

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.

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

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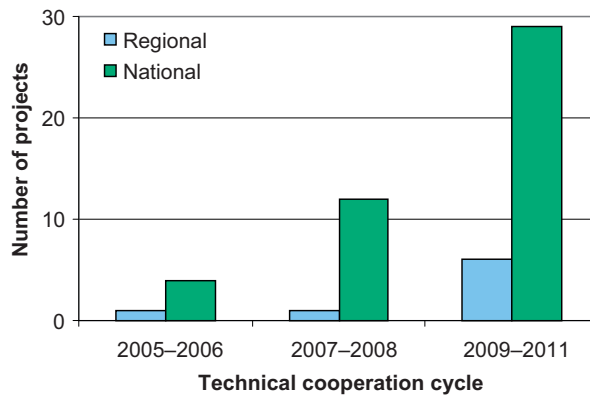


FIG. 1. Technical cooperation projects related to nuclear power.

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

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

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.

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

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.

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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

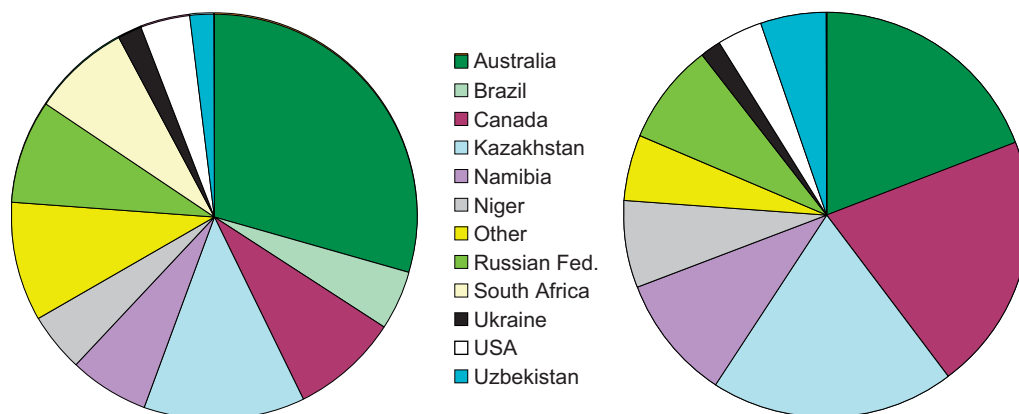


FIG. 2. Geographical distribution of identified conventional uranium resources recoverable at a cost of less than \$130/kg U (left) and of uranium production in 2008 (right).

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.

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,

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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 produc-

tively. 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

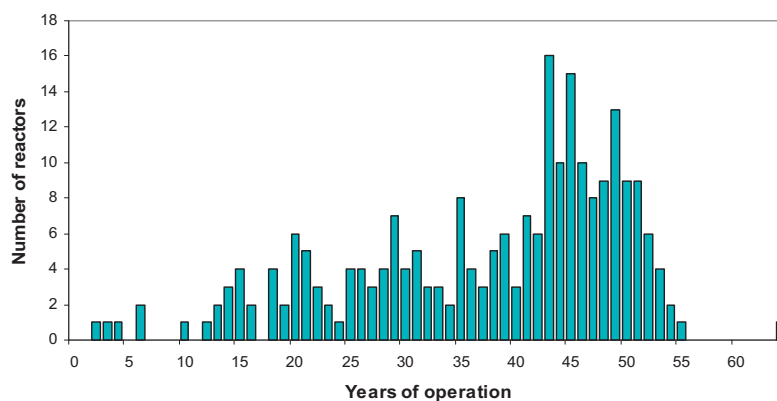


FIG. