACT coordination and planning meetings on cancer control. The Agency also provided the United Nations with information on cancer treatment to assist in its discussions to revise the Millennium Development Goals. In addition, PACT hosted a special seminar entitled 'The Globalization of Cancer'.

Water Resources

Objective

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

Water scarcity and sustainable management of water resources topped the agenda at the 5th World Water Forum, held in Istanbul in March. The forum highlighted the need for scientific information on the world's water resources, and called for increased monitoring of these resources and continual assessment of how they are changing in response to climate change and to current water and land use practices. During the year, the Agency made important contributions in these areas, both through its publications on global water resources and through technical cooperation projects aimed at increasing Member State capacity for using isotopes to assess and manage their water resources.

Improving the Assessment of Water Resources

The *Atlas of Isotope Hydrology: The Americas* was completed in 2009, presenting isotope and related hydrological information for 23 Member States in North and South America. Based on approximately 19 000 records, the atlas presents data obtained from 150 Agency projects implemented between 1968 and 2008. This follows the publication of two other atlases in the series, one in 2007 covering Africa and another in 2008 covering Asia and the Pacific. The series is intended as a reference for scientists and practitioners in the field of hydrology and water resources.

In 2009, the Agency made its database of isotope measurements from non-Agency projects on rivers and groundwater available to Member States (*http://www.iaea.org/water*). The database includes 32 000 records from Latin America, 19 000 from Asia and 13 000 from Africa.

A key to understanding the impact of climate and land use changes on rivers is the residence time of water, an important parameter that describes the cycle time of water in a watershed and governs the interaction between groundwater and river systems. At an Agency technical meeting held in January on estimating the residence time of water in watersheds, meeting participants evaluated the impacts of hydrogeological factors and scaling on residence time estimation and suggested the more frequent use of isotopes such as tritium to characterize older components of flow. Participants also identified research needs related to the use of isotopes in improving residence time characterization. The recommendations will be used to develop future CRPs.

With the addition of 25 new stations in Latin America and Africa, the Agency's Global Network of Isotopes in Precipitation (GNIP) was expanded to a total of 185 stations. GNIP data are critical for understanding past changes in climate, and wider geographical coverage improves their use in climate studies.

In 2009, the Agency published an assessment of pollutant behaviour in the unsaturated zone between the land surface and the regional water table, and its relevance for preventing groundwater pollution (IAEA-TECDOC-1618). The assessment is based on the results of a recently completed CRP that addressed the combined use of conventional hydrological and nuclear techniques to study transport and other processes in the unsaturated zone. The study has led to improvements in identifying the means of pollutant transport to aquifers and in characterizing complex physicochemical processes in the unsaturated zone that act to modify pollutant concentrations.

"In 2009, the Agency published an assessment of pollutant behaviour in the unsaturated zone between the land surface and the regional water table, and its relevance for preventing groundwater pollution."

A numerical model of groundwater flow in the Nubian Aquifer system — shared by Chad, Egypt, the Libyan Arab Jamahiriya and Sudan — was developed in cooperation with these four Member States and the US Geological Survey. The isotopic age of groundwater (as old as one million years) was used to verify the model, which was then used to analyse transboundary issues related to the current and planned use of the aquifer. The aim is to develop an action programme for shared aquifer management.

Assessment of groundwater resources in the Upper Lempa River Basin — the Trifinio

Aquifer shared by El Salvador, Guatemala and Honduras — was completed as part of a technical cooperation project. Stable isotope, tritium and hydrochemical analyses of surface and groundwater samples were performed, leading to the development of conceptual groundwater flow models. The results were used to produce the first transboundary hydrogeological map of the Trifinio Aquifer, which will be used to support the selection and management of groundwater in the area.

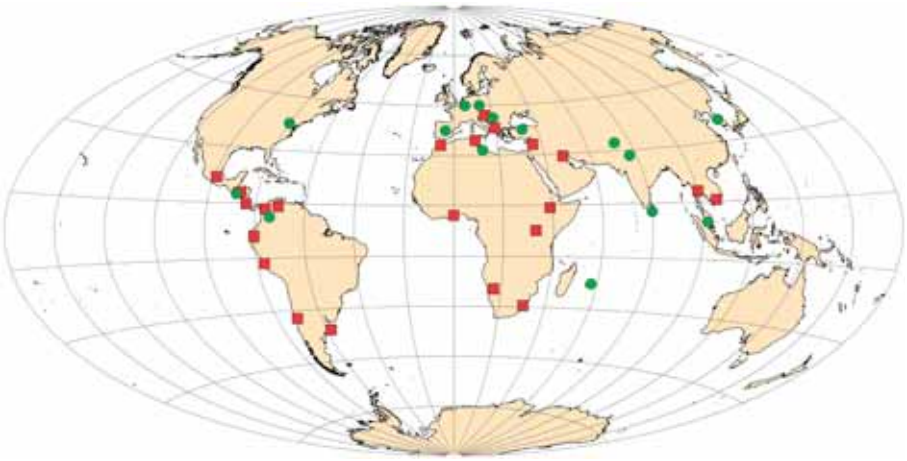
Similarly, the study of the transboundary Zarumilla Aquifer — shared by Ecuador and Peru — was completed in 2009, with isotope data showing the presence of a shallow aquifer recharged from the Zarumilla River and a deeper aquifer recharged from precipitation in the nearby mountains. The radiocarbon age of the deeper aquifer groundwater is up to several thousand years. As a result, the deeper aquifer has not been affected by pollution from mining and agricultural practices in the region and is a potentially safe source of drinking water.

Increasing Awareness and Strengthening Member State Capabilities

To highlight Agency activities related to transboundary aquifer management and integrated climate, water and energy planning, a side event and 'learning centre' were organized during the 17th session of the United Nations Commission on Sustainable Development, held in May in New York. In a technical session at the 5th World Water Forum, the Agency made key contributions to hydrological data requirements for water management and the role of isotopes therein. It also participated in a 'UN Pavilion' at the Forum with an exhibit of its water resources activities. Finally, the Agency co-sponsored four scientific conferences where the role of isotopes in hydrology was emphasized: 'Water, Environment, Energy and Society' (New Delhi, India, January); 'Efficient Groundwater Resources Management' (Bangkok, February); 'Hydroecology 2009' (Vienna, April);

"In a technical session at the 5th World Water Forum, the Agency made key contributions to hydrological data requirements for water management and the role of isotopes therein."

The Agency assists Member States in becoming self-reliant in the use of stable isotopes to manage their water resources through the use of a relatively inexpensive, laser based isotope analysis machine. In 2009, 12 additional Member States were provided with laser machines within the framework of their national technical cooperation projects. Two training workshops were held, in May and September, involving 15 participants from 12 countries. After initial training at the Agency, all 22 Member State laboratories have installed and operated the laser machines without the need for further expert assistance from the Agency.



Laser analyser and training provided through the Agency

Training provided through Agency workshops

and the Joint International Convention of the International Association of Hydrological Sciences/ International Association of Hydrogeologists (Hyderabad, India, September).

In cooperation with UNESCO and the University of the Republic of Uruguay, a two month training course on groundwater hydrology was held in Montevideo in September and October. An advanced regional training course on isotope techniques for river basin management, including river–groundwater interactions, was co-sponsored by the Agency and the Argonne National Laboratory and held in Argonne, USA, in May, with 18 participants from Latin America.

Environment

Objective

To enhance the capabilities of Member States in understanding environmental dynamics and the identification and mitigation of marine and terrestrial environment problems caused by radioactive and non-radioactive pollutants using nuclear techniques.

Climate Change and Economic Aspects Related to Ocean Acidification

In 2009, the Agency used isotope studies and numerical models to better understand and project how ocean acidification will alter marine resources in the 21st century. For example, the Agency conducted a series of applied radioecological studies under expected levels of high carbon dioxide and low pH, using calcium-45 and other isotopes to help investigate the effects of ocean acidification on commercially important organisms such as fish larvae and molluscs and key species in marine food webs in polar and temperate waters. Calcium-45 is a key tool in measuring rates of calcification, such as in corals whose reefs provide a fish habitat and breeding grounds, a defence against storms and erosion, and as the foundation of a multibillion dollar tourism industry (Fig. 1).

Ocean acidification may affect entire marine food webs, impacting on natural biodiversity and aquaculture, as highlighted by the Intergovernmental Panel on Climate Change (IPCC) during the 15th Conference of the Parties to the UNFCCC, known as COP-15, in Copenhagen in December. This phenomenon may also strengthen the toxicity of pollutants, such as heavy metals, thereby affecting the safety of seafood. Results published by the Agency were incorporated into the Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity prepared for COP-15.

Capacity Building and Networking

The IAEA Marine Environment Laboratory (IAEA-MEL), located in Monaco, acts as a focal point for collaborative initiatives in such areas as the certification of reference materials, marine radioactive and non-radioactive pollution monitoring and assessment, training, and methodological development and harmonization. In 2009, the Agency supported three CRPs and 34 technical cooperation projects involving approximately 100 Member States.

Several regional and interregional training courses, hosted both at IAEA-MEL and in Member State laboratories, supported the UNEP Regional Seas Programme in the implementation of various international conventions. The courses covered such topics as the applications of ecological risk assessment methodologies in the evaluation of the impact of radionuclides and other contaminants on marine organisms, and analytical techniques and

FIG. 1. Ocean acidification adversely affects many marine organisms such as corals, oysters, mussels and molluscs.

FIG. 2. Demonstration of the use of isotope techniques in the identification of the source of organic compounds during an Agency training course in Kuwait City.

quality assurance/quality control of data on trace metals, organochlorine pesticides, polychlorinated biphenyls and organotin compounds (Fig. 2).

ALMERA Network

Established by the Agency in 1995, the Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) network is a cooperative effort of radioanalytical laboratories worldwide. At the end of 2009, ALMERA consisted of 120 laboratories representing 75 different countries. The 6th Coordination Meeting of ALMERA was held in Budapest in November (Fig. 3). In addition, an Asia–Pacific regional ALMERA meeting was held in Daejeon, Republic of Korea, in April 2009, attended by 81 participants from 10 Member States.

As part of its role as convenor of the network, the IAEA organized two proficiency tests for members on the determination of naturally occurring radionuclides in phosphogypsum and water, and on the determination of gamma emitting radionuclides in simulated air filters (Fig. 4). To assist the members in assessing their capabilities in the event of an emergency, the tests incorporated a rapid reporting time limit utilizing on-line reporting of results directly to the Agency's reference material web site (*http://nucleus.iaea.org/rpst/index.htm*).

FIG. 3. Visit to the Paks nuclear power plant during the ALMERA Coordination Meeting in Hungary.

FIG. 4. Preparation of simulated air filter reference material for the ALMERA proficiency test.

Supporting Quality in Measurements for the Terrestrial Environment

Since 2006, the Agency has been organizing annual worldwide proficiency tests to help radioanalytical laboratories assess their performance. In the 2009 test, 1800 samples were prepared and distributed to 300 participants from 76 countries. A Latin American regional proficiency test on the determination of trace elements and radionuclides in algae, soil and spiked water was also performed as part of a technical cooperation project for Latin America.

As part of its cooperation with the International Bureau of Weights and Measures, the Agency conducted a comparison and pilot study with national metrology institutes on the measurement of radionuclides in naturally occurring radioactive material. A phosphogypsum material was characterized for naturally occurring radionuclides and was subsequently issued as a certified reference material (IAEA-434).

The in situ implementation of nuclear spectrometry techniques has reached a high level of performance in recent years, and offers certain advantages over more traditional characterization procedures of a contaminated site. In order to build Member State capacities in this area, an 'Advanced School' on in situ X ray fluorescence and gamma ray spectrometry was held at the ICTP in Trieste, Italy, in October.

Radionuclide Behaviour in the Terrestrial Environment

Electricity generation by nuclear power is expected to expand in the Asian region over the next decades, and appropriate tools and data are required to increase the rigour of environmental assessments. In this context, the Agency organized a seminar on the uptake of radionuclides into staple crops in the Asian region in Daejeon, Republic of Korea. The seminar summarized current radioecological research and identified existing gaps in this research area in the Asia–Pacific region.

The naturally occurring radionuclide radon-222, together with its radioactive progeny, has been widely used to study a variety of atmospheric processes and to test and validate comprehensive global chemical transport models. A technical meeting on sources and measurements of these radionuclides was held in Vienna in June, co-sponsored by WMO. A major focus of the meeting was on approaches for estimating radon flux from the ground, as well as for improving the quality assurance of measurements.

"Electricity generation by nuclear power is expected to expand in the Asian region over the next decades, and appropriate tools and data are required to increase the rigour of environmental assessments."

Intentionally discharged tracers are widely used in environmental investigations because they allow detailed observations of individual components of complex systems. However, there is concern about the use of radioactive isotopes in environmental research, and decision makers generally favour the use of non-radioactive alternatives if they are available. A meeting on the use of tracers to study surface water processes was held to update and report on the recent advances in this area.

Radioisotope Production and Radiation Technology

Objective

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

Radioisotopes and Radiopharmaceuticals[1]

Progress continues around the world in the development of molecular imaging techniques using radiopharmaceuticals, with particular interest in positron emission tomography (PET). In this context, the Agency initiated a CRP on the production of fluorine-18 radiopharmaceuticals other than fluorodeoxyglucose (FDG) for application in oncology and neuroscience. The CRP is expected to develop methodologies for production of selected non-FDG fluorine-18 radiopharmaceuticals to meet the demand for new PET based diagnostic agents.

To facilitate the availability of radiopharmaceuticals in Member States, the Agency is helping to build national capacities for the development and production of radioisotope products and radiopharmaceuticals. A CRP that concluded in 2009 focused on improved high current liquid and gas targets for cyclotron produced radioisotopes. Involving laboratories in 12 Member States, the CRP helped to develop methods for using high power targets to increase the purity and specific activity of radionuclides such as carbon-11, fluorine-18, nitrogen-13 and iodine-123, while ensuring the reliability of the production of radiopharmaceuticals derived from these radionuclides. Equally importantly, these advances have helped to minimize the radiation exposure of operators.

"To facilitate the availability of radiopharmaceuticals in Member States, the Agency is helping to build national capacities for the development and production of radioisotope products and radiopharmaceuticals."

Therapeutic radiopharmaceuticals are important in the treatment of cancers, particularly neuroendocrine tumours, for which there are very few other therapeutic options. A CRP on the development of lutetium-177 based

[1] Molybdenum-99 related information is covered in the Nuclear Science chapter.

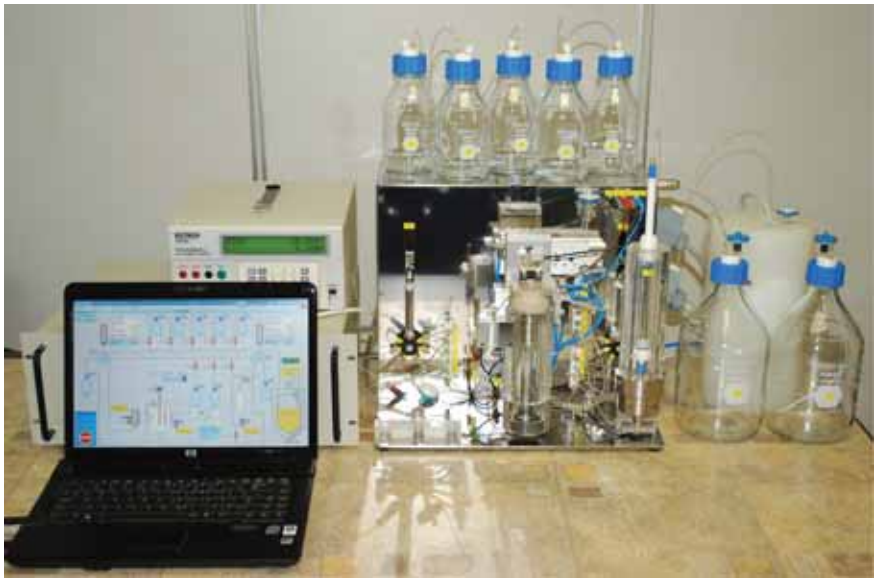


FIG. 1. 'Kamadhenu', a fully automated strontium-90/yttrium-90 electrochemical generator designed and built by Isotope Technology Dresden using technology developed through an Agency CRP. (Photograph courtesy of J. Comor.)

therapeutic radiopharmaceuticals for targeted therapy was completed in 2009. Lutetium-177 was produced in 11 of the 16 participating Member States, thereby enhancing the availability of this important radionuclide. The CRP also supported the wider application of the peptide based product ^{177}Lu-DOTATATE, and more than one thousand neuroendocrine cancer patients were treated with the ^{177}Lu-DOTATATE formulated by the CRP participants. A new therapeutic radiopharmaceutical, ^{177}Lu-EDTMP, was also developed, which is useful for bone pain palliation in cancer patients.

Another CRP resulted in the development of a strontium-90/yttrium-90 electrochemical generator. The technology was then used by a company to develop a fully automated generator called 'Kamadhenu' (Fig. 1), capable of providing up to 37 GBq (1 Ci) of high radionuclidic purity yttrium-90 each day. The first generator is being installed in Cuba under a technical cooperation project. The results of this work were published by the Agency in *Therapeutic Radionuclide Generators: ^{90}Sr/^{90}Y and ^{188}W/^{188}Re Generators* (Technical Reports Series No. 470).

Member State interest in the development and use of therapeutic radiopharmaceuticals labelled with beta emitting radionuclides is very high. A technical meeting to review the current status and challenges in the development, clinical trials and production of these therapeutic agents found lutetium-177 and yttrium-90 to be the most promising, with several countries having the capability to produce these radionuclides in large quantities and with high enough specific activities for regular clinical use.

"Member State interest in the development and use of therapeutic radiopharmaceuticals labelled with beta emitting radionuclides is very high."

The Agency continues to support countries in setting up cyclotron based radiopharmaceutical production facilities for manufacturing PET and reactor based radioisotope products for diagnosis and therapy. Under a technical cooperation project in Brazil, a second cyclotron centre in Recife (Fig. 2) began routine production of FDG, the main tracer used in PET imaging. Under the same project, two national workshops, each attended by more than 300 participants, were held to develop awareness among radiopharmacists and physicians about the production and clinical application of PET radiopharmaceuticals.

The Agency published *Cyclotron Produced Radionuclides: Guidelines for Setting Up a Facility* (Technical Reports Series No. 471) to assist institutions interested in setting up new cyclotron centres for SPECT and PET radiopharmaceuticals production according to good manufacturing practices. Further guidance was provided with the publication of *Cyclotron Produced Radionuclides: Physical Characteristics and Production Methods* (Technical Reports Series No. 468).

FIG. 2. A cyclotron beam extractor (left) and production hot cell (right) for manufacturing PET radionuclides in Recife, Brazil.

FIG. 3. Optimizing phosphoric acid production using radiotracer techniques at a plant in Tunisia.

Applications of Radiation Technology

Nanotechnology is a diverse and rapidly growing area where the advantages of radiation methods can be exploited to create and characterize new advanced materials. To support capacity building in this area, the Agency, together with the ICTP, and the Horia Hulubei National Institute of Physics and Nuclear Engineering and the Lucian Blaga University of Sibiu (both in Romania), organized a workshop on 'Trends in Nanoscience: Theory, Experiment, Technology' in Sibiu that was attended by more than 50 participants. And as part of a technical cooperation project for Europe, 20 participants were trained in radiation methods for the synthesis and characterization of materials at the nanoscale for applications ranging from medicine to electronics.

Radiotracer techniques are an important means of improving the efficiency of mineral processing, with potentially large energy and cost savings. Through an AFRA technical cooperation project, the Agency

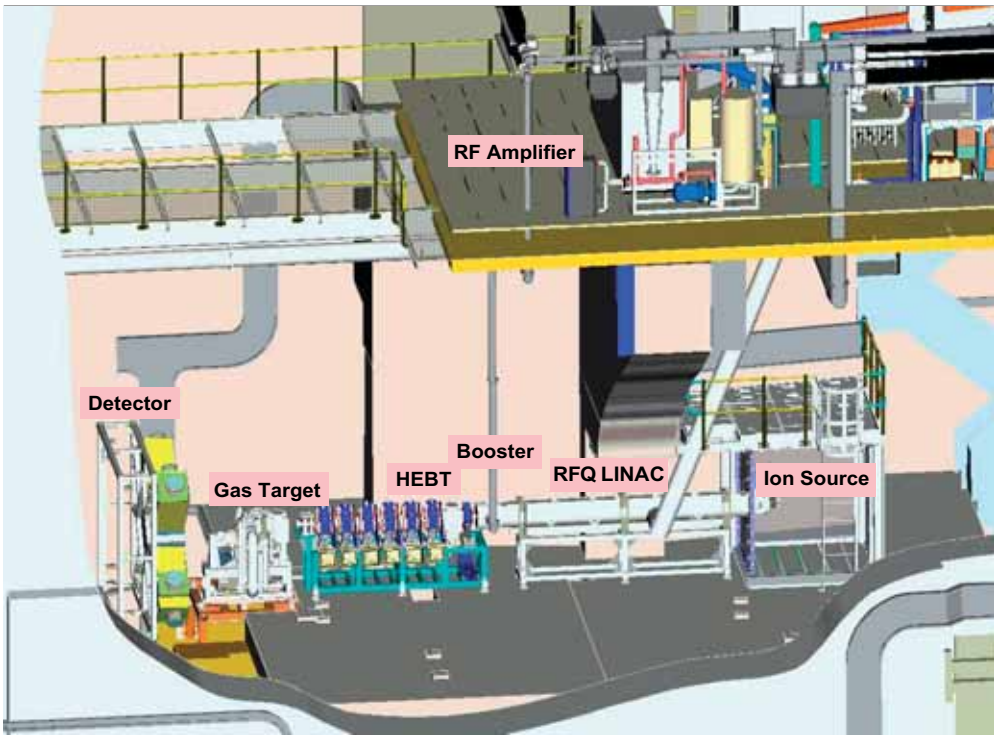


FIG. 4. An accelerator based neutron generator at Necsa (South Africa), previously used by the De Beers company to detect diamonds in kimberlite, is being adapted for use in other industrial applications such as locating and identifying organic and inorganic contaminants in wool bales.

supported Member States in applying radiotracer techniques for optimizing processing plants in the phosphate industry in Morocco and Tunisia (Fig. 3), and in the gold processing and cement production industries in Ghana. In one cement plant in Ghana, the radiotracer residence time distribution method was used to optimize the clinker grinding process, thereby increasing production by 10%. To support the training of personnel in radioisotope and radiation technology in industrial applications, the Agency published *Leak Detection in Heat Exchangers and Underground Pipelines Using Radiotracers* (Training Course Series No. 38).

An important application of neutron based techniques is the detection of illicit materials and explosives. In a CRP completed in 2009, participants demonstrated that the most successful technique for large container scanning is fast neutron radiography. As a result of work undertaken in this CRP, one fully assembled device became commercially available in 2009.

In a related technical meeting on fast neutron resonance radiography applications, participants reviewed the current status and challenges in the development of devices capable of producing elemental images (including in three dimensions) of medium to large sized objects with adequate spatial resolution for such applications as screening air cargo or unattended luggage, as well as for quality control in the textile industry (Fig. 4). Two prototype facilities, one a fixed device and the other portable, were developed.

Safety and Security

Incident and Emergency Preparedness and Response

Objective

To establish effective and compatible national, regional and international capabilities and arrangements for preparedness, early warning, timely response to actual, potential or perceived nuclear or radiological incidents and emergencies independent of whether the incident or emergency arises from an accident, negligence or a deliberate act, and for sharing official, technical and public information among Member States and relevant international organizations.

Emergency Preparedness and Response around the World in 2009

The ability to adequately respond to a nuclear or radiological emergency remains a central element of international nuclear safety and radiation protection efforts. Although further capacity building efforts in this area are required, experience showed that those countries involved in a response coordinated by the Agency significantly improved their emergency response capabilities. Subsequent events were reported in a timely manner and the response was conducted independently and successfully. If the events required international assistance, these countries knew well the procedures to activate an international response.

Capacity Building and Assistance to Member States

The evaluation of Member State self-assessments of national emergency preparedness and response capabilities underlines the need to continue efforts to strengthen them. Agency assistance includes the organization, on request, of Emergency Preparedness Review (EPREV) missions. In 2009, the Agency conducted two such missions. In addition, eight missions were carried out to assist in developing and strengthening different aspects of national emergency preparedness and response systems. Three Integrated Regulatory Review Service (IRRS) missions were conducted to review emergency preparedness and response aspects of national regulatory systems.

"The Agency organized 25 training courses at the regional and national levels on various aspects of emergency preparedness and response."

The Agency organized 25 training courses at the regional and national levels on various aspects of emergency preparedness and response. In addition, three Agency Fellows were

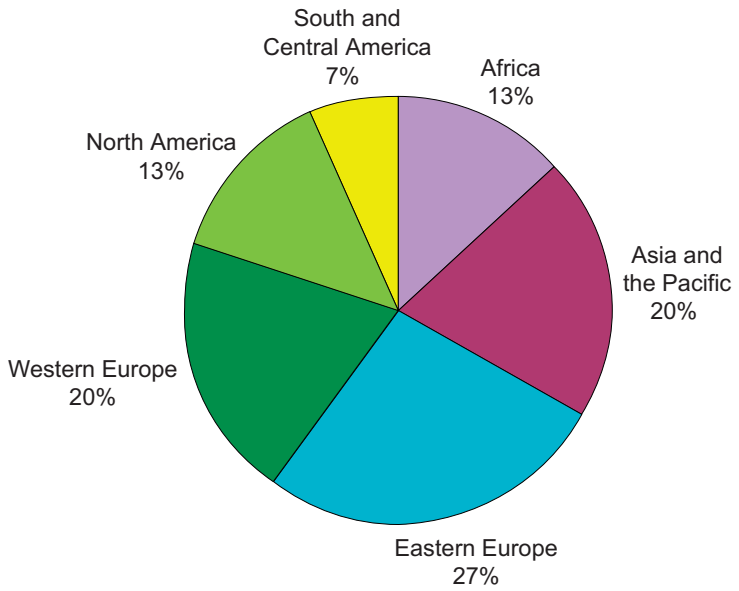


FIG. 1. Distribution by region of Member State capabilities registered with RANET.

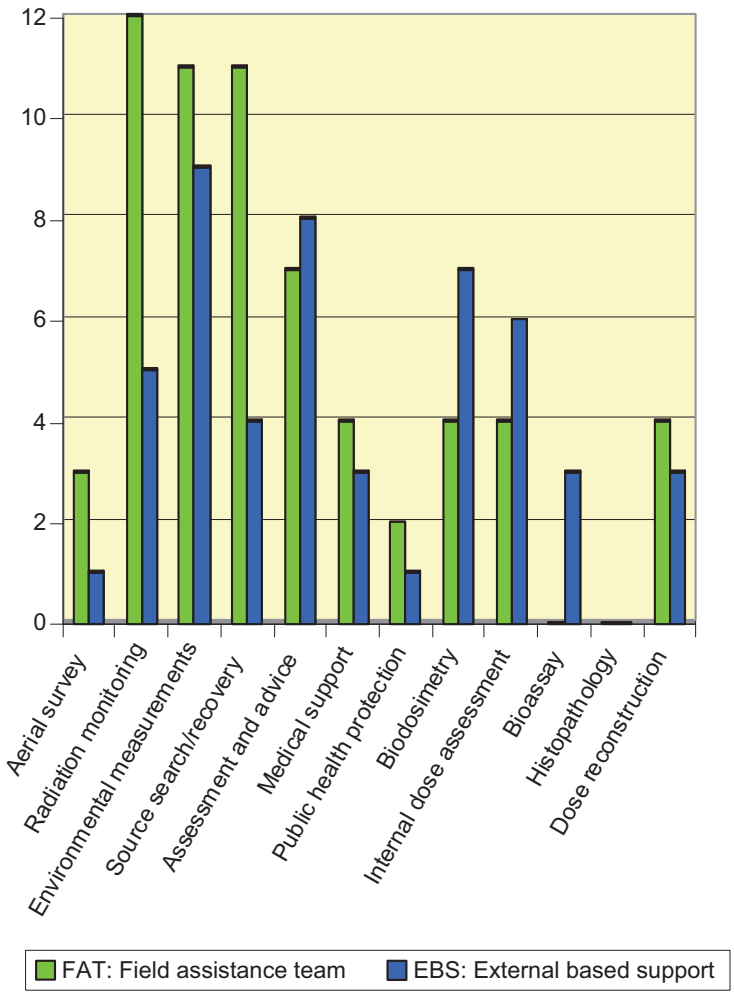


FIG. 2. Member State capabilities registered with RANET.

trained as part of technical cooperation projects, and awareness briefings on emergency preparedness and response were given to 18 delegations from Member States.

By the end of 2009, 16 Member States had registered a number of assistance capabilities with the Agency's Response Assistance Network (RANET) (Fig. 1). While this is an improvement over the previous year and while more Member States have pledged to register with the network, RANET requires significantly greater commitment by Member States in order to serve as an effective and reliable assistance tool. In addition, certain capabilities are yet to be registered (for example, histopathology), as shown in Fig. 2.

An international exercise in 2009 tested current capabilities for the safe and expeditious transport of samples for biological dosimetry assessment. Known as 'ShipEx-1', this exercise was a test of RANET and international cooperation. Blood samples were shipped from the Peruvian Institute of Nuclear Energy, in Peru, to participating laboratories in 13 countries within the Latin American Biological Dosimetry Network and the IAEA Response Assistance Network. Conclusions from the exercise are expected to contribute to the timely and safe shipment of biological samples in international assistance missions.

Event Response

Through various reporting mechanisms, the Agency was informed of 211 safety related events involving, or suspected of involving, ionizing radiation. Most of these events were found to have no safety significance and/or no radiological impact on people or the environment. In 22 cases, the Agency authenticated and verified information, and also provided information or assistance to the requesting party.

Following a request for assistance from Ecuador, the Agency organized a field mission to provide medical advice, and later treatment, in a case related to overexposure due to the handling of an

iridium-192 industrial radiography source. France provided the medical treatment to the exposed person, who recovered after several months of intense and specialized medical therapy.

Unified Reporting System

In response to a request by the Agency's General Conference for a review of the mechanisms for reporting incidents and emergencies, the Secretariat is developing a unified reporting system that will replace the Agency's current Early Notification and Assistance Conventions (ENAC) web site and the Nuclear Events Web-based System (*http://www-news.iaea.org/news/*). A preview of the system was made available for test use by national authorities during the year. The system is expected to go into operation in 2010.

Key Emergency Preparedness and Response Publications

In 2009, the Agency undertook revision of a publication issued earlier, *Cytogenetic Analysis for Radiation Dose Assessment* (Technical Reports Series No. 405). The revision took account of the lessons learned from application of this manual in past emergencies and during exercises, as well as new methods and techniques developed over the last few years. A *First Responder's Toolkit* was published, containing manuals on responding to radiological emergencies and CD-ROMs for training courses and e-learning. An *Emergency Planner's Toolkit* was also issued containing two manuals: *Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency — 2003* (EPR-Method) and *Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency — 2005* (EPR-Exercises).

Implementation began in 2009 of the emergency preparedness and response part of the Norwegian funded Safe Nuclear Energy Project, entitled 'Regional Excellence Programme Romania'. Draft procedures for response to emergencies at research reactors of TRIGA design were developed based on the methodology used in generic procedures for response to emergencies at research reactors.

Safety of Nuclear Installations

Objective

To enable Member States to ensure appropriate levels of safety during the design, construction and operations throughout their total life cycle of all types of nuclear installations through the availability of a set of safety standards and assistance in their applications. To enable Member States seeking to embark on nuclear power production programmes to develop appropriate safety infrastructures through the availability of Agency guidance and assistance.

Regulatory Safety Services

The Agency continued to promote and support the establishment of a global safety regulatory regime through facilitating international peer reviews of Member State regulatory bodies. In 2009, full scope Integrated Regulatory Review Service (IRRS) missions were carried out in Canada and the Russian Federation, and follow-up missions visited France and the United Kingdom. These missions identified demonstrable improvements as a result of the earlier IRRS missions.

Nuclear Safety Infrastructure for Countries Embarking on Nuclear Power Programmes

In addition to supporting countries with developed nuclear power programmes, significant efforts were made during the year to assist the increasing number of countries embarking on nuclear power projects. Strengthening regulatory systems and helping build the necessary infrastructure were major areas of focus at the national, regional and international levels, mainly through training courses and workshops, and also through the formulation of guidelines for competency self-assessment. In addition, the Agency continued to support the development of knowledge sharing through networking activities.

A key activity was the completion of a Safety Guide entitled *Establishing the Safety Infrastructure for a Nuclear Power Programme*. The publication provides a 'road map' of safety related actions to be taken in the first three phases of the development of a nuclear power programme in order to achieve a high level of safety during the lifetime of the nuclear power plant.

International Nuclear Safety Centre

To support regulators and operators in Member States, and to provide a platform for promoting harmonization, sustainability and knowledge management, the Agency established the International Nuclear Safety Centre (INSaC) (Fig. 1). Through the Centre, the Agency will further integrate, unify and expand the range and capacity building efforts of its various safety initiatives, with the Agency's safety standards serving as a catalyst in promoting a globally harmonized approach to nuclear safety. In 2009, the Centre's activities in safety assessment education and training resulted in the development of an analytical training simulator and the implementation of a pilot course on the essential level of knowledge required.

"Six different reactor safety cases were reviewed, focusing on conceptual as well as mature designs."

A Generic Reactor Safety Review (GRSR) framework was developed during the year to provide Member States with early appraisals of reactors. The Agency's safety standards form the basis for individual evaluations. Six different reactor safety cases were reviewed, focusing on conceptual as well as mature designs. In 2009, a review of the APR-1400 advanced reactor in the Republic of Korea was completed. In addition, two International Probabilistic Safety Assessment Review Team (IPSART) missions were carried out. One examined the design PSA of the Belene WWER-1000 reactor in Bulgaria and the second mission addressed the Level-1 Internal Events PSA for the Chashma Unit 1 nuclear power plant in Pakistan.

Operational Safety Services

The Agency's operational safety services — and the Operational Safety Review Team (OSART) programme in particular — continued to be requested by Member States. Six OSART missions were undertaken in China, France, Japan, Spain, Sweden and Ukraine. Six OSART follow-up missions to Belgium, France, Germany, Sweden

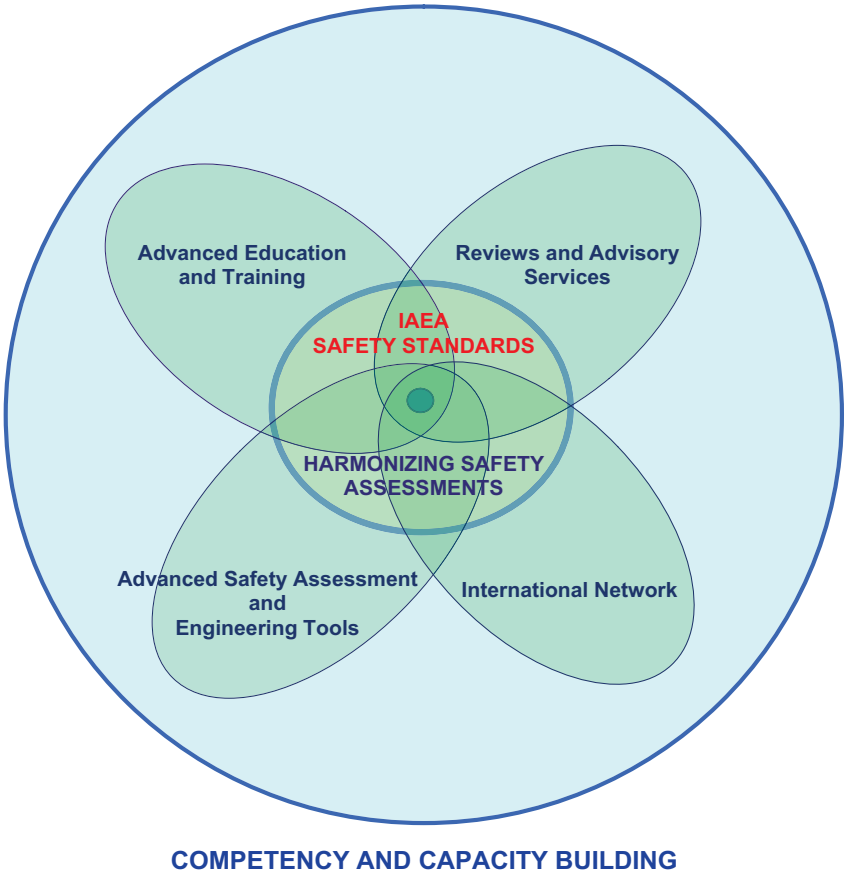


FIG. 1. The role of INSaC and how it fits in the wider context of global nuclear safety and security.

and Ukraine, and a follow-up Peer Review of Operational Safety Performance Experience (PROSPER) mission to Brazil demonstrated successful resolution of issues identified during the earlier missions. New review modules in the areas of long term operation, transition from operation to decommissioning, applications of probabilistic safety assessment and accident management are now available. The capability to perform an OSART mission at a plant in the construction phase and at a corporate organization with multiple nuclear power plants is being developed. In addition, a Safety Culture Assessment Review Team (SCART) follow-up review in Spain, a SCART mission to Mexico and a safety service for Safety Aspects of Long Term Operation of Water Moderated Reactors Peer Review Service (SALTO) in the Netherlands were conducted.

Operating Experience

The Incident Reporting System (IRS) is an international system jointly operated by the Agency and the OECD/NEA and has more than 3600 reports in its database. In 2009, recommendations made in IRS topical studies and with regard to selected events contained in the IRS database were reviewed to confirm that lessons learned from significant events have been mostly covered by the Agency's safety standards. In addition, an action plan was developed by the Agency to improve the international operating experience processes.

Application of the Code of Conduct on the Safety of Research Reactors

The Agency continued to encourage Member States to apply the Code of Conduct and to make greater use of the safety standards. To support this effort, the Agency held several technical meetings in 2009 on the safety of research reactors, on the Incident Reporting System for Research Reactors, and on ageing management, modernization and refurbishment. Training activities included a regional workshop for Africa on safety analysis, preparation and review of safety documents, and two regional workshops for Asia on operational radiation protection and periodic safety review. The Agency also published a Safety Guide on radiation protection and waste management; progress was

made in the development of another four guides, which will provide additional guidance on the application of the Code.

Enhancing Networking and Sharing of Expertise and Operating Experience

During 2009, the Agency established a web based Research Reactor Information Network to further enhance the sharing of knowledge, experience and information on good safety practices. The Agency also facilitated the establishment of a Regional Advisory Safety Committee for Africa (RASCA) to share expertise and address important safety issues for research reactors in this region.

The Agency organized two technical meetings for the national coordinators of the Incident Reporting System for Research Reactors (IRSRR) and fuel cycle facilities (FINAS). Currently, 51 Member States participate in the IRSRR. Operational as a web based system in 2008, FINAS now covers 80% of the fuel cycle facilities worldwide.

International Seismic Safety Centre

The main objective of the Agency's International Seismic Safety Centre (ISSC) is to revise current and develop new safety guides in the areas of: assessment against seismic, volcanic, meteorological and hydrological hazards; seismic re-evaluation of existing installations; and criteria for site selection. For example, a safety report was prepared outlining the criteria and methodologies for pre-earthquake planning and post-earthquake response actions following seismic events affecting nuclear power plants. A range of activities was carried out through the extrabudgetary projects on seismic and tsunami safety. In addition, development began of an External Events Notification System for earthquakes and tsunamis, in cooperation with the US Nuclear Regulatory Commission, the US Geological Survey and the US National Oceanic and Atmospheric Administration. Finally, the Agency conducted safety review missions to six Member States to assist them in selecting their first nuclear power plant site.

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Radiation and Transport Safety

Objective

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

New Requirements for Safe Transport

A revised version of the Agency's transport regulations was published in 2009. These safety requirements are increasingly being implemented internationally through coordination with other United Nations agencies and through the active involvement of Member States and industry in their development and application. While denials and delays of shipment of radioactive material continue to occur in all parts of the world, an inter-agency database, developed as part of an action plan to address denials of shipment, is helping to identify trends in order to focus international actions on root causes and responses.

"A revised version of the Agency's transport regulations was published in 2009."

In 2009, the Agency participated in discussions held by a group of coastal and shipping States, with a view to maintaining dialogue and consultation aimed at improving communication and mutual understanding, and building confidence in relation to the safe maritime transport of radioactive material. In a related activity, a concept document was initiated describing the necessary response of coastal States to maritime emergencies involving radioactive material.

Improving Radiation Safety Infrastructure

As part of its efforts to improve regulatory infrastructure for radiation safety, the Agency undertook 24 missions to Member States. In addition, it launched a new web based platform called RASIMS (the Radiation Safety Information Management System (*http://rasims.iaea.org*)) to provide Member States with a clearer picture of the status of national radiation safety infrastructures (Fig. 1). RASIMS is also intended to help identify country and region specific needs and facilitate prioritization of resources to enhance safety.

Improving the Control of Radioactive Sources

There is a possibility of radioactive sources falling out of regulatory control at the end of

FIG. 1. The RASIMS web page for collecting and evaluating information on national radiation safety infrastructures.

their useful lives. This problem of orphan sources is exacerbated by the lack of suitable disposal facilities. Long term management strategies for these disused radioactive sources were discussed at a meeting in Vienna to share experience in implementing the Code of Conduct on the Safety and Security of Radioactive Sources, at a meeting of senior regulators at the General Conference, and at an international conference on 'Effective Nuclear Regulatory Systems', held in December in Cape Town. From these discussions, it was concluded that the management of disused sources is the weakest point in the chain of control over radioactive sources, and that one option for remedying the situation would be to facilitate the exchange of experience and information on the implementation of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and to strengthen the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources.

Education and Training in Radiation, Transport and Waste Safety

In 2001, a strategic approach to education and training in radiation protection and waste safety was endorsed by General Conference resolution GC(45)/RES/10C. It outlined the vision, objectives and outcomes to be achieved at the end of ten years. In view of the end of the implementation period, the Secretariat, in July 2009, carried out an analysis to identify current strengths and areas where activities need to be continued or improved.

The analysis pointed out that the African, Asia–Pacific, European and Latin American regions all now have at least one operational regional training centre for the provision of training according to the Agency's safety standards and in response to regional and national needs. In addition, a comprehensive portfolio of training materials is available, as are mechanisms for collecting and collating the data and information needed to determine education and training needs in these regions (e.g. the Education and Training Appraisal service).

Areas for improvement were also identified, such as the need to strengthen the train the trainers approach and to consolidate the activities of the regional training centres through long term agreements. Detailed guidance was also required on the development of a national education and training strategy in radiation protection and safety.

Radon in Dwellings and Workplaces: A New Approach in the International Basic Safety Standards

The *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (the BSS) are currently being updated. During 2009, drafts of the revised BSS were discussed by the Agency's four Safety Standards Committees, and agreement was reached on the text to be provided to Member States for comment. A key technical issue addressed was the control of exposure to radon, a naturally occurring radioactive gas, in both dwellings and workplaces. At a technical meeting held on this issue in Vienna in December, the participants recommended that exposure to radon in workplaces where the exposure is directly related to the work should be regarded as occupational exposure. All other exposure in workplaces and in dwellings should be controlled through the use of reference levels and optimized radiation protection measures. Different reference level values were recommended to reflect differences in the numbers of hours typically spent at home and at work.

"During 2009, drafts of the revised BSS were discussed by the Agency's four Safety Standards Committees, and agreement was reached on the text to be provided to Member States for comment."

Investment in Training for the Protection of Patients

Current studies show large differences in exposure for the same medical examinations, indicating a significant potential for dose reduction and optimization of medical exposures. The Agency provides theoretical and practical training, as well as training materials, for health professionals on the radiation protection of patients (Fig. 2). It also provides guidance to end users through a dedicated web site (*http://rpop.iaea.org/RPoP/RPoP/Content/index.htm*), which last year generated more than half a million hits per month.

Radiation Protection of Workers: A New Information System

Detailed operational and feedback information is lacking on occupational exposures in the medical, research and industrial areas, where radiation uses

FIG. 2. Practical training in dose measurement using computed tomography at a regional training course in Nicaragua (left); and Agency training materials in Spanish on radiation protection of patients (right).

can lead to significant occupational exposures, both in normal operations and in accident situations. To address these gaps, the Agency developed the Information System on Occupational Exposure in the Medical, Industrial and Research Areas (ISEMIR). The first working group of ISEMIR focused on interventional cardiology. In addition, questionnaires sent to regulatory bodies and interventional cardiologists showed that information on occupational exposure in interventional cardiology was limited and of poor quality, that radiation protection habits in cardiac catheterization laboratories were well short of desired levels, and that regulatory requirements for radiation protection training needed improvement. A pilot trial began in December aimed at developing a system for regular collection of occupational exposure data.

The 2009 ISOE International ALARA Symposium

As part of its responsibilities as the technical centre for the Information System on Occupational Exposure (ISOE), the Agency hosted the 2009 ISOE International ALARA Symposium. Co-sponsored by the Agency and the OECD/NEA, the ISOE provides a forum for radiation protection professionals from both nuclear power plant utilities and regulatory authorities to share dose reduction information and operational experience and to coordinate international cooperative projects to optimize radiological protection of workers at nuclear power plants. Papers and presentations from the symposium are available on-line (*http://www.isoe-network.net/*).

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.

Support for International Conventions

The management of spent fuel and radioactive waste is a complex undertaking requiring concerted action by States and international bodies. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) had 53 Contracting Parties at the end of 2009. The third Review Meeting of the Contracting Parties took place in May. The meeting emphasized policy and technical issues on the disposal of waste, decommissioning, disused sealed sources, past practices, knowledge management, stakeholder involvement and international cooperation. Improvements for future Review Meetings were also identified.

In response to a request by the Contracting Parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention), the Agency proposed a concept for radiological protection of the marine environment that includes humans and marine flora and fauna.

"The management of spent fuel and radioactive waste is a complex undertaking requiring concerted action by States and international bodies."

Review Services

The Agency expanded its review services in 2009 when it used its recently published safety requirements on predisposal management of radioactive waste (IAEA Safety Standards Series No. GSR Part 5) in a large scale review in Ukraine of all operating nuclear power plants and their waste related facilities. Other work carried out as part of these services included a review of the Central Organisation for Radioactive Waste (COVRA) facilities that handle and store all radioactive waste in the Netherlands (Fig. 1). A particular objective of the review was to provide an external evaluation of the compliance of COVRA's treatment and storage facilities with the Agency's safety standards.

The Agency conducted a review of the technical documentation for a proposed near surface disposal facility for low level waste (LLW) at Saligny, in Romania. This was done to support a submission for a siting licence application by the national radioactive waste management agency of Romania to the regulatory authority.

FIG. 1. A building for the interim storage of high level radioactive waste and spent fuel at the COVRA site, the Netherlands, which is designed to provide safe storage for at least 100 years.

A review was also performed of work undertaken by the Spanish Research Centre for Energy, Environment and Technology (CIEMAT) for the radiological characterization of the soil in the area of Palomares, Spain, where United States Air Force planes carrying nuclear weapons crashed in 1966 and the unexploded nuclear weapons contaminated the environment.

International Chernobyl Research and Information Network

In April, the International Chernobyl Research and Information Network (ICRIN) was launched as a joint initiative of the Agency, UNDP, UNICEF and WHO. Funded by the United Nations Trust Fund for Human Security, this three year initiative is designed to provide information and advice to affected communities in Belarus, the Russian Federation and Ukraine through education and training. Workshops were also arranged in Kiev and Moscow for improving dialogue between scientists, the public and the media.

Licensing Disposal Facilities for Radioactive Waste

During the General Conference in September 2009, the Swedish Radiation Safety Authority and the Agency organized a round-table discussion on the licensing of geological repositories. The participants concluded that the good progress achieved in geological disposal was the result of careful work in a number of countries that is focused on demonstrating a high level of safety in an open and transparent manner, with firm political commitment. To address some of the issues that have arisen during the development of safety standards for radioactive waste disposal, the Agency convened an international workshop entitled 'Demonstrating the Safety and Licensing of Radioactive Waste Disposal' in Cape Town in December. More than 90 international experts discussed developments in international standards and the activities of the Agency's intercomparison and harmonization projects on preparing the safety case for disposal facilities. The results of the workshop were subsequently presented at an international conference on 'Effective Nuclear Regulatory Systems: Further Enhancing the Global Nuclear Safety and Security Regime', convened by the Agency in Cape Town in December.

"During the General Conference in September 2009, the Swedish Radiation Safety Authority and the Agency organized a round-table discussion on the licensing of geological repositories."

DISPONET

Following the growing demand from Member States for assistance in the disposal of LLW, an international disposal network (DISPONET) was established by the Agency in April to facilitate the sharing of information in this area and the coordination of support to Member States with less advanced programmes. A workshop on post-operational environmental monitoring and surveillance of disposal facilities for radioactive waste held in September led to recommendations regarding termination of control, understanding of facility performance, early planning for monitoring and surveillance, and knowledge preservation.

Long Term Management of Disused Sealed Sources

Discussions at a workshop on 'Sustainable Management of Disused Sealed Sources — Working Towards Disposal', organized in Bangkok by the Agency and the Asian Nuclear Safety Network, centred on international cooperation, national policies and strategies for source management, storage and disposal, and associated regulatory aspects to strengthen the safety and security of disused sealed radioactive sources. The Borehole Disposal of Sealed Radioactive Sources (BOSS) system was recognized as a mature concept ready for implementation in candidate Member States, in particular those where disused sources prevail in radioactive waste inventories.

Source Recovery Operations

The Agency assisted seven Member States in managing a total of 597 radioactive sources, of which 54 were classified as high activity sources. Most of the sources were conditioned and stored in the centralized storage facilities of the countries concerned. Of particular significance was the deployment of a mobile hot cell for operations in Sudan and the United Republic of Tanzania (Fig. 2). This mobile facility is used in countries that do not have the required infrastructure to condition high activity sources by themselves.

FIG. 2. Mobile hot cell deployed in the United Republic of Tanzania.

Decommissioning of Facilities Using Radioactive Material

Within the project on the Use of Safety Assessment in Planning and Implementation of Decommissioning of Facilities Using Radioactive Material, working groups on decommissioning planning, conduct and termination concluded their activities in 2009 (Fig. 3). At the same time, working groups on the implementation of the safety assessment results and review of the implementation, modifications and evolutions of safety assessment results were launched.

International Decommissioning Network and the Research Reactor Decommissioning Demonstration Project

The Agency's International Decommissioning Network (IDN) and the Research Reactor Decommissioning Demonstration Project (R2D2P) support countries with small scale programmes for the decommissioning of research reactors. A key objective is to provide practical examples and demonstration exercises. Workshops held in 2009 included a general training course on decommissioning at the Argonne National Laboratory, USA, a hands-on small reactor dismantling workshop at the Australian Nuclear Science and Technology Organisation in Sydney, and a group visit to the Dounreay and Sellafield nuclear installations in the United Kingdom for senior managers on decommissioning of sites with multiple facilities. The workshops also covered decommissioning cost estimation based on a simplified costing methodology developed for operators of smaller facilities, as well as characterization, dismantling and decontamination technologies, including materials management and clearance (Fig. 4).

FIG. 3. Remotely operated liner removal at the SILOE research reactor in Grenoble, France.

FIG. 4. Collecting data for the decommissioning cost estimate exercise at the Philippine Research Reactor PRR-1, Manila.

Remediation of Land Contaminated by Radioactive Material

One of the main topics at an international conference held in May in Astana, Kazakhstan, was uranium legacy issues in Central Asia. The primary objectives of the conference were to facilitate international cooperation within the region, and to promote the application of international safety standards and best practices. Recommendations from the conference included: strengthening of regulatory frameworks and capacity; development of training and educational programmes that support remediation activities; better coordination of international support; and establishment of an international network of regulators working in similar areas for sharing ideas and experience.

Central Asian Initiative on Remediation of Legacy Sites for Uranium Production

In response to requests for technical assistance from the Central Asian republics of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, and to address issues of legacy uranium production sites (Fig. 5), the Agency initiated several projects that include workshops and scientific visits to learn from similar projects in other countries. Sampling and analytical equipment was upgraded, and management and laboratory staff were trained. Experts worked with the four Member States to evaluate their monitoring and remediation activities and to assess the status and radiological impact of residues at the former uranium mining

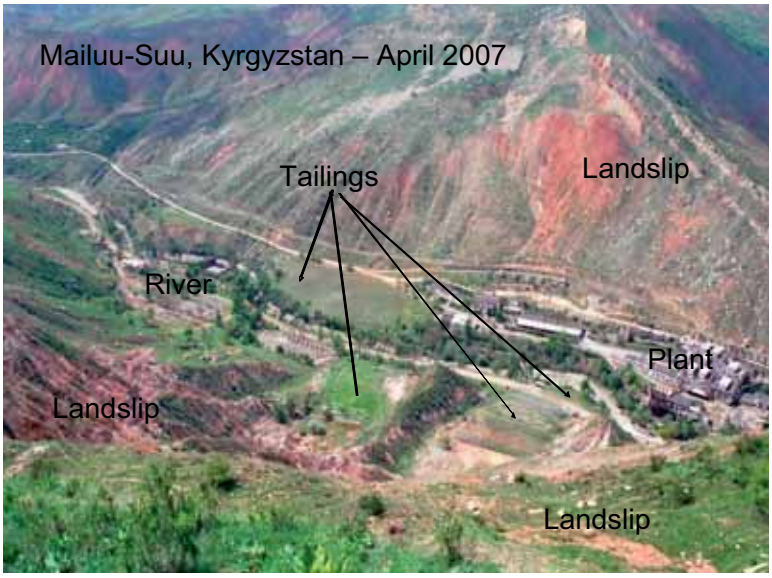

FIG. 5. The Mailuu-Suu site in Kyrgyzstan. The tailings piles are in the centre of the photograph and the potential landslips are on the left (red soil) and across the river on the hillside.

FIG. 6. The defuelling of a damaged nuclear submarine involved removal of the reactor core with liquid metal cooling.

and milling sites. The Agency provided advice on the development of a regulatory framework and environmental monitoring programmes, and improvements to the national legislation were identified. A number of other international organizations are also active in the region with related projects (for example, the EBRD, the EuropeAid Co-operation Office, the OSCE, UNDP and the World Bank). Better integration of these efforts was sought through a series of coordination meetings. In 2009, the Agency also developed a report on uranium legacy sites in Central Asia to provide a technical basis for future planning by national and international organizations.

The Contact Expert Group

The Agency's Contact Expert Group (CEG) dealt with a wide range of nuclear legacy issues in the Russian Federation in 2009, including the defuelling of a damaged nuclear submarine (Fig. 6), the removal of all undamaged submarine spent fuel from the former naval base at Gremikha and the transfer of two fuelled nuclear submarines from Kamchatka to Primorski Krai. Another achievement was the removal of all radioisotope thermoelectric generators from the Murmansk and Arkhangelsk regions and from the country's Pacific Coast. Also in 2009, the CEG held a workshop on safety and licensing issues in implementing the legacy programme in the Russian Federation, giving special attention to ensuring safe operation of the Mayak plant, where the legacy spent fuel is being reprocessed.

Nuclear Security

Objective

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

Nuclear Security Plan and Financial Resources

The *IAEA Nuclear Security Plan for 2010–2013* was approved by the Board of Governors in September 2009 (Fig. 1). The new plan is built on lessons learned from the implementation of previous plans and is designed to respond to priorities identified by the Secretariat in conjunction with Member States, with particular regard to changes in the nuclear security situation since the introduction of the previous plan and recommendations generated in external evaluations. It seeks to move from ad hoc interventions to providing long term, sustained improvements in nuclear security. The plan envisages a budget of approximately €23 million per year, the majority of which comes from the Nuclear Security Fund (NSF).

In 2009, the Board of Governors approved an increase in the 2010 Regular Budget for the Agency's nuclear security work. This increase will support the establishment of an effective nuclear security information platform, the development and publication of nuclear security recommendations and guidance, the provision to States, upon request, of services for nuclear security assessment and evaluation, and the development of human resources. Regular Budget funding will be used specifically to provide for the necessary staffing and to fund the participation of senior experts from Member States in Agency nuclear security activities. Notwithstanding the increase, the Agency will continue to rely on extrabudgetary funding from the NSF to implement the majority of the new plan.

"In 2009, the Board of Governors approved an increase in the 2010 Regular Budget for the Agency's nuclear security work."

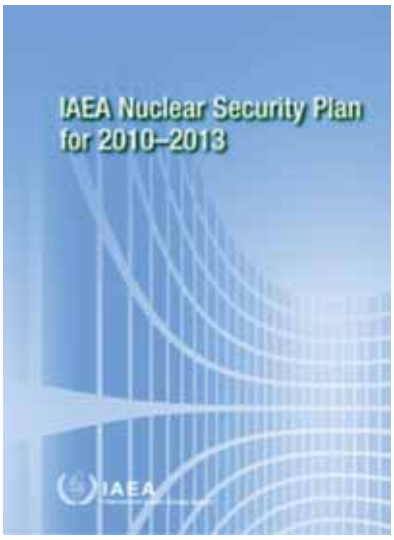

FIG. 1. The IAEA Nuclear Security Plan for 2010–2013.

Nuclear Security Assessments

Nuclear security advisory missions continued to be key tools to assess the needs of States. During 2009, the Agency conducted 14 such missions. More than half dealt with physical protection and with legal, regulatory and practical measures for controlling nuclear and other radioactive material. Several additional missions reviewed measures for the detection of illicit nuclear trafficking and the response to nuclear security incidents. The Agency also conducted a number of technical visits, which addressed security needs at locations including border crossings, medical facilities, scientific institutes and industrial sites.

The Agency develops Integrated Nuclear Security Support Plans (INSSPs) on behalf of States to facilitate the comprehensive implementation of nuclear security improvements. Two States approved INSSPs during the year, bringing the total number of approved INSSPs to 18. In addition, meetings were held with ten other States to finalize their INSSPs.

International Symposium on Nuclear Security

The Agency convened an international symposium on nuclear security issues in March–April in Vienna which attracted more than 500 participants from 76 States. The symposium noted the need to: strengthen legal elements of the international nuclear security framework; continue to harmonize efforts in the areas of

security, safeguards and safety; and promote participation in initiatives for the exchange of nuclear security information, particularly with regard to lessons learned. The symposium encouraged the strengthening of national efforts to secure nuclear and other radioactive material, associated facilities and transports, which should be complemented by increased efforts at the global level. Specific proposals included the production of model elements of legal frameworks, the extension of threat assessment to sensitive technologies, the improvement of reporting on security incidents, and the creation of nuclear forensic reference data. The Secretariat took account of the symposium findings and specific proposals in preparing the *IAEA Nuclear Security Plan for 2010–2013*.

Capacity Building in Member States

The Agency completed its largest project to date, focused on capacity building in States for the physical protection of facilities. Funded by Canada, the project involved the upgrading of the nuclear security training facilities at the Interdepartmental Special Training Centre (ISTC) in Obninsk, the Russian Federation (Fig. 2). Completed upgrades to ISTC's technical infrastructure in 2006 — including the equipping of a training auditorium — supported indoor nuclear security training. Subsequently, two training laboratories were furnished with equipment for a central and a local alarm station. Three outdoor training areas were also constructed, featuring a full scale model of a nuclear power plant perimeter fencing area, a range of fences used at power plants, and equipment for studying separate models of detection sensors. The ISTC's new facilities were inaugurated in May 2009, with the first international training courses taking place there in October and November 2009.

"The Agency completed its largest project to date focused on capacity building in States for the physical protection of facilities."

Human Resource Development

The Agency continued to assist States in the area of nuclear security human resource development. In 2009, it conducted 51 training events on all aspects of nuclear security, reaching 1275 people from 120 countries (Fig. 3).

The third and fourth Agency assisted Master's programmes in nuclear security commenced in 2009. These are designed to underpin nuclear security improvements through the development of core technical skills. Supported by the Agency, the Tomsk Polytechnic University launched a Master of Science course in nuclear security, the curriculum of which is based on the Agency's guidance. The Naif Arab University for Security Sciences (NAUSS) in Saudi Arabia offered a course entitled 'Introduction to Nuclear Security' as a component of its existing Master of Science Programme in Security. NAUSS has requested the Agency's support in developing teaching materials and providing guest lecturers to implement the courses.

Guidance on Nuclear Security for Member States

The tenth and eleventh publications in the IAEA Nuclear Security Series were issued during the year.

FIG. 2. The Interdepartmental Special Training Centre in Obninsk, the Russian Federation.

FIG. 3. Participants at an Agency regional training course for trainers in radiation detection techniques, Accra, Ghana, April 2009.

The *Implementing Guide — Development, Use and Maintenance of the Design Basis Threat* is intended for decision makers from organizations involved in establishing measures for protecting nuclear material against potential internal and/or external adversaries. The other *Implementing Guide — Security of Radioactive Sources* includes recommended measures for preventing, detecting and responding to malicious acts involving radioactive sources. It also provides guidance on preventing the loss of control of sources.

Illicit Trafficking Database

The Agency's Illicit Trafficking Database (ITDB) contains information on illicit trafficking and other unauthorized activities and events from 1993 onward. Membership in the ITDB programme grew by five States, of which four were African, bringing the number of participating States to 109. By 31 December 2009, States had reported, or otherwise confirmed, a total of 1801 incidents to the database; 239 incidents were reported by States in 2009, of which 124 had occurred during the year (others having occurred earlier). Of those that had occurred during the year, nine incidents involved illegal possession of and attempts to sell nuclear material or radioactive sources. In 26 cases, thefts or losses of radioactive sources were reported. The remaining 89 incidents involved discoveries of uncontrolled material, unauthorized disposals, and inadvertent unauthorized shipments and storage of nuclear material, radioactive sources and radioactively contaminated material. Additional incidents included one involving both HEU and LEU, one incident involving both depleted uranium and thorium, one involving both natural uranium and thorium, and two incidents involving uranium in which the information reported for use in the database was not sufficient to determine the category of material involved. Three of these incidents involved theft, six involved attempted sales, five involved unauthorized possession of nuclear material, 11 involved unauthorized disposal, five involved discovery, four involved unauthorized or undeclared storage, and two involved either missing or lost materials.

Information provided to the ITDB demonstrates that illicit trafficking in both nuclear material and radioactive sources is continuing, pointing to vulnerabilities in protection, accounting and detection systems, and in regulatory infrastructures. It provides evidence for the need for further improvement of measures to control and secure nuclear and other radioactive material, wherever it is used or located, and of capabilities to detect illicit trafficking and other unauthorized acts involving such material.

"Information provided to the ITDB demonstrates that illicit trafficking in both nuclear material and radioactive sources is continuing, pointing to vulnerabilities in protection, accounting and detection systems, and in regulatory infrastructures."

Nuclear Security Equipment Laboratory

An essential element of the Agency's nuclear security assistance to States is the provision of

equipment for detecting and responding to the unauthorized movement of nuclear and other radioactive material, including illicit trafficking. Through the Nuclear Security Equipment Laboratory, the Agency provided to States 471 instruments for radiation detection, including remote monitoring systems and radiation portal monitors.

Risk Reduction

The Agency continued to assist States in establishing systems and technical measures for protecting against malicious access to nuclear material, and the associated facilities and transports, as well as to radioactive material and waste. In more than a dozen countries, the Agency completed upgrades to facilities housing nuclear material or radioactive sources.

In 2009, the Agency was an implementing partner in operations to repatriate to the Russian Federation more than 225 kg of spent HEU fuel from Kazakhstan, the Libyan Arab Jamahiriya, Poland and Romania, as well as 18.9 kg of fresh HEU fuel from Hungary. In addition, 597 vulnerable radioactive sources, of which 54 were Category 1 or 2 sources, were recovered in seven countries.

Verification

Safeguards

Objective

To provide independent, impartial, timely and credible safeguards conclusions, and assurance that States are abiding by their nuclear non-proliferation commitments; and to contribute, as appropriate, to verifying nuclear arms control and reduction agreements.

Safeguards Conclusions for 2009

At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force, based upon the evaluation of all information available to it for that year. This is a continuous, iterative process that involves the integration and assessment of all of the information available to the Agency about that State's nuclear activities and plans. Information is at the heart of modern verification; in fact, the Agency frequently refers to its work as being 'information driven' safeguards. Information driven safeguards are safeguards whose planning, conduct and evaluation are based on an ongoing analysis of all safeguards relevant information available to the Agency about a State to focus verification activities in the field and at Headquarters.

"At the end of each year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force, based upon the evaluation of all information available to it for that year."

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

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

In 2009, safeguards were applied for 170[1] States with safeguards agreements in force with the Agency. Eighty-nine States had both CSAs and APs in force. For 52 of these States,[2] the Agency concluded that all nuclear material remained in peaceful activities. For the remaining 37 States, the Agency had not yet completed all the necessary evaluations and could therefore conclude only that the declared nuclear material remained in peaceful activities. Similarly, for 73 States with CSAs in force but without APs, the Agency was only able to draw that conclusion.[3]

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

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

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1 The 170 States do not include the Democratic People's Republic of Korea (DPRK), where the Agency did not implement safeguards and, therefore, could not draw any conclusions.

2 And for Taiwan, China.

3 The 73 States do not include the DPRK as the Agency was not able to implement safeguards in that State and, therefore, could not draw any conclusion.

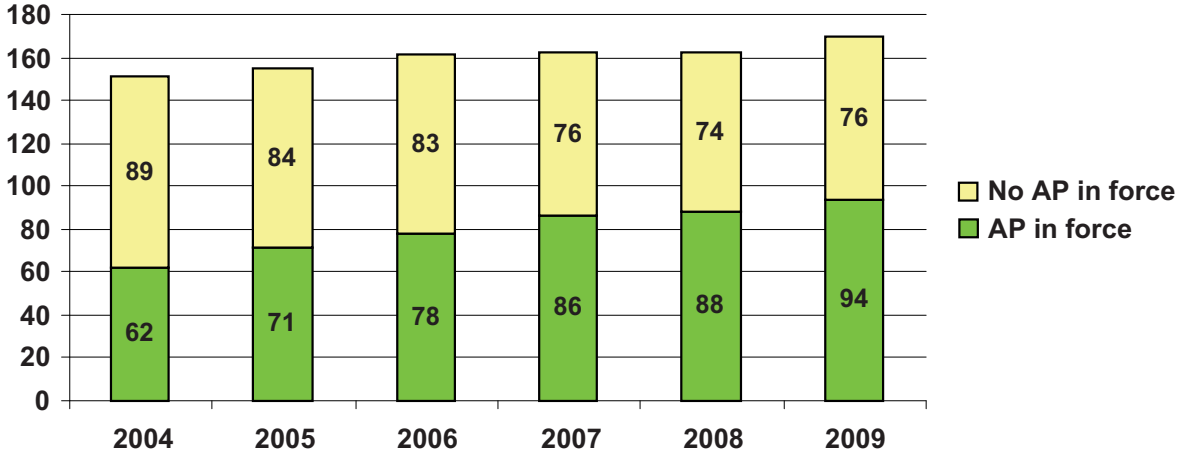


FIG. 1. Status of APs for States with safeguards agreements in force, 2004–2009 (the DPRK is not included).

As of 31 December 2009, 22 non-nuclear-weapon States party to the NPT had yet to bring CSAs into force pursuant to the Treaty. For these States, the Secretariat could not draw any safeguards conclusions.

A broader conclusion was drawn for the first time for 1 State and was reaffirmed for 51 States.

Conclusion of Safeguards Agreements and Additional Protocols

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of small quantities protocols.[4] During 2009, CSAs entered into force for eight States,[5] and APs entered into force for six States.[6] The status of safeguards agreements and APs as of 31 December 2009 is shown in Fig. 1. During the year, six States[7] signed CSAs and nine States[8] signed APs. The Board of Governors approved CSAs for five States[9] and APs for nine States.[10] By the end of 2009, three quarters of States with CSAs had signed APs and more than half of States with CSAs had APs in force. Moreover, nearly three quarters of the countries with nuclear material under safeguards had APs in force.

In order to implement a Board decision in 2005, the Agency continued to communicate with States with a view to amending or rescinding their SQPs. During 2009, SQPs were amended to reflect the modified text for five States.[11]

An INFCIRC/66/Rev.2-type safeguards agreement for India, covering India's civilian nuclear facilities, was signed and entered into force.

The Secretariat continued to implement the Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols, which was updated in September 2009. During the year, the Secretariat convened two outreach initiatives: a briefing on Agency safeguards in New York in May as a side event at the Preparatory Committee for the 2010 NPT Review Conference; and an interregional seminar on the Agency's safeguards system for

[4] Many States with minimal or no nuclear activities have concluded a small quantities protocol (SQP) to their CSA. Under SQPs, the implementation of most of the safeguards procedures of CSAs 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. 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.

[5] Bahrain, Central African Republic, Comoros, Kenya, Mauritania, Qatar, Saudi Arabia, Sierra Leone.

[6] Central African Republic, Colombia, Comoros, Kenya, Mauritania, United States of America.

[7] Central African Republic, Chad, Kenya, Qatar, Rwanda, Timor-Leste.

[8] Central African Republic, Chad, India, Kenya, Rwanda, Serbia, Timor-Leste, United Arab Emirates, Zambia.

[9] Djibouti, Congo, Kenya, Rwanda, Vanuatu.

[10] Bahrain, Congo, Djibouti, India, Kenya, Rwanda, Serbia, United Arab Emirates, Vanuatu.

[11] Lesotho, Nicaragua, The Former Yugoslav Republic of Macedonia, Uganda, the United Republic of Tanzania.

States with limited nuclear material and activities, conducted in Arusha, United Republic of Tanzania, in November. In addition, consultations on the amendment of SQPs and the conclusion and entry into force of safeguards agreements and APs were held throughout the year with representatives from both Member and non-Member States.

Cooperation with SSACs/RSACs

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 their regional equivalents (RSACs), and on the level of their cooperation with the Agency. In 2009, the Secretariat continued to work with SSACs and RSACs on safeguards implementation issues, such as the quality of operator systems for the measurement of nuclear material, the timeliness and accuracy of State reports and declarations, and support for the Agency's verification activities.

"Member State Support Programmes continued to make substantial contributions to Agency safeguards."

A number of States improved the timeliness and quality of their safeguards reporting in 2009. To help other States in this area, a series of training courses were held and an IAEA SSAC Advisory Service (ISSAS) mission was carried out.

Member State Support Programmes continued to make substantial contributions to Agency safeguards. As of 31 December 2009, 21 States and organizations had formal Support Programmes.[12]

The Agency held three liaison meetings with the European Commission in 2009 to discuss the implementation of integrated safeguards approaches in European Union countries, and agreement was reached on a joint IAEA–European Commission safeguards approach for all major facility types.

Implementation of Integrated Safeguards

For those States for which a broader conclusion has been drawn, the Secretariat is able to implement 'integrated safeguards' — an optimum combination of all safeguards measures available to the Agency under CSAs and APs to achieve maximum effectiveness and efficiency in meeting the Agency's safeguards obligations. Integrated safeguards were implemented during the whole of 2009 in 36 States.[13] Safeguards implementation activities were carried out for these States in accordance with the State level safeguards approaches and annual implementation plans approved for each individual State. By the end of 2009, integrated safeguards approaches were approved for 24 of the 25 non-nuclear-weapon States in the European Union and integrated safeguards were being implemented in 21 of them.

The Secretariat concluded that the evaluation and verification activities planned for 2009 for the 36 States under integrated safeguards had been satisfactorily implemented and that the State-specific technical objectives had been achieved.

Owing to the size and complexity of their fuel cycles, integrated safeguards are being introduced in a phased manner in Canada and Japan. The use of 'low frequency' unannounced inspections has substantially decreased the inspection effort needed in both States, and the transition to full implementation of integrated safeguards is expected to result in additional savings.

Implementing Safeguards in the Islamic Republic of Iran (Iran)

During 2009, the Director General submitted four reports to the Board of Governors on the implementation of Iran's CSA and relevant provisions of United Nations Security Council resolutions.

While the Agency has continued to verify the non-diversion of declared nuclear material in Iran, Iran has not provided the necessary cooperation to permit the Agency to confirm that all nuclear material in Iran is in peaceful activities.

Since March 2007, Iran has not implemented the modified text of its Subsidiary Arrangements on the early provision of design information and has not

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

[13] Australia, Austria, Bangladesh, Bulgaria, Canada, Chile, Croatia, Cuba, the Czech Republic, Ecuador, Finland, Ghana, Greece, the Holy See, Hungary, Indonesia, Ireland, Italy, Jamaica, Japan, Latvia, Lithuania, Luxembourg, Mali, Malta, Monaco, Norway, Palau, Peru, Poland, Portugal, the Republic of Korea, Romania, Slovenia, Uruguay and Uzbekistan.

been forthcoming in providing information about the design of facilities. Contrary to the requests of the Agency's Board of Governors and of the United Nations Security Council, Iran has not implemented the AP, without which the Agency remained unable to provide credible assurances about the absence of undeclared nuclear material and activities in Iran.

Nor did Iran cooperate with the Agency to address a number of outstanding issues regarding possible military dimensions to its nuclear programme. These issues relate to the alleged studies on the green salt project, high explosives testing, the design of a missile re-entry vehicle; the circumstances of the acquisition of the 'uranium metal' document; procurement and R&D activities of military related institutes and companies that could be nuclear related; and the production of nuclear equipment and components by companies belonging to defence industries.

"Until 14 April 2009, in the context of the ad hoc monitoring and verification arrangement ... foreseen in the Initial Actions agreed at the Six-Party Talks, the Agency continued to implement monitoring and verification measures ..."

Contrary to the decisions of the United Nations Security Council, Iran did not suspend its enrichment related activities, and continued with the operation of the Pilot Fuel Enrichment Plant and the construction and operation of the Fuel Enrichment Plant at Natanz. Moreover, in October, Iran announced that it was constructing an additional enrichment facility, the Fordow Fuel Enrichment Plant. Subsequently, Iran announced its intention to build ten new enrichment plants.

Iran continued its work on heavy water related projects, again contrary to the requirements of the United Nations Security Council, including the construction of the IR-40 heavy water moderated research reactor at Arak and operation of a Heavy Water Production Plant.

Since August 2008, Iran has declined to discuss outstanding issues related to possible military dimensions of its nuclear programme, asserting that the allegations are baseless and that the information to which the Agency is referring is based on forgeries. The relevant information available to the Agency, however, is extensive, broadly consistent and credible. In order to confirm that all nuclear material is in peaceful activities, the Agency needs to have confidence in the absence of possible military dimensions to Iran's nuclear programme. It is important, therefore, that Iran cooperate with the Agency to clarify those outstanding issues which give rise to concerns.

Implementing Safeguards in the Syrian Arab Republic (Syria)

During 2009, the Director General submitted four reports to the Board of Governors on the implementation of Syria's CSA. The Agency continued its verification activities in relation to the allegations that an installation destroyed by Israel at Dair Alzour in Syria in September 2007 had been a nuclear reactor under construction. Syria has yet to provide a credible explanation for the origin and presence of particles of anthropogenic natural uranium (i.e. produced as a result of chemical processing). Syria has not cooperated with the Agency since 2008 in connection with the unresolved issues related to the Dair Alzour site and the three other locations to which it is allegedly functionally related.

In 2009, the Agency found anthropogenic natural uranium particles at the Miniature Neutron Source Reactor (MNSR) near Damascus. Though Syria has provided some information about the experiments carried out at the MNSR and the origin of the material, it did not cooperate fully with the Agency by providing design information related to MNSR, required nuclear material accountancy reports and detailed explanations of experiments carried out with undeclared natural uranium.

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

Since December 2002, the Agency has not implemented safeguards in the DPRK and, therefore, cannot draw any safeguards conclusion regarding nuclear material in that country.

Until 14 April 2009, in the context of 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, the Agency continued to implement monitoring and verification measures related to the shutdown of three installations and construction of one installation at the Yongbyon nuclear facility, and the construction of one installation at Taechon. On that date, the DPRK informed the Agency that it had decided to cease all cooperation with the Agency immediately. It requested Agency personnel to remove all Agency containment and surveillance

FIG. 2. Installing surveillance equipment at a nuclear facility.

equipment from the facilities (not allowing them to access the facilities thereafter), and required them to leave the DPRK as soon as possible. The DPRK also informed the inspectors that it had decided to reactivate all facilities and to proceed with the reprocessing of spent fuel.

During 2009, until 14 April, the Agency neither observed any operation of the three shutdown installations at Yongbyon, nor any construction activities at the two installations under construction at Yongbyon and Taechon. On 15 April, following the DPRK's decision to cease all cooperation with the Agency, the Agency inspectors at Yongbyon removed all seals and switched off the surveillance cameras and departed from the DPRK the following day. Since that time, the Agency has not been able to implement the ad hoc monitoring and verification arrangement in the DPRK. Consequently, the Agency is unable to make any statements in relation to nuclear material inventories in the DPRK.

Following the DPRK's announcement on 25 May 2009 that it had conducted an underground nuclear test, the United Nations Security Council adopted resolution 1874 (2009), which, inter alia, required the DPRK to abandon its nuclear weapons programme, return to the NPT and Agency safeguards at an early date, and re-enter the Six-Party Talks without any preconditions.

Equipment Development and Implementation

In 2009, 964 attended non-destructive assay (NDA) systems were used in the field, along with a number of related technical support activities. Technological advances continue: for example, load cells used at enrichment and fuel fabrication plants have been modernized, and complementary access kits have been repackaged to facilitate use. Development work continued on defining cost effective and non-intrusive verification measures for spent fuel storage in situations where access is difficult. High resolution gamma spectrometry, combined with the In Situ Object Counting System (ISOCS) data evaluation methodology, have been used in several facilities to quantitatively verify uranium hold up, HEU scraps, and uranium and plutonium waste.

To ensure the reliability of the Agency's standard equipment systems, significant resources were expended on preventive maintenance and equipment upgrades. By the end of 2009, the Agency had 1133 cameras connected to 587 systems operating at 240 facilities (Fig. 2) in 33 States.[14] More joint use surveillance equipment was deployed in European Union States (in particular, in Germany at light water reactors receiving MOX fuel), and joint use surveillance equipment was installed in India, where new facilities came under safeguards, and in Japan at MOX facilities and the Monju Fast Breeder Reactor.

"To ensure the reliability of the Agency's standard equipment systems, significant resources were expended on preventive maintenance and equipment upgrades."

The Agency made significant progress in the implementation of new sealing systems and containment verification techniques. In 2009, two ultrasonic sealing systems were finalized and

[14] And in Taiwan, China. These figures include the DPRK.

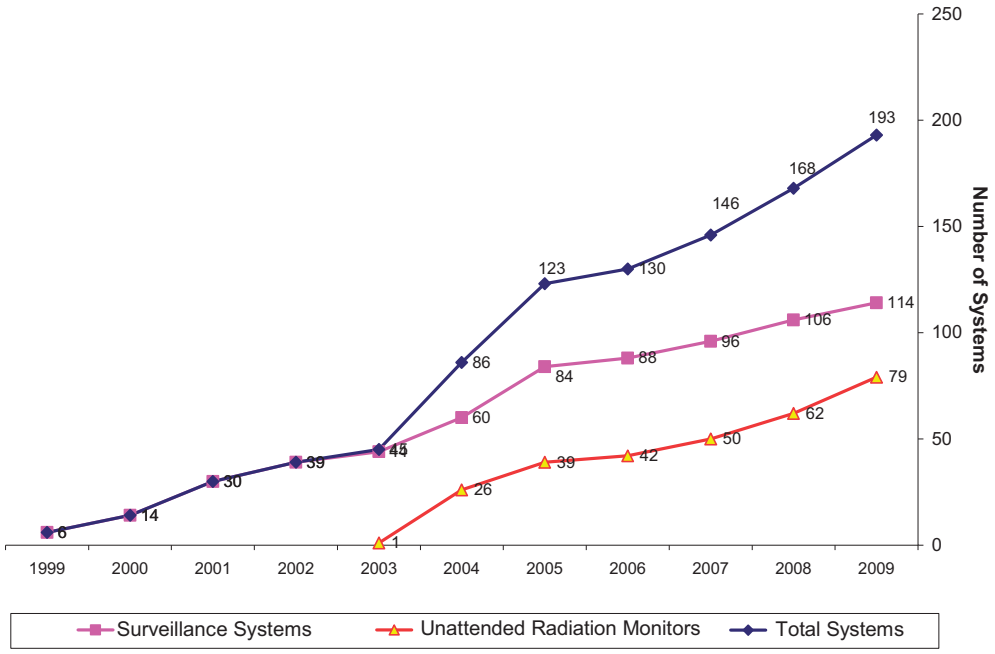


FIG. 3. Increased use of remote monitoring over the last ten years.

authorized for use as the underwater Joint Research Centre (JRC) Candu Sealing System and JRC Dry Storage Seal.

Remote Monitoring

The use of remote monitoring systems to transmit data is helping to enhance the effectiveness and efficiency of safeguards implementation. The IAEA Remote Monitoring Data Centre was strengthened and is now able to monitor systems on a near real time basis.

At the end of the year, 193 surveillance and radiation monitoring systems with remote transmission capabilities were installed at 84 facilities in 18 States.[15] Twenty-five new safeguards systems with remote monitoring were implemented during 2009. Figure 3 shows the increased use of remote monitoring over the last ten years. By the end of 2009, there were 129 unattended monitoring systems (UMSs) installed in 21 States at 48 facilities. During the year, three new installations of UMSs were carried out, 11 major upgrades were implemented and 56 maintenance missions were conducted.

A satellite project with the European Space Agency was officially started in July which will provide satellite communications for three remotely monitored facilities. One more such site will be added before the end of the pilot stage.

Enhancing Sample Analysis

The safeguards analytical service provides logistical support, analysis of samples and evaluation of results (Fig. 4). In 2009, more than 150 shipments of nuclear material samples and around 35 quality control samples were made. The sample analysis is performed in the Agency's Safeguards Analytical Laboratory (SAL) in Seibersdorf and the Network of Analytical Laboratories (NWAL) comprising SAL and 14 national laboratories located in Member States. Approximately 800 environmental samples were analysed by NWAL (excluding SAL) in 2009, with a further 120 nuclear material samples and 50 heavy water samples analysed throughout the entire network. The Agency needs to expand the NWAL and there is a growing willingness among Member States to contribute.[16]

A new thermal ionization mass spectrometer was installed at SAL for the measurement of uranium isotopes, and a method for determining impurities in uranium samples was validated. The

[15] And in Taiwan, China.

[16] Belgium, Czech Republic, Finland, France, Hungary and the Russian Federation have indicated their wish to provide additional laboratory support, and laboratories in Brazil, China, Hungary and the Republic of Korea are currently undergoing qualification to join the NWAL.

FIG. 4. Taking environmental samples at a nuclear facility.

development of a new software application for the control of a robot arm system and its associated hardware was completed in SAL and will be used for making automatic chemical separations. A shipment of loaded mass spectrometer filaments from the On-Site Laboratory in Rokkasho, Japan, was shipped to SAL and analysed as part of an external quality control exercise.

Satellite Imagery Analysis

In 2009, the Agency took advantage of new, higher resolution commercial sensors to improve capabilities for monitoring nuclear sites and facilities worldwide. Contracts were arranged with new imagery providers to diversify sources and ensure the integrity and authenticity of satellite imagery. New high resolution radar imagery was used operationally, providing the Agency with day/night and all weather monitoring capabilities. The ongoing demand for mapping products resulted in the production of more and standardized maps, 3-D visualization products and interactive geospatial tools. Considerable effort was expended in 2009 by satellite imagery analysts to identify and monitor high priority undeclared sites and activities. The use of imagery analysis to gain insight into previously undeclared programmes and activities proved to be a great asset to the Agency's investigations, particularly in those cases where access was either restricted or denied.

"In 2009, the Agency took advantage of new, higher resolution commercial sensors to improve capabilities for monitoring nuclear sites and facilities worldwide."

During the year, the Secretariat acquired 503 commercial satellite images in support of safeguards verification activities (up from 317 in 2008). The imagery was acquired from 24 different Earth observation satellites and covered 26 countries. Among these images, 317 were purchased from the public archives of the Agency's commercial satellite imagery providers, and the remaining 186 were specially requested by the Agency itself. The Secretariat produced 156 imagery analysis reports, including several imagery derived and geographical information system products to support inspection activities (up from 95 in 2008).

Open Source Information

The Agency conducts daily searches of open media, compiles information to assist in preparing annual State evaluation reports, and responds to specific requests for open source information. During the year, State files containing open source information were provided for over 100 State evaluations, and open source analytical reports were provided to support evaluations on high priority safeguards issues, as well as in-field activities. Approximately 2500 articles on issues relating to safeguards were disseminated via daily information bulletins. Open source research also supported the analysis of clandestine procurement networks and the evaluation of incidents involving nuclear material trafficking.

Further developments in information processing were achieved including, for example, a translation service that can translate text and files from several

languages into English, without sending data over the Internet. It is now also possible to search multiple Internet search engines from a single interface, and to perform simple analysis of the results. Approximately 9700 items were added to the Open Source Information System in 2009.

Significant Safeguards Projects

IRP

The objective of the Agency's safeguards information system reengineering project (IRP) is to increase the effectiveness and efficiency of information processing by replacing the current obsolete system with a modern, integrated one. The project will ensure better support and accessibility of data, including remote access by field offices and inspectors. A new safeguards portal was implemented from the beginning of 2010. Phase III of the IRP continued in 2009, having been revised to ensure the integration and consistency of the overall project. Phase III comprises 16 projects, including six that were completed at the end of 2008. In 2009, the majority of the remaining contracts were awarded and preparation made for the technical implementation. The eventual goal is to complete the entire project in 2011. Information from open sources, commercial satellite imagery, in-house databases and other sources was collected, analysed and used extensively to support the evaluation of State nuclear activities in 2009.

"In 2009, the majority of the remaining contracts were awarded and preparation made for ... technical implementation [of the IRP]. The eventual goal is to complete the entire project in 2011."

Japan MOX Fuel Fabrication Plant

A draft safeguards approach, based primarily on the use of random interim inspections supported by unattended NDA and containment/surveillance measures, was developed for the Japan MOX Fuel Fabrication Plant (JMOX). The approach is designed to ensure effective safeguards while achieving greater efficiency. The Joint Technical Committee (JTC), comprising representatives from the Agency and Japanese bodies, is coordinating the development of the JMOX safeguards equipment and software. The conceptual studies of the NDA equipment to be developed by the Agency were completed in 2009, and some of the equipment developed by Japan has already been manufactured. The operator's revised construction schedule for the plant envisages construction to start in May 2010, with commercial operation scheduled for mid-2015.

Novel Technology Project

The Novel Technology Project, aimed at identifying and developing advanced technologies capable of detecting undeclared nuclear activities, focused on: atmospheric gaseous compound detection to verify the status of a reprocessing facility as well as the absence of unreported activities; laser induced breakdown spectrometry (LIBS) for the on-site sampling and analysis of unknown substances found during inspections; optically stimulated luminescence to verify the absence of previous nuclear material storage or activities at inspected locations; and technologies required for safeguards implementation at geological repositories, which include microseismic monitoring, inspector geo-location and underground communications. In December 2009, the handheld LIBS prototype instrument, developed for the Agency by the Canadian Member State Support Programme, was delivered to the Agency.

Chernobyl

The objective of the Chernobyl Safeguards Project is to develop safeguards approaches and instrumentation for routine safeguards implementation at the existing and newly built facilities at the Chernobyl site. The new spent fuel conditioning plant and new safe confinement over the damaged Reactor Unit 4 are expected to be in operation in 2013. Construction of the spent fuel conditioning facility (part of the new dry spent fuel storage) has been delayed due to a revision of the facility's design. The Agency is directly involved in the early design stages in order to integrate appropriate safeguards systems. In 2009, the Agency performed additional tests of surveillance systems inside the damaged reactor hall of Unit 4. Testing of Phase 1 of the site data integration was also completed.

ECAS

Enhancing the capabilities of the safeguards analytical services — the ECAS project — consists

of two parallel projects. Project 1 addresses the sustainability and enhancement of the Agency's particle analysis capabilities for environmental samples, and Project 2 addresses the new Nuclear Material Laboratory. For Project 1, a contract was concluded for the acquisition and installation of the ultrahigh sensitivity secondary ion mass spectrometer for the Clean Laboratory at SAL. Another contract was concluded for designing and building a Clean Laboratory Extension to accommodate the new spectrometer. Construction work is expected to be completed by the end of 2010 and the laboratory to be fully operational by mid-2011. The specification of the new Nuclear Material Laboratory has been prepared. The contract for the conceptual design was signed in 2010 and construction is planned to start in the middle of 2011.

Two workshops on the future of SAL were held in 2009. Member States were informed of progress with the ECAS project and of the Agency's plan to enhance and expand the NWAL. A number of Member States provided extrabudgetary contributions and expert consultants to this end.

Support

Training

The requirements of training have increased significantly for a number of reasons. Developments in safeguards and nuclear fuel cycle related technologies, an increasing focus on the State level approach, and the pace towards information driven safeguards have all necessitated a corresponding evolution in training practice. Moreover, the expansion of tasks and responsibilities of safeguards staff, particularly inspectors and analysts, in combination with the introduction of new safeguards equipment and technologies, has added to the importance of proper training.

As a result, the safeguards training curriculum is being maintained and updated in a continual and reactive process. Two major challenges are: to provide safeguards staff with new skills and abilities while maintaining existing competencies, particularly in nuclear material accountancy; and to offer a balanced training programme to meet the needs of safeguards staff in both technical and behavioural competencies. Support from Member States has been essential to the safeguards training programme, particularly in hosting courses involving practical exercises requiring nuclear facilities and/or nuclear material. In 2009, 48 different courses were conducted for safeguards staff.

"Support from Member States has been essential to the safeguards training programme, particularly in hosting courses involving practical exercises requiring nuclear facilities and/or nuclear material."

Quality Management

During 2009, the Agency continued to implement its quality management system. Staff training to raise awareness of the system was undertaken and quality managers regularly reviewed the system's performance — taking corrective action where necessary. The Agency continued to develop a methodology to establish and monitor the cost of carrying out safeguards activities and to enable cost comparisons of different safeguards implementation options. Implementation of a formal knowledge management programme, focused on retaining critical expertise of staff members who will retire or otherwise leave the Agency, began in late 2009. A methodology for analysing safeguards processes is being developed so as to embed the sharing of knowledge.

Standing Advisory Group on Safeguards Implementation

The Standing Advisory Group on Safeguards Implementation (SAGSI) held two plenary meetings in 2009, at which it considered: strategic planning; guidelines for SSACs; the State level concept, including cost methodology; the resolution of anomalies under integrated safeguards; and the *Safeguards Research and Development Plan 2010–2011*. SAGSI also finalized its longstanding work on two important issues: cooperation between the Agency and SSACs; and the strategic objectives, structure and content of future *Safeguards Implementation Reports* (the Agency's annual report on the Secretariat's safeguards findings and conclusions).

The Future

Strategic Planning

The Agency continued to develop its long range strategic planning process in order to be better

prepared for future safeguards challenges and to increase both its effectiveness and efficiency. Under this process, a new set of strategic objectives was developed and approved. In light of these objectives, potential strategic issues facing the Agency were identified by considering opportunities and challenges against its current capability to address them. The process is aimed at developing the Agency's first ever long term strategic plan, including a long term R&D plan, covering the period 2010–2021.

Research and Development Programme

Research and development are essential to meet the safeguards challenges of the future. As the Secretariat lacks its own research capabilities, the assistance of Member State Support Programmes (MSSPs) is crucial. The new Research and Development Programme for Nuclear Verification 2010–2011, which reflects the need to achieve greater efficiency and effectiveness, consists of 24 projects in such areas as verification technology development, safeguards concepts, information processing and analysis, and training. At the beginning of 2009, 344 MSSP tasks were in progress. During the year, 27 were completed, 8 were terminated, and 31 new tasks were started, leaving 340 ongoing at the end of 2009. Workshops to facilitate the further development of safeguards included the second Japan–IAEA workshop on Advanced Safeguards Technology for Future Nuclear Fuel Cycles, held in Japan in November.

"In June 2009, the Agency agreed on an extended Memorandum of Understanding with the International Science and Technology Centre (ISTC) on how to further mutual cooperation."

In June 2009, the Agency agreed on an extended Memorandum of Understanding with the International Science and Technology Centre (ISTC) on how to further mutual cooperation. Russian scientific research institutes and universities reconfirmed their willingness to support the Agency through the ISTC in the areas of, for example, NDA techniques for safeguards verification, novel safeguards technologies, and training for inspectors and analysts. As mentioned earlier, a project with the European Space Agency to provide satellite communications started in July.

Safeguards for Future Facilities

The Agency has undertaken activities to prepare for safeguarding new types of facilities in the future. These activities include not only evaluating safeguards approaches for specific facility types, but also assessing the proliferation resistance of overall nuclear energy systems and the implementation of safeguards early in the design stages of a facility. For the effective and efficient implementation of safeguards at a new facility, safeguards concepts need to be considered in the initial design planning stages, not only to improve its ability to be safeguarded and its proliferation resistance, but also to facilitate design changes when the costs of making such changes are still reasonably low.

During 2009, the Agency participated in assessments of proliferation resistant nuclear energy systems through INPRO and the Generation IV International Forum (GIF), specifically in three assessment and review meetings under INPRO and in two working group meetings under GIF.

The Agency also issued its initial report addressing work required to develop a safeguards by design (SBD) methodology. Under the SBD concept, international safeguards would be fully integrated into the design process of a nuclear facility from the initial planning through design, construction, operation and decommissioning. A general SBD document is under preparation that will provide the basis for facility specific guidance to identify design features and operating practices that will ensure effective and cost efficient safeguards implementation for facility designers and operators, as well as for the Agency.

Technical Cooperation

Management of Technical Cooperation for Development

Objective

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

Some 80% of the Agency's membership consists of non-nuclear-power States. What drives countries to become members of the Agency? In many cases, major development challenges are key motivating factors. The Agency, through its technical cooperation programme, aims to enhance socioeconomic advancements in its Member States, by supporting the use of appropriate nuclear science and technology to address major sustainable development priorities at the national, regional and interregional levels. The programme is built around six thematic areas — human health, agricultural productivity and food security, water resource management, environmental protection, physical and chemical applications, and sustainable energy development. The programme also addresses safety and security issues of 'global good' that cut across all the thematic areas. The programme contributes to the achievement of several of the United Nations Millennium Development Goals.

The Agency's technical cooperation programme rests on 50 years of collaboration with Member States. It is unique in the United Nations system, as it combines significant technical and developmental competencies. All Member States are eligible for support, although in practice technical cooperation activities tend to focus on the needs and priorities of less developed countries.

Strengthening the Agency's Technical Cooperation Programme

In the first year of the 2009–2011 technical cooperation programme cycle, 453 new national projects, 124 new regional projects and 6 new interregional projects were initiated. At the same time, 351 projects were closed (including 9 cancellations). Active projects now total 1082, with an additional 256 in the process of being closed.

The Secretariat paid special attention to improving overall programme management in 2009. Throughout the first half of the year, a major 'fixing exercise' was undertaken in response to an internal review of the management of the programme. The exercise concentrated on several interrelated areas, which covered documenting standard operating procedures, streamlining processes and procedures, and establishing good practices and policies for project management. Key outputs include a draft operations manual, and a 'document repository' that provides a single entry point for all documents that guide the work of the technical cooperation programme. Improvements have been made in areas that are critical to the long term success of the programme, such as the development of project and programme indicators, and greater involvement with the United Nations system.

The IT strategy for technical cooperation was also reviewed in 2009, with a focus on optimizing support of programme delivery in an efficient and cost effective manner. In addition, the aim was to ensure that the technical cooperation programme can respond to changing IT and programmatic contexts in the framework of the introduction of the Agency-wide Information System for Programme Support (AIPS).

"In the first year of the 2009–2011 technical cooperation programme cycle, 453 new national projects, 124 new regional projects and 6 new interregional projects were initiated."

The Agency implemented a three year technical cooperation programme cycle that would bring it into step with the Regular Budget cycle by 2012. This will allow the Secretariat and Member States to plan resources for the programme more strategically, and to provide leverage more effectively for all available inputs, including management resources, funding and technical backstopping.

Managing for Impact and Promoting Quality

In line with ongoing efforts, the Agency focused on promoting quality throughout the technical cooperation programme. In particular, emphasis was placed on strengthening the tools for good

project management and improving the results based approach, which has been in place in the technical cooperation programme since 1997 and in the Agency since 2002. The objective has been to increase the efficiency and the effectiveness of the programme, as well as to promote sustainability and long term impact.

Periodic Progress Reporting was introduced for project monitoring at both the output and outcome levels. This facilitates reporting by counterparts on a regular basis through the Programme Cycle Management Framework (PCMF) IT platform. The consolidation of experiences and recommendations cited in the reports will help to build institutional memory on the projects and to draw lessons for the future.

Supporting the Achievement of the Millennium Development Goals

Two internal studies were carried out in 2009 to assess the degree to which the technical cooperation programme contributes to the attainment of the Millennium Development Goals (MDGs). These were important for two reasons: when Member States propose their country programme for the next technical cooperation cycle, it is likely that they will have the MDGs in mind; and in September 2011, the United Nations will hold a special summit to encourage efforts to achieve the MDGs. The studies were complementary: one concentrated on the Agency's overall approach to development; the other examined technical cooperation activities in specific thematic areas. The findings were encouraging. The study on the Agency's approach to development found that one third of the total portfolio of technical cooperation projects could be regarded as contributing directly and indirectly to the achievement of the MDGs, with another 16% contributing to the creation of an enabling environment for their achievement. It noted that while the MDGs may not currently be a main driver of the technical cooperation programme, the underlying tenets of the MDG framework are as important as the MDGs themselves, and can be applied effectively to the Agency's technical cooperation programme.

"Two internal studies were carried out in 2009 to assess the degree to which the technical cooperation programme contributes to the attainment of the Millennium Development Goals ..."

The study on thematic areas found a greater correlation between the MDGs and the objectives and activities of the technical cooperation programme. It examined the Agency mandate and the technologies applied through the programme in the context of each MDG, and concluded that the Agency is making a contribution to six of the eight goals, namely, eradication of extreme poverty and hunger, reduced child mortality, improved maternal health, combating HIV/AIDS, malaria and other diseases, environmental sustainability, and global partnership for development.

Country Programme Frameworks

In 2009, the Secretariat, together with Member States, strengthened efforts to increase the number of Country Programme Frameworks (CPFs). As a result, 19 CPFs were signed (on behalf of Cameroon, Côte d'Ivoire, Cuba, Dominican Republic, Egypt, Jordan, Kazakhstan, Kuwait, Lebanon, Mauritania, Mongolia, Myanmar, Pakistan, Senegal, Serbia, Sierra Leone, Sri Lanka, Sudan and Tunisia), and a further 50 are in preparation. Valid CPFs are expected to facilitate national work and to provide a context for the preparation of the 2012–2013 technical cooperation programme.

In support of the Agency's efforts to align and provide leverage for its technical cooperation activities within the larger development context, the CPF preparation process now makes extensive use of national development plans and United Nations Development Assistance Frameworks (UNDAFs). This helps not only to ensure that the application of nuclear techniques is integrated with existing development initiatives and plans, but also to identify areas where such techniques might be usefully deployed. The Agency's increased focus on alignment with United Nations activities was reflected when the Agency became signatory to seven new UNDAFs in 2009. At present, technical cooperation country officers (PMOs) are engaged in 22 ongoing UNDAF processes to ensure that programme activities are reflected in the UNDAF Action Plan Results Matrix.

Coordination with the United Nations System and Other International Organizations

Concerted outreach and partnership efforts were undertaken vis-à-vis United Nations organizations to link the technical cooperation programme with

ongoing United Nations Country Team (UNCT) efforts throughout 2009. This involved general as well as targeted communication about technical cooperation activities, presentations of the programme to selected audiences, and collaboration with the Development Assistance Committee (DAC) of the OECD to establish the level of Official Development Assistance (ODA) the Agency is providing to Member States. In May 2009, the DAC concluded that 100% of the Technical Cooperation Fund and 33% of the Regular Budget were in the category of ODA.

Linkages between the Agency's regional divisions for Africa and Europe and the regional bureaus of UNDP were established. Joint programming initiatives can now be identified more easily, as there is significant overlap in regional activities (e.g. health, food security, water, climate change and sustainable energy). In Central Asia, the Agency now provides the technical leadership for a multi-country programme coordinated by UNDP.

In Asia and the Pacific, RCA Member States, through the regional office in the Republic of Korea, have established collaboration with UNDP, which partially funded an RCA project on the mitigation of the coastal impact of natural disasters such as tsunamis using nuclear or isotope based techniques. RCA has also established linkages with the Forum for Nuclear Cooperation in Asia, the Partnerships in Environmental Management for the Seas of East Asia, and the Asian Regional Cooperative Council for Nuclear Medicine, with the aim of promoting regional cooperation in nuclear science and technology related fields.

Member State Support for the Placement of Fellows

Fellowship placement and management institutions located in the host country play an important role in the Agency's fellowship programme, both with regard to administrative issues and in supporting reporting on the programme. In 2009, several contracts were initiated between fellowship placement and management institutions and the Agency. These included a contract extension with the United Kingdom's British Council at reduced rates, a contract extension with Germany's InWent — Capacity Building International, and a new contract with the Abdus Salam International Centre for Theoretical Physics (ICTP), in Trieste, Italy, for the placement and management of Fellows and scientific visitors. Representatives of other placement institutions also visited the Agency to discuss the placement of Fellows in their countries and to investigate possible enhancements to processes and procedures. These institutions included: the Belgian Technical Cooperation (the implementing partner of the Belgian Development Cooperation); the Department of Atomic Energy, India; the Korea Nuclear International Cooperation Foundation, Republic of Korea; the Nuclear Energy Corporation of South Africa; and Argonne National Laboratory, USA.

Regional Programming

The Regional Agreements and other Member State groups play a strategically important role in furthering the goals of sustainability and promoting horizontal cooperation. The approach of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA), for example, supports the Agency's technical cooperation objective of national ownership as outlined in the *Technical Cooperation Strategy*, and could contribute to paving the way for effective national execution, in view of the potential of regional agreements to facilitate the delivery of services. In 2009, AFRA's establishment of the Programme Management Committee, the Partnership Building and Resource Mobilization Committee, and the High Level Steering Committee for Human Resource Development and Nuclear Knowledge Management enhanced the implementation of the AFRA Agreement. Action was also taken to operationalize the AFRA Fund, to which several AFRA Member States have already contributed. It is expected that the AFRA Fund will attract substantial support from multilateral and bilateral development partners, thereby enhancing regional self-reliance.

"The Regional Agreements and other Member State groups play a strategically important role in furthering the goals of sustainability and promoting horizontal cooperation."

In Latin America, regional programming is undertaken primarily through the Regional Cooperative Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL), guided by the Regional Strategic Profile approved in 2007. In

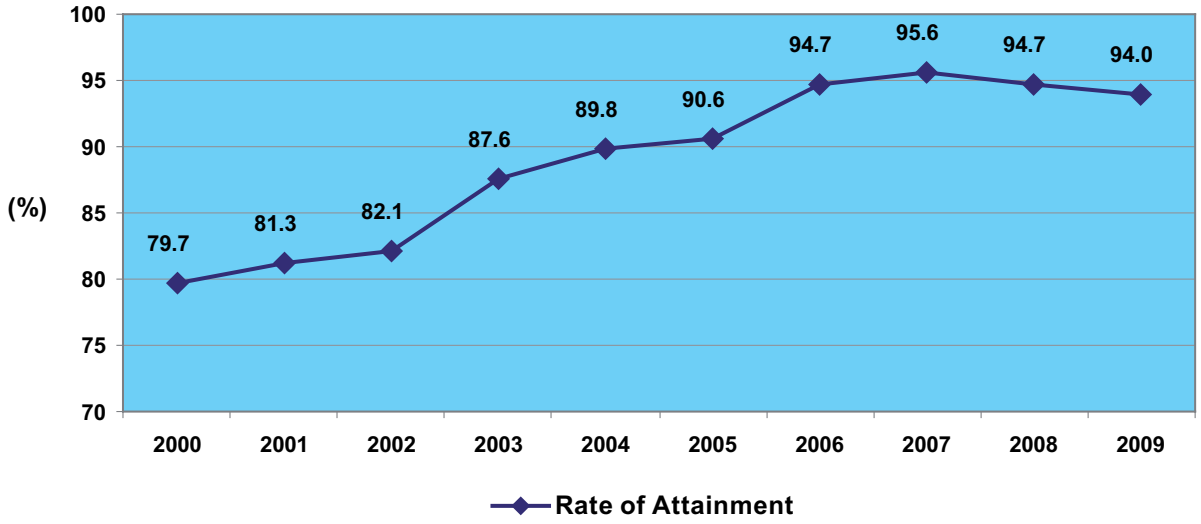


FIG. 1. Rate of attainment on pledges for the TCF, 2000–2009.

2009, the Secretariat and Member States decided to develop technical and management leadership in the region through more integrated national and regional programming and by utilizing the ARCAL management structure. In Asia and the Pacific, an important step forward was taken in December 2009 when National Liaison Officers from the region agreed to develop a Regional Cooperative Framework (RCF). The RCF is expected to help in the formulation of a more relevant regional technical cooperation programme for Asia and the Pacific that will complement the national programmes of Member States.

Programmatic Indicators and Financial Monitoring

The Agency initiated a quarterly review of eight programmatic indicators in 2009 to measure how successfully the technical cooperation programme is implemented over the course of the year. The indicators include: financial implementation rate and net obligations (to measure timely financial performance); Member States with CPFs (to ensure that all Member States have a valid CPF); quantity and value of budget revisions (to measure the efficiency of programme budgeting); and number of projects closed (to ensure and encourage the timely closure of projects). Baseline data for the indicators have been established for 2008 and 2009, which will support their future review. This is expected to improve the overall performance of the programme.

"The Agency initiated a quarterly review of eight programmatic indicators in 2009 to measure how successfully the technical cooperation programme is implemented over the course of the year."

Financial Highlights

Pledges against the 2009 Technical Cooperation Fund (TCF) totalled $79.9 million, not including national participation costs (NPCs) or assessed programme costs (APCs) against the target of $85 million, with the rate of attainment at the end of 2009 standing at 94% (Fig. 1). Payments against the 2009 TCF, at the end of the same year, totalled $77.5 million, with a rate of attainment (on payments) of 91.1%. The difference between pledges and payments ($2.4 million) is mainly due to the receipt of 2009 TCF contributions in early January 2010. The use of these resources resulted in an implementation rate of 80.2%.

For the programme as a whole (therefore including extrabudgetary contributions, NPCs, APCs, in-kind contributions and miscellaneous income), new resources stood at $112.2 million. Implementation for 2009, measured against the adjusted programme, for the TCF and extrabudgetary parts, reached a rate of 77.2%.

Legislative Assistance

Faced with increased demand from Member States, the Agency further intensified its legislative assistance activities.

In particular, it organized six international and regional workshops. Further, the Agency provided country specific bilateral legislative assistance — essentially by means of written comments and advice in drafting national nuclear legislation — to 24 Member States.

At the request of Member States, individual training was also provided to several individuals, notably through short term scientific visits organized at Agency Headquarters, as well as longer term fellowships, allowing individuals to gain further practical experience in nuclear law.

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

Annex

Note: Tables A19–A25 are available on the attached CD-ROM.

Table A1. Allocation and utilization of regular budget resources in 2009 (unless otherwise indicated, the amounts in this table are in euros)

Programme/**Major Programme**	Budget			Expenditure		Unused
	Original at $1.0000	Adjusted at $1.3893[a]	Transfers[b]	Amount	Per cent rate of utilization (4) / (2)	(over expended) adjusted budget (2) + (3) – (4)
	(1)	(2)	(3)	(4)	(5)	(6)
Operational and Recurrent Portion of the Regular Budget						
1. Nuclear Power, Fuel Cycle and Nuclear Science						
Overall Management, Coordination and Common Activities	907 351	850 894		850 117	99.9%	777
Nuclear Power	5 703 336	5 287 948		5 325 066	100.7%	(37 118)
Nuclear Fuel Cycle and Materials Technologies	2 567 201	2 378 239		2 278 722	95.8%	99 517
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development	10 389 925	9 748 626	(598)	9 517 341	97.6%	230 687
Nuclear Science	9 170 001	8 731 975		8 739 838	100.1%	(7 863)
Subtotal — Major Programme 1	**28 737 814**	**26 997 682**	**(598)**	**26 711 084**	**98.9%**	**286 000**
2. Nuclear Techniques for Development and Environmental Protection						
Overall Management, Coordination and Common Activities	908 293	847 932		1 095 849	129.2%	(247 917)
Food and Agriculture	12 360 284	11 737 172		11 642 989	99.2%	94 183
Human Health	8 732 724	8 229 058		8 155 884	99.1%	73 174
Water Resources	3 416 257	3 193 843		3 126 793	97.9%	67 050
Environment	5 449 001	5 161 582		5 117 908	99.2%	43 674
Radioisotope Production and Radiation Technology	1 996 306	1 861 091		1 891 255	101.6%	(30 164)
Subtotal — Major Programme 2	**32 862 865**	**31 030 678**	**0**	**31 030 678**	**100.0%**	**0**
3. Nuclear Safety and Security						
Overall Management, Coordination and Common Activities	921 566	860 841		994 994	115.6%	(134 153)
Incident and Emergency Preparedness and Response	1 421 618	1 330 686		1 367 106	102.7%	(36 420)
Safety of Nuclear Installations	8 450 303	7 927 724	12 356	7 747 936	97.7%	192 144
Radiation and Transport Safety	5 394 160	5 064 201		5 069 549	100.1%	(5 348)
Management of Radioactive Waste	6 379 963	5 937 917		5 946 910	100.2%	(8 993)
Nuclear Security	1 114 066	1 041 936		1 049 166	100.7%	(7 230)
Subtotal — Major Programme 3	**23 681 676**	**22 163 305**	**12 356**	**22 175 661**	**100.1%**	**0**
4. Nuclear Verification						
Overall Management, Coordination and Common Activities	1 063 133	1 001 487		1 020 777	101.9%	(19 290)
Safeguards	116 087 347	108 953 352	(9 771)	104 249 350	95.7%	4 694 231
Subtotal — Major Programme 4	**117 150 480**	**109 954 839**	**(9 771)**	**105 270 127**	**95.7%**	**4 674 941**
5. Policy, Management and Administration						
Subtotal — Major Programme 5	**75 050 660**	**72 000 335**	**(1 844)**	**71 115 887**	**98.8%**	**882 604**
6. Management of Technical Cooperation for Development						
Subtotal — Major Programme 6	**16 307 161**	**15 458 918**	**(143)**	**15 390 508**	**99.6%**	**68 267**
Total Operational and Recurrent Budget	**293 790 656**	**277 605 757**	**0**	**271 693 945**	**97.9%**	**5 911 812**
Essential Investments Portion of the Regular Budget						
1. Nuclear Power, Fuel Cycle and Nuclear Science	51 050	46 201		34 700	75.1%	11 501
2. Nuclear Techniques for Development and Environmental Protection	193 990	175 563		175 563	100.0%	0
3. Nuclear Safety and Security	112 310	101 642		101 642	100.0%	0
4. Nuclear Verification	3 367 074	3 068 168		552 400	18.0%	2 515 768
5. Policy, Management and Administration	1 489 710	1 441 042		1 150 040	79.8%	291 002
6. Management of Technical Cooperation for Development	319 800	279 208		270 428	96.9%	8 780
Total Essential Investments	**5 533 934**	**5 111 824**	**0**	**2 284 773**	**44.7%**	**2 827 051**
Total Agency Programmes	**299 324 590**	**282 717 581**	**0**	**273 978 718**	**96.9%**	**8 738 863**
Transfer to the Major Capital Investment Fund[c]				8 738 863	0.0%	(8 738 863)[c]
Total Regular Budget	**299 324 590**	**282 717 581**	**0**	**282 717 581**	**100.0%**	**0**
Reimbursable Work for Others[d]	2 523 046	2 361 589		2 902 550	122.9%	(540 961)[d]
Grand Total	**301 847 636**	**285 079 170**	**0**	**285 620 131**	**100.2%**	**(540 961)**

[a] Appropriations in General Conference Resolution GC(52)/RES/5 of October 2008 were revalued at the UN average rate of exchange of $1.3893 to €1.00.

[b] Based on the decision of the Board of Governors in document GOV/1999/15, an amount of €12 356 was transferred to Major Programme 3 'Nuclear Safety and Security' to cover the cost of emergency assistance provided in Ecuador. To recover this advance, year end unencumbered balances in the Regular Budget Appropriation Sections were used.

[c] In accordance with the Agency's Programme and Budget document GC(53)/5 dated August 2009, €8 738 863 was transferred to the Major Capital Investment Fund to support major infrastructure investments.

[d] (€540 961) represents the costs of additional services provided to: (1) other VIC based organizations; and (2) projects financed from the Technical Cooperation Fund and extrabudgetary resources.

Table A2. Extrabudgetary funds in support of the regular budget 2009
(unless otherwise indicated, the amounts in this table are in euros)

Programme/**Major Programme**	Extrabudgetary budget figures 2009[a]	Resources			Expenditure as at 31 December 2009	Unused balance
		Unused balance as at 1 January 2009	New resources in 2009	Total available in 2009 (2) + (3)		(4) – (5)
	(1)	(2)	(3)	(4)	(5)	(6)
1. Nuclear Power, Fuel Cycle and Nuclear Science						
Overall Management, Coordination and Common Activities						
Nuclear Power	2 112 929	2 057 758	3 313 343	5 371 101	2 352 394	3 018 707
Nuclear Fuel Cycle and Materials Technologies	397 177	257 798	320 944	578 742	399 079	179 663
Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development		135 347	73 992	209 339	93 881	115 458
Nuclear Science	327 747	96 436	1 767 941	1 864 377	349 550	1 514 827
Subtotal — Major Programme 1	**2 837 853**	**2 547 339**	**5 476 220**	**8 023 559**	**3 194 904**	**4 828 655**
2. Nuclear Techniques for Development and Environmental Protection						
Overall Management, Coordination and Common Activities		126 863	76 000	202 863	78 457	124 406
Food and Agriculture	2 222 267	25 564	1 880 132	1 905 696	1 500 870	404 826
Human Health	946 454	582 173	1 021 105	1 603 278	686 403	916 875
Water Resources		100 113	203 000	303 113	98 824	204 289
Environment	699 042	121 944	446 824	568 768	559 945	8 823
Radioisotope Production and Radiation Technology		3 844		3 844		3 844
Subtotal — Major Programme 2	**3 867 763**	**960 501**	**3 627 061**	**4 587 562**	**2 924 499**	**1 663 063**
3. Nuclear Safety and Security						
Overall Management, Coordination and Common Activities	2 621 943	1 613 947	1 680 903	3 294 850	1 142 688	2 152 162
Incident and Emergency Preparedness and Response	1 262 225	988 266	983 871	1 972 137	796 859	1 175 278
Safety of Nuclear Installations	2 495 339	4 194 372	5 126 055	9 320 427	4 629 495	4 690 932
Radiation and Transport Safety	2 214 114	616 585	558 098	1 174 683	595 158	579 525
Management of Radioactive Waste	1 328 869	779 603	1 072 230	1 851 833	828 969	1 022 864
Nuclear Security	15 500 042	3 963 828	20 876 845	24 840 673	13 415 305	11 425 368
Subtotal — Major Programme 3	**25 422 532**	**12 156 601**	**30 298 002**	**42 454 603**	**21 408 474**	**21 046 129**
4. Nuclear Verification						
Overall Management, Coordination and Common Activities		1 888 123	(1 726 986)	161 137	25	161 112
Safeguards	15 709 939	17 348 600	17 760 598	35 109 198	13 089 907	22 019 291
Subtotal — Major Programme 4	**15 709 939**	**19 236 723**	**16 033 612**	**35 270 335**	**13 089 932**	**22 180 403**
5. Policy, Management and Administration						
Subtotal — Major Programme 5	**701 335**	**2 980 989**	**2 518 584**	**5 499 573**	**2 615 319**	**2 884 254**
6. Management of Technical Cooperation for Development						
Subtotal — Major Programme 6	**0**	**215 239**	**129 280**	**344 519**	**229 332**	**115 187**
Total Extrabudgetary Programme Fund	**48 539 422**	**38 097 392**	**58 082 759**	**96 180 151**	**43 462 460**	**52 717 691**

[a] Column (1): Extrabudgetary budget figures include: (a) €2 406 851 from United Nations organizations; and (b) €16 174 967 for the Nuclear Security Fund.

Table A3(a). Disbursements by technical field and region in 2009

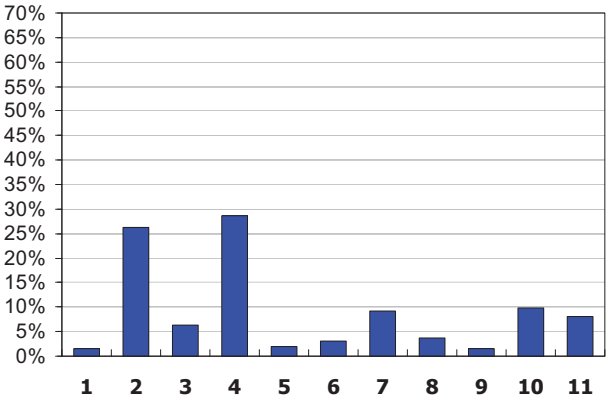
Summary of all regions (in thousands of dollars)

	Technical field	Africa	Asia and the Pacific	Europe	Latin	Global/Inter-regional	Total
1	Environment	361.2	1 147.8	1 109.3	859.6	78.7	3 556.6
2	Food and Agriculture	6 510.3	3 159.6	695.0	1 691.4	113.9	12 170.2
3	Human Capacity Development and Programme Support	1 571.4	1 136.9	2 385.6	1 248.0	1 716.3	8 058.2
4	Human Health	7 097.2	2 923.0	4 726.3	2 825.7	98.4	17 670.6
5	Nuclear Fuel Cycle	486.1	811.5	2 282.4	985.7	0.0	4 565.7
6	Nuclear Power	736.9	1 362.4	423.7	1 285.0	289.9	4 097.9
7	Nuclear Safety	2 257.9	3 210.0	4 638.3	2 589.4	147.4	12 842.9
8	Nuclear Science	918.1	707.0	4 927.7	352.9	50.7	6 956.4
9	Nuclear Security	390.8	361.3	466.4	127.3	0.0	1 345.8
10	Radioisotope Production and Radiation Technology	2 433.8	3 260.6	2 708.4	1 989.8	82.6	10 475.3
11	Water Resources	1 984.9	521.9	169.4	950.8	0.0	3 627.0
	Total	24 748.6	18 601.9	24 532.6	14 905.7	2 577.9	85 366.8

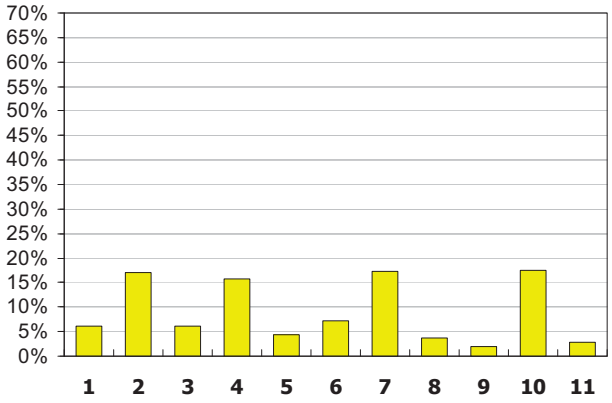
Table A3(b). Graphical representation of the information in Table A3(a)

Distribution by region
(in thousands of dollars)

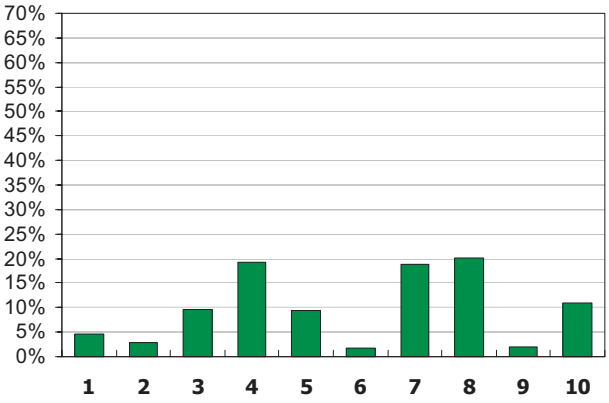
Africa: $24 748.6



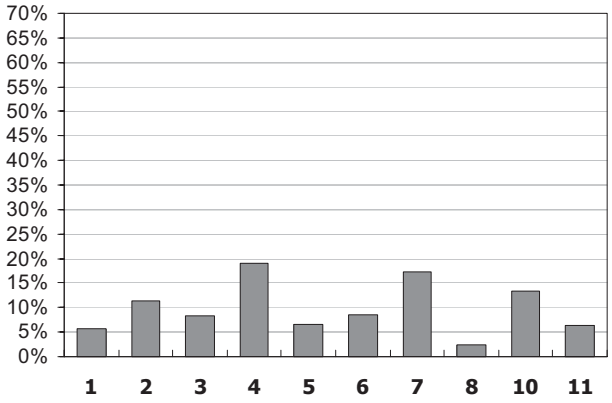
Asia and the Pacific: $18 601.9



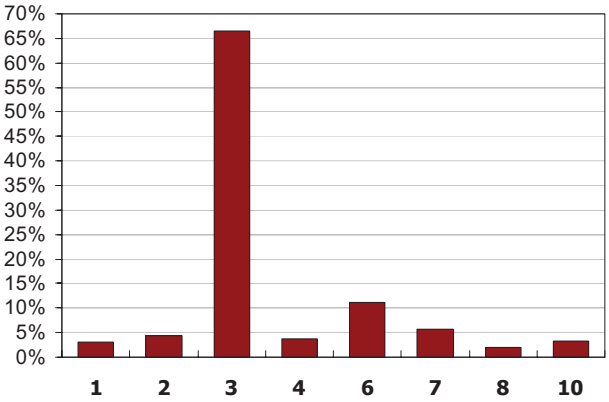
Europe: $24 532.6



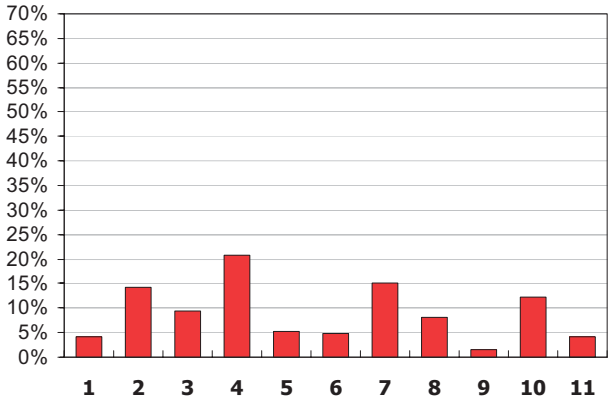
Latin America: $14 905.7



Global/Interregional: $2 577.9



Total: $85 366.8



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

Table A4. Amount of nuclear material and heavy water at the end of 2009 by agreement

Type of material	Quantity of material (SQs)[a]			Quantity in SQs
	Comprehensive safeguards agreements[b]	INFCIRC/66[c] type agreement	Voluntary offer agreements	
Nuclear material				
Plutonium[d] contained in irradiated fuel and in fuel elements in reactor cores	110 182.67	1201.94	16 024.77	127 408.39
Separated plutonium outside reactor cores	1520.57	5.01	10 182.80	11 708.39
HEU (equal to or greater than 20% ^{235}U)	246.54	1.37	0.235	248.15
LEU (less than 20% ^{235}U)	15 271.58	202.76	813.30	16 287.66
Source material[e] (natural and depleted uranium and thorium)	8137.50	141.28	1468.45	9747.24
^{233}U	18.71	—	—	18.72
Total SQs[a]	**135 377.60**	**1552.38**	**28 489.58**	**165 418.57[f]**
Non-nuclear material[g]				
Heavy water (tonnes)	0.71[h]	448.81	—	—

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

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

c Covering facilities in India, Israel and Pakistan.

d The quantity includes an estimated 11 460 SQs of plutonium in irradiated fuel, which is not yet reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountancy and containment/surveillance measures are applied), and plutonium in fuel elements loaded into the core.

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

f Does not include nuclear material reported by SQP States of 0.52 SQs.

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

h In Taiwan, China.

Table A5. Number of facilities under safeguards or containing safeguarded material on 31 December 2009

Facility type	Number of facilities			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b] type agreements	Voluntary offer agreements	Total
Power reactors	221	7	1	229
Research reactors and critical assemblies	149	3	1	153
Conversion plants	18	0	0	18
Fuel fabrication plants	42	3	1	46
Reprocessing plants	11	1	1	13
Enrichment plants	13	0	3	17
Separate storage facilities	111	2	5	118
Other facilities	76	0	0	76
Subtotals	**642**	**16**	**12**	**670**
Other locations outside facilities[c] (LOFs)	454	1	0	455
Totals	**1096**	**17**	**12**	**1125**

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

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Afghanistan	X	In force: 20 February 1978	257	In force: 19 July 2005
Albania[1]		In force: 25 March 1988	359	Signed: 2 December 2004
Algeria		In force: 7 January 1997	531	Approved: 14 September 2004
Andorra	X	*Signed: 9 January 2001*		*Signed: 9 January 2001*
Angola				
Antigua and Barbuda[2]	X	In force: 9 September 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 December 1997
Austria[4]		Accession: 31 July 1996	193	In force: 30 April 2004
Azerbaijan	Amended: 20 November 2006	In force: 29 April 1999	580	In force: 29 November 2000
Bahamas[2]	Amended: 25 July 2007	In force: 12 September 1997	544	
Bahrain	In force: 10 May 2009	In force: 10 May 2009	767	Approved: 26 November 2009
Bangladesh		In force: 11 June 1982	301	In force: 30 March 2001
Barbados[2]	X	In force: 14 August 1996	527	
Belarus		In force: 2 August 1995	495	Signed: 15 November 2005
Belgium		In force: 21 February 1977	193	In force: 30 April 2004
Belize[5]	X	In force: 21 January 1997	532	
Benin	*Amended: 15 April 2008*	*Signed: 7 June 2005*		*Signed: 7 June 2005*
Bhutan	X	In force: 24 October 1989	371	
Bolivia[2]	X	In force: 6 February 1995	465	
Bosnia and Herzegovina[6]		In force: 28 December 1973	204	
Botswana		In force: 24 August 2006	694	In force: 24 August 2006
Brazil[7]		In force: 4 March 1994	435	
Brunei Darussalam	X	In force: 4 November 1987	365	
Bulgaria[8]		Accession: 1 May 2009	193	Accession: 1 May 2009
Burkina Faso	Amended: 18 February 2008	In force: 17 April 2003	618	In force: 17 April 2003
Burundi	In force: 27 September 2007	In force: 27 September 2007	719	In force: 27 September 2007
Cambodia	X	In force: 17 December 1999	586	
Cameroon	X	In force: 17 December 2004	641	Signed: 16 December 2004
Canada		In force: 21 February 1972	164	In force: 8 September 2000
Cape Verde	*Amended: 27 March 2006*	*Signed: 28 June 2005*		*Signed: 28 June 2005*
Central African Republic	In force: 7 September 2009	In force: 7 September 2009	777	In force: 7 September 2009

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Chad	*Signed: 15 September 2009*	*Signed: 15 September 2009*		*Signed: 15 September 2009*
Chile[9]		In force: 5 April 1995	476	In force: 3 November 2003
China		In force: 18 September 1989	369*	In force: 28 March 2002
Colombia[9]		In force: 22 December 1982	306	In force: 5 March 2009
Comoros	In force: 20 January 2009	In force: 20 January 2009	752	In force: 20 January 2009
Congo, Republic of the	*Approved: 8 September 2009*	*Approved: 8 September 2009*		*Approved: 8 September 2009*
Costa Rica[2]	Amended: 12 January 2007	In force: 22 November 1979	278	Signed: 12 December 2001
Côte d'Ivoire		In force: 8 September 1983	309	Signed: 22 October 2008
Croatia	Amended: 26 May 2008	In force: 19 January 1995	463	In force: 6 July 2000
Cuba[2]		In force: 3 June 2004	633	In force: 3 June 2004
Cyprus[10]		Accession: 1 May 2008	193	Accession: 1 May 2008
Czech Republic[11]		Accession: 1 October 2009	193	Accession: 1 October 2009
Democratic People's Republic of Korea		In force: 10 April 1992	403	
Democratic Republic of the Congo		In force: 9 November 1972	183	In force: 9 April 2003
Denmark[12]		In force: 21 February 1977	193	In force: 30 April 2004
Djibouti	*Approved: 3 March 2009*	*Approved: 3 March 2009*		*Approved: 3 March 2009*
Dominica[5]	X	In force: 3 May 1996	513	
Dominican Republic[2]	Amended: 11 October 2006	In force: 11 October 1973	201	Signed: 20 September 2007
Ecuador[2]	Amended: 7 April 2006	In force: 10 March 1975	231	In force: 24 October 2001
Egypt		In force: 30 June 1982	302	
El Salvador[2]	X	In force: 22 April 1975	232	In force: 24 May 2004
Equatorial Guinea	X	*Approved: 13 June 1986*		
Eritrea				
Estonia[13]		Accession: 1 December 2005	193	Accession: 1 December 2005
Ethiopia	X	In force: 2 December 1977	261	
Fiji	X	In force: 22 March 1973	192	In force: 14 July 2006
Finland[14]		Accession: 1 October 1995	193	In force: 30 April 2004
France		In force: 12 September 1981 In force: 26 October 2007[15]	290* 718	In force: 30 April 2004
Gabon	X	*Signed: 3 December 1979*		*Signed: 8 June 2005*
Gambia	X	In force: 8 August 1978	277	
Georgia		In force: 3 June 2003	617	In force: 3 June 2003
Germany[16]		In force: 21 February 1977	193	In force: 30 April 2004
Ghana		In force: 17 February 1975	226	In force: 11 June 2004

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Greece[17]		Accession: 17 December 1981	193	In force: 30 April 2004
Grenada[2]	X	In force: 23 July 1996	525	
Guatemala[2]	X	In force: 1 February 1982	299	In force: 28 May 2008
Guinea				
Guinea-Bissau				
Guyana[2]	X	In force: 23 May 1997	543	
Haiti[2]	X	In force: 9 March 2006	681	In force: 9 March 2006
Holy See	Amended: 11 September 2006	In force: 1 August 1972	187	In force: 24 September 1998
Honduras[2]	Amended: 20 September 2007	In force: 18 April 1975	235	Signed: 7 July 2005
Hungary[18]		Accession: 1 July 2007	193	Accession: 1 July 2007
Iceland	X	In force: 16 October 1974	215	In force: 12 September 2003
India		In force: 30 September 1971 In force: 17 November 1977 In force: 27 September 1988 In force: 11 October 1989 In force: 1 March 1994 In force: 11 May 2009	211 260 360 374 433 754	 Signed: 15 May 2009
Indonesia		In force: 14 July 1980	283	In force: 29 September 1999
Iran, Islamic Republic of		In force: 15 May 1974	214	Signed: 18 December 2003
Iraq		In force: 29 February 1972	172	Signed: 9 October 2008
Ireland		In force: 21 February 1977	193	In force: 30 April 2004
Israel		In force: 4 April 1975	249/Add.1	
Italy		In force: 21 February 1977	193	In force: 30 April 2004
Jamaica[2]	Rescinded: 15 December 2006	In force: 6 November 1978	265	In force: 19 March 2003
Japan		In force: 2 December 1977	255	In force: 16 December 1999
Jordan	X	In force: 21 February 1978	258	In force: 28 July 1998
Kazakhstan		In force: 11 August 1995	504	In force: 9 May 2007
Kenya	In force: 18 September 2009	In force: 18 September 2009	778	In force: 18 September 2009
Kiribati	X	In force: 19 December 1990	390	Signed: 9 November 2004
Korea, Republic of		In force: 14 November 1975	236	In force: 19 February 2004
Kuwait	X	In force: 7 March 2002	607	In force: 2 June 2003
Kyrgyzstan	X	In force: 3 February 2004	629	Signed: 29 January 2007
Lao People's Democratic Republic	X	In force: 5 April 2001	599	
Latvia[19]		Accession: 1 October 2008	193	Accession: 1 October 2008
Lebanon	Amended: 5 September 2007	In force: 5 March 1973	191	
Lesotho	Amended: 8 September 2009	In force: 12 June 1973	199	Approved: 24 September 2008
Liberia				

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Libyan Arab Jamahiriya		In force: 8 July 1980	282	In force: 11 August 2006
Liechtenstein		In force: 4 October 1979	275	Signed: 14 July 2006
Lithuania[20]		Accession: 1 January 2008	193	Accession: 1 January 2008
Luxembourg		In force: 21 February 1977	193	In force: 30 April 2004
Madagascar	Amended: 29 May 2008	In force: 14 June 1973	200	In force: 18 September 2003
Malawi	Amended: 29 February 2008	In force: 3 August 1992	409	In force: 26 July 2007
Malaysia		In force: 29 February 1972	182	Signed: 22 November 2005
Maldives	X	In force: 2 October 1977	253	
Mali	Amended: 18 April 2006	In force: 12 September 2002	615	In force: 12 September 2002
Malta[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 December 2009		In force: 10 December 2009
Mauritius	Amended: 26 September 2008	In force: 31 January 1973	190	In force: 17 December 2007
Mexico[22]		In force: 14 September 1973	197	Signed: 29 March 2004
Micronesia, Federated States of				
Monaco	Amended: 27 November 2008	In force: 13 June 1996	524	In force: 30 September 1999
Mongolia	X	In force: 5 September 1972	188	In force: 12 May 2003
Montenegro	*Signed: 26 May 2008*	*Signed: 26 May 2008*		*Signed: 26 May 2008*
Morocco	Rescinded: 15 November 2007	In force: 18 February 1975	228	Signed: 22 September 2004
Mozambique	*Approved: 22 November 2007*	*Approved: 22 November 2007*		*Approved: 22 November 2007*
Myanmar	X	In force: 20 April 1995	477	
Namibia	X	In force: 15 April 1998	551	Signed: 22 March 2000
Nauru	X	In force: 13 April 1984	317	
Nepal	X	In force: 22 June 1972	186	
Netherlands	X	In force: 5 June 1975 [15] In force: 21 February 1977	229 193	In force: 30 April 2004
New Zealand[23]	X	In force: 29 February 1972	185	In force: 24 September 1998
Nicaragua[2]	Amended: 12 June 2009	In force: 29 December 1976	246	In force: 18 February 2005
Niger		In force: 16 February 2005	664	In force: 2 May 2007
Nigeria		In force: 29 February 1988	358	In force: 4 April 2007
Norway		In force: 1 March 1972	177	In force: 16 May 2000
Oman	X	In force: 5 September 2006	691	

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Pakistan		In force: 5 March 1962 In force: 17 June 1968 In force: 17 October 1969 In force: 18 March 1976 In force: 2 March 1977 In force: 10 September 1991 In force: 24 February 1993 In force: 22 February 2007	34 116 135 239 248 393 418 705	
Palau	Amended: 15 March 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[9]	X	In force: 23 March 1984	316	In force: 11 December 2001
Papua New Guinea	X	In force: 13 October 1983	312	
Paraguay[2]	X	In force: 20 March 1979	279	In force: 15 September 2004
Peru[2]		In force: 1 August 1979	273	In force: 23 July 2001
Philippines		In force: 16 October 1974	216	Signed: 30 September 1997
Poland[24]		Accession: 1 March 2007	193	Accession: 1 March 2007
Portugal[25]		Accession: 1 July 1986	193	In force: 30 April 2004
Qatar	In force: 21 January 2009	In force: 21 January 2009	747	
Republic of Moldova	X	In force: 17 May 2006	690	Approved: 13 September 2006
Romania		In force: 27 October 1972	180	In force: 7 July 2000
Russian Federation		In force: 10 June 1985	327*	In force: 16 October 2007
Rwanda	*Signed: 18 November 2009*	*Signed: 18 November 2009*		*Signed: 18 November 2009*
Saint Kitts and Nevis[5]	X	In force: 7 May 1996	514	
Saint Lucia[5]	X	In force: 2 February 1990	379	
Saint Vincent and the Grenadines[5]	X	In force: 8 January 1992	400	
Samoa	X	In force: 22 January 1979	268	
San Marino	X	In force: 21 September 1998	575	
São Tomé e Príncipe				
Saudi Arabia	X	In force: 13 January 2009	746	
Senegal	X	In force: 14 January 1980	276	Signed: 15 December 2006
Serbia[26]		In force: 28 December 1973	204	Signed: 3 July 2009
Seychelles	Amended: 31 October 2006	In force: 19 July 2004	635	In force: 13 October 2004
Sierra Leone	X	In force: 4 December 2009		
Singapore	Amended: 31 March 2008	In force: 18 October 1977	259	In force: 31 March 2008
Slovakia[27]		Accession: 1 December 2005	193	Accession: 1 December 2005
Slovenia[28]		Accession: 1 September 2006	193	Accession: 1 September 2006
Solomon Islands	X	In force: 17 June 1993	420	
Somalia				
South Africa		In force: 16 September 1991	394	In force: 13 September 2002

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a,b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

State	SQP[c]	Status of safeguards agreement(s)	INFCIRC	Status of Additional Protocol(s)
Spain		Accession: 5 April 1989	193	In force: 30 April 2004
Sri Lanka		In force: 6 August 1984	320	
Sudan	X	In force: 7 January 1977	245	
Suriname[2]	X	In force: 2 February 1979	269	
Swaziland	X	In force: 28 July 1975	227	Approved: 4 March 2008
Sweden[29]		Accession: 1 June 1995	193	In force: 30 April 2004
Switzerland		In force: 6 September 1978	264	In force: 1 February 2005
Syrian Arab Republic		In force: 18 May 1992	407	
Tajikistan[30]	Amended: 6 March 2006	In force: 14 December 2004	639	In force: 14 December 2004
Thailand		In force: 16 May 1974	241	Signed: 22 September 2005
The Former Yugoslav Rep. of Macedonia	Amended: 9 July 2009	In force: 16 April 2002	610	In force: 11 May 2007
Timor-Leste	*Signed: 6 October 2009*	*Signed: 6 October 2009*		*Signed: 6 October 2009*
Togo	X	*Signed: 29 November 1990*		*Signed: 26 September 2003*
Tonga	X	In force: 18 November 1993	426	
Trinidad and Tobago[2]	X	In force: 4 November 1992	414	
Tunisia		In force: 13 March 1990	381	Signed: 24 May 2005
Turkey		In force: 1 September 1981	295	In force: 17 July 2001
Turkmenistan		In force: 3 January 2006	673	In force: 3 January 2006
Tuvalu	X	In force: 15 March 1991	391	
Uganda	Amended: 24 June 2009	In force: 14 February 2006	674	In force: 14 February 2006
Ukraine		In force: 22 January 1998	550	In force: 24 January 2006
United Arab Emirates	X	In force: 9 October 2003	622	Signed: 8 April 2009
United Kingdom	X	In force: 14 December 1972[31] In force: 14 August 1978 Approved: 16 September 1992[15]	175 263*	In force: 30 April 2004
United Rep. of Tanzania	Amended: 10 June 2009	In force: 7 February 2005	643	In force: 7 February 2005
United States of America	X	In force: 9 December 1980 In force: 6 April 1989[15]	288* 366	In force: 6 January 2009
Uruguay[2]		In force: 17 September 1976	157	In force: 30 April 2004
Uzbekistan		In force: 8 October 1994	508	In force: 21 December 1998
Vanuatu	*Approved: 8 September 2009*	*Approved: 8 September 2009*		*Approved: 8 September 2009*
Venezuela[2]		In force: 11 March 1982	300	
Vietnam		In force: 23 February 1990	376	Signed: 10 August 2007
Yemen, Republic of	X	In force: 14 August 2002	614	
Zambia	X	In force: 22 September 1994	456	Signed: 13 May 2009
Zimbabwe	X	In force: 26 June 1995	483	

Table A6. Status with regard to the conclusion of safeguards agreements, additional protocols[a, b] and small quantities protocols[c] (as of 31 December 2009) (cont.)

Key

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

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

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

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

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

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

[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 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.

[27] 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.

[28] 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.

[29] 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.

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

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

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	AFGHANISTAN			P		Sr	Sr						S	P	
*	ALBANIA	P		P		P	P						S	P	P
*	ALGERIA			Pr	CS	Pr	Pr		S				S	P	P
	ANDORRA			Pr											
*	ANGOLA					P							S		
	ANTIGUA BARBUDA			P	CS										
*	ARGENTINA	P	P	Pr		Pr	Pr	S	P	P	P	CS	S	P	P
*	ARMENIA		P	P		P	P		P				S		
*	AUSTRALIA	P		P	CS	Pr	Pr		P	P		S			
*	AUSTRIA			Pr	CS	P	Pr		Pr	P				P	P
*	AZERBAIJAN			Pr									S		
	BAHAMAS			Pr											
	BAHRAIN														
*	BANGLADESH			P		P	P		P				S		
	BARBADOS														
*	BELARUS	Pr	P	Pr		Pr	Pr		P	P	P		S	P	P
*	BELGIUM	Pr		Pr		P	P	S	P	P					
*	BELIZE												S		
*	BENIN	P											S		
	BHUTAN														
*	BOLIVIA	P	P	P		Pr	Pr						S		
*	BOSNIA AND HER.	P	P	P		P	P						S		
*	BOTSWANA			P									S		
*	BRAZIL	P	P	P		P	P		P	P			S	P	P
	BRUNEI														
*	BULGARIA	P	P	P	CS	P	P	P	P	P			S	P	P
*	BURKINA FASO			P									S		
	BURUNDI														
	CAMBODIA			P											
*	CAMEROON	P	P	P		P	P	P					S		
*	CANADA	Pr		P		Pr	Pr		P	P				P	P

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	CAPE VERDE			P											
*	CENT. AFR. REP.			P											
*	CHAD														
*	CHILE	Pr	Pr	P	CS	P	P	P	P				S		
*	CHINA	Pr		Pr	CS	Pr	Pr		P	Pr			S		
*	COLOMBIA	P	S	P		P	Pr						S		
	COMOROS			P											
	CONGO														
*	COSTA RICA			P		P	P						S		
*	CÔTE D'IVOIRE					S	S						S		
*	CROATIA	P	P	P	CS	P	P	P	P	P			S	P	P
*	CUBA	Pr	P	Pr		Pr	Pr		S				S		
*	CYPRUS	P		Pr		P	P		P				S		
*	CZECH REPUBLIC	P	P	P		P	P	P	P	P	S	S	S	P	P
	DPRK					Sr	Sr								
*	D. REP. CONGO	P		P		S	S						S		
*	DENMARK	Pr		P		P	Pr	P	Pr	Pr					
	DJIBOUTI			P											
	DOMINICA			P											
*	DOMINICAN REP.			P									S		
*	ECUADOR	P		P									S		
*	EGYPT	P	P			Pr	Pr	P	S				S		
*	EL SALVADOR			P		Pr	Pr						S	P	
	EQ. GUINEA			P											
*	ERITREA														
*	ESTONIA	P	P	P	CS	P	P	P	P	P			S	P	P
*	ETHIOPIA												S	P	
	FIJI			P	CS										
*	FINLAND	P		Pr		P	Pr	P	P	P				P	P
*	FRANCE			Pr		Pr	Pr	S	P	P				P	P
*	GABON			P	CS	P	P								

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	GAMBIA														
*	GEORGIA			P						P			S		
*	GERMANY	Pr		Pr		Pr	Pr	P	P	P				P	P
*	GHANA	P		P					S				S		
*	GREECE	P		Pr		Pr	Pr	P	P	P			S	P	P
	GRENADA			P											
*	GUATEMALA			Pr		P	P						S		
	GUINEA			P											
	GUINEA-BISSAU			P											
	GUYANA			P											
*	HAITI			S									S		
*	HOLY SEE	P				S	S							P	P
*	HONDURAS			P									S		
*	HUNGARY	Pr	P	P	CS	P	P	P	P	P	S		S	P	P
*	ICELAND	P		P		P	P		P	P			S	P	P
*	INDIA	P		Pr	CS	Pr	Pr		P						
*	INDONESIA	Pr		Pr		Pr	Pr		P	S	S	S	S		
*	IRAN, ISL. REP.	P				Pr	Pr						S		P
*	IRAQ	P				Pr	Pr						S		
*	IRELAND	P		Pr		P	Pr		P	P			S	P	P
*	ISRAEL		Sr	Pr		Pr	Pr		S				S		
*	ITALY	Pr		Pr		Pr	Pr	P	P	P	S	S		P	P
*	JAMAICA	P		P									S		
*	JAPAN	P		P		P	Pr		P	Pr				P	P
*	JORDAN	Pr		Pr	CS	P	P		P				S		
*	KAZAKHSTAN	P		P					S	S			S		
*	KENYA			P	CS								S		P
	KIRIBATI														
*	KOREA, REP.	Pr		Pr		P	Pr		P	P			S	P	P
*	KUWAIT	P		Pr		P	P		P				S		
*	KYRGYZSTAN									P			S		

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
	LAO P. DEM. REP.														
*	LATVIA	P	P	P		P	P	P	P	P	P		S	P	P
*	LEBANON		P	P		P	P		P	S	S	S	S		
	LESOTHO														
*	LIBERIA														
*	LIBYAN ARAB J.			P	CS	P	P		P				S	P	
*	LIECHTENSTEIN			P	CS	P	P							P	P
*	LITHUANIA	P	P	P	CS	P	P	P	P	P	S	S	S	P	P
*	LUXEMBOURG	Pr		Pr		P	P		P	P				P	P
*	MADAGASCAR			P									S		
*	MALAWI														
*	MALAYSIA					Pr	Pr						S		
	MALDIVES														
*	MALI			P		P	P		P				S		
*	MALTA			P									S	P	P
*	MARSHALL IS.			P											
*	MAURITANIA			P	CS								S		
*	MAURITIUS	P				Pr	Pr						S		
*	MEXICO	Pr	P	P		P	P		P				S	P	
	MICRONESIA														
*	MONACO			P		Pr	Pr		S					P	P
*	MONGOLIA	P		P		P	P						S		
*	MONTENEGRO	P	P	P		P	P						S		
*	MOROCCO	Pr	S	P		P	P	S	S	P	P	CS	S	P	
*	MOZAMBIQUE			Pr		P	P								
*	MYANMAR					Pr							S	P	P
*	NAMIBIA			P									S		
	NAURU			P											
*	NEPAL														
*	NETHERLANDS	P		Pr		Pr	Pr	P	P	P				P	P
*	NEW ZEALAND	P		P		P	Pr								

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	NICARAGUA	P		P		Pr	Pr		S				S		
*	NIGER	P	P	P	CS	S	S						S		
*	NIGERIA	P	P	P	CS	P	P		P	P			S		
	NIUE			P											
*	NORWAY	P		Pr	CS	P	Pr	P	P	P					
	OMAN			Pr		Pr	Pr								
*	PAKISTAN	Pr		Pr		Pr	Pr		P				S	P	P
*	PALAU			P											
*	PANAMA			P		P	P						S	P	
	PAPUA N. GUINEA														
*	PARAGUAY			P		S	S						S		
*	PERU		P	Pr		Pr	Pr		P	S	S	S	S	P	P
*	PHILIPPINES	P	P	P		P	P	S	S	S	S	S	S		
*	POLAND	P	P	P	CS	P	P	P	P	P	S		S	P	P
*	PORTUGAL	Pr		Pr		P	P	S	P	P			S		
*	QATAR			Pr		P	P						S		
*	REP. OF MOLDOVA	Pr	P	P	CS	P	P		P				S		
*	ROMANIA	Pr	P	Pr	CS	Pr	Pr	P	P	P	P	CS	S	P	P
*	RUSSIAN FED.	Pr	P	Pr	CS	Pr	Pr		P	P					
	RWANDA														
	ST KITTS NEVIS			P											
	SAINT LUCIA														
	ST VINCT GRENAD.		P			P	P	P							
	SAMOA														
	SAN MARINO														
	SÃO TOMÉ PRN.														
*	SAUDI ARABIA			Pr		Pr	Pr						S		
*	SENEGAL	P		P		P	P		P	P			S		
*	SERBIA	P	P	P		P	P						S		
*	SEYCHELLES			P	CS								S		
*	SIERRA LEONE					S	S						S		

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	SINGAPORE	Pr				P	P		P				S		
*	SLOVAKIA	P	P	P		Pr	Pr	P	P	P			S	P	P
*	SLOVENIA	P		P	CS	P	P	P	P	P			S	P	P
	SOLOMON ISLANDS														
	SOMALIA														
*	SOUTH AFRICA	Pr		Pr		Pr	Pr		P	P			S		
*	SPAIN	P	S	Pr	CS	Pr	Pr	S	P	P			S	P	P
*	SRI LANKA					Pr	Pr		P				S		
*	SUDAN			P		S	S		S				S		
	SURINAME														
	SWAZILAND			P											
*	SWEDEN	P		Pr		P	Pr	P	P	P				P	P
*	SWITZERLAND	Pr		Pr	CS	P	P	S	P	P				P	P
*	SYRIAN ARAB REP.	P				S	S		S				S		
*	TAJIKISTAN	P		P									S		
*	THAILAND	Pr				Pr	Pr						S		
*	TFYR MACEDONIA		P	P		P	P		P				S		
	TIMOR-LESTE														
	TOGO			P											
	TONGA			P											
	TRINIDAD TOBAGO		P	P											
*	TUNISIA	P		P		P	P		S				S		P
*	TURKEY	Pr		Pr		Pr	Pr	P	P				S	P	P
	TURKMENISTAN			P	CS										
	TUVALU														
*	UGANDA			P									S		
*	UKRAINE	Pr	P	P	CS	Pr	Pr	P	Pr	P	S	S	S	P	P
*	UTD ARAB EMR.			P	CS	Pr	Pr		P	P			S		
*	UNITED KINGDOM	P	S	Pr		Pr	Pr	S	P	P				P	P
*	UTD REP. TANZANIA			P		P	P						S		
*	USA			P		Pr	Pr		P	P		CS			

Table A7. Participation by States in multilateral treaties for which the Director General is depositary, conclusion of Revised Supplementary Agreements and acceptance of amendments to Articles VI and XIV.A of the Agency's Statute (status as of 31 December 2009) (cont.)

	STATE	P&I	VC	CPPNM	CPPNM-AM	ENC	AC	JP	NS	RADW	PAVC	SUPP	RSA	VI	XIV.A
*	URUGUAY		P	P		P	P	P	P	P			S		
*	UZBEKISTAN			P						P			S		
	VANUATU														
*	VENEZUELA												S		
*	VIETNAM	P				Pr	Pr						S		
*	YEMEN			P											
*	ZAMBIA												S		
*	ZIMBABWE					S	S						S		

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

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 2009, two States became Party to the Agreement. By the end of the year, there were 81 Parties.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2009, one State became Party to the Convention. By the end of the year, there were 36 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2009, the status remained unchanged, with two Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2009, four States became Party to the Convention. By the end of the year, there were 142 Parties.

Amendment to the Convention on the Physical Protection of Nuclear Material. Adopted on 8 July 2005. In 2009, 11 States adhered to the Amendment, bringing the total to 33 States.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2009, four States became Party to the Convention. By the end of the year, there were 106 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 2009, three States became Party to the Convention. By the end of the year, there were 104 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 2009, one State became Party to the Protocol. By the end of the year, there were 26 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2009, four States became Party to the Convention. By the end of the year, there were 66 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 2009, five States became Party to the Convention. By the end of the year, there were 51 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 2009, the status remained unchanged, with five Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Opened for signature on 29 September 1997. In 2009, the status remained unchanged, with four Contracting States and 13 Signatories.

Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA). In 2009, two States became Party to the Agreement. By the end of the year, there were 111 States that concluded RSA Agreements.

Fourth Agreement to Extend the 1987 Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) (reproduced in INFCIRC/167/Add.22). Entered into force on 26 February 2007 with effect from 12 June 2007. In 2009, two States became Party to the Agreement. By the end of the year, there were 15 Parties.

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

African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (Third Extension) (reproduced in INFCIRC/377). Entered into force on 4 April 2005. In 2009, three States became Party to the Agreement. By the end of the year, there were 33 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 2009, three States became Party to the Agreement. By the end of the year, there were 18 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 2009, the status remained unchanged, with seven 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 2009, the status remained unchanged, with seven Parties.

Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/703). Entered into force on 24 October 2007. In 2009, the status remained unchanged, with six Parties.

Table A9. Integrated Regulatory Review Service (IRRS) missions in 2009

Type	Country
Preparatory IRRS for main mission	Vietnam
IRRS	Canada
IRRS	Lebanon
IRRS	Peru
IRRS	Russian Federation
IRRS	Vietnam
IRRS 2nd Mission	United Kingdom
IRRS Follow-up	France
IRRS Self-Assessment Seminar	Russian Federation

Table A10. Safety Culture Assessment Review Team (SCART) missions in 2009

Type	Organization	Country
SCART	Laguna Verde	Mexico
SCART Follow-up	Santa-Maria de Garona	Spain

Table A11. Operational Safety Review Team (OSART) missions in 2009		
Type	**Nuclear power plant**	**Country**
Preparatory OSART	Ringhals	Sweden
Preparatory OSART	Doel	Belgium
Preparatory OSART	St Alban	France
Preparatory OSART	Bohunice	Slovakia
OSART	Mihama	Japan
OSART	Oskarshamn	Sweden
OSART	Fessenheim	France
OSART	Vandellos	Spain
OSART	South Ukraine	Ukraine
OSART	Ling Ao	China
Follow-up OSART	Tihange	Belgium
Follow-up OSART	South Ukraine	Ukraine
Follow-up OSART	Neckarwestheim	Germany
Follow-up OSART	Khmelnitsky	Ukraine
Follow-up OSART	Forsmark	Sweden
Follow-up OSART	Chinon	France

Table A12. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2009		
Type	**Organization/Nuclear power plant**	**Country**
PROSPER Follow-up	Angra-1	Brazil

Table A13. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2009		
Type	**Location**	**Country**
INSARR	Kingston	Jamaica
INSARR	Abuja	Nigeria
INSARR Follow-up	Rabat	Morocco
INSARR Follow-up	Accra	Ghana
INSARR Follow-up	Tehran	Islamic Republic of Iran
INSARR Follow-up	Tashkent	Uzbekistan

Table A14. Emergency Preparedness Review (EPREV) missions in 2009	
Type	**Country**
EPREV	The Former Yugoslav Republic of Macedonia
EPREV	Malaysia
EPR component in the following IRRS missions in 2009:	
IRRS	Peru
IRRS	Vietnam
IRRS	United Kingdom

Table A15. International Nuclear Security Advisory Service (INSServ) missions in 2009	
Type	**Country**
INSServ	Cuba

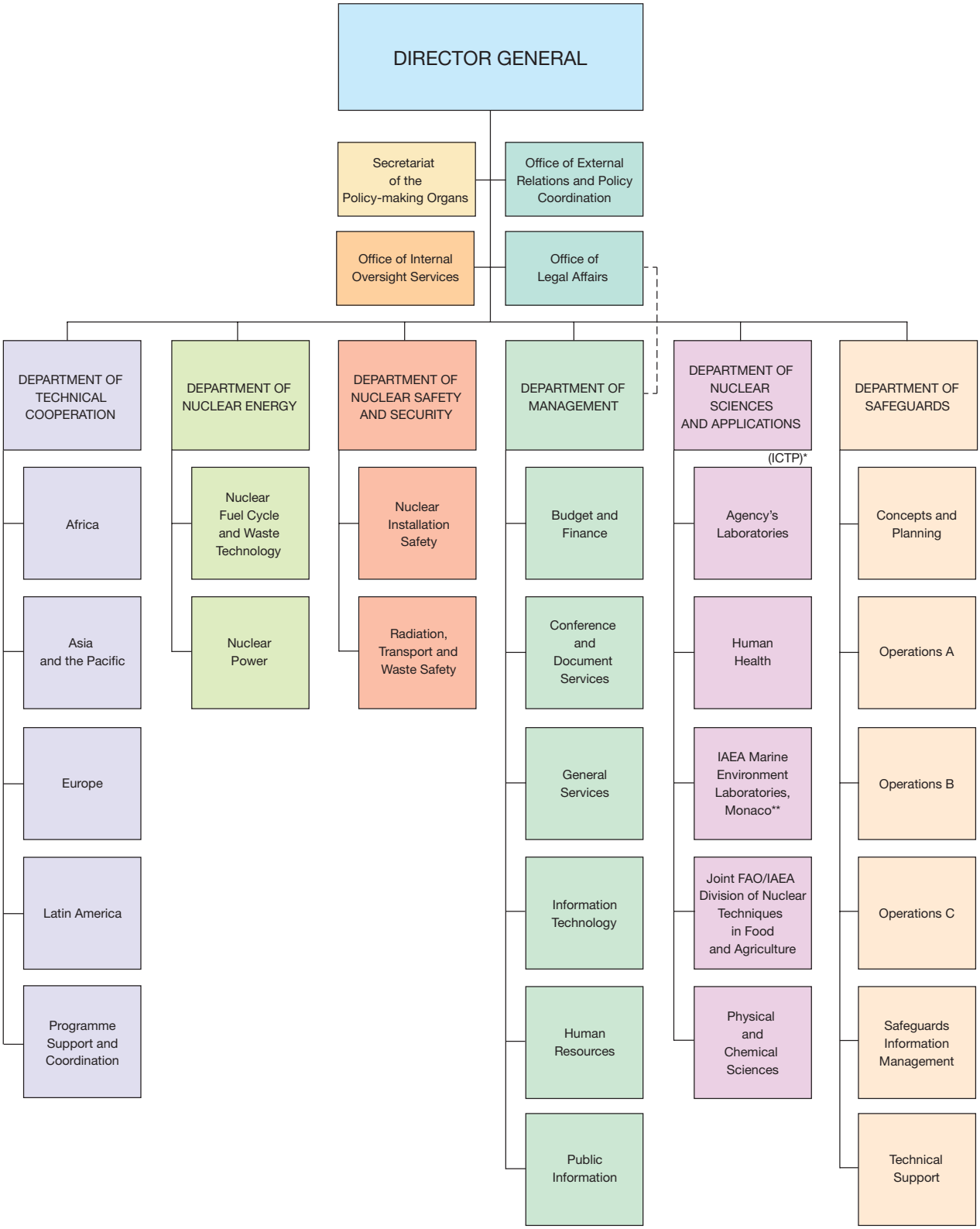
Table A16. International Physical Protection Advisory Service (IPPAS) missions in 2009	
Type	**Country**
IPPAS	Netherlands
IPPAS	Finland
IPPAS	Turkmenistan
IPPAS	Bangladesh
IPPAS	Singapore
IPPAS Follow-up	Belarus
International Team of Experts mission	Uzbekistan

Table A17. IAEA SSAC Advisory Service (ISSAS) missions in 2009	
Type	**Country**
ISSAS	Saudi Arabia

Table A18. International PSA Review Team (IPSART) missions in 2009	
Type	**Nuclear Power Plant**
IPSART	Chashma, Pakistan
IPSART	Belene, Bulgaria

Organizational Chart

(as of 31 December 2009)



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

** With the participation of UNEP and IOC.

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

Article II of the IAEA Statute

IAEA

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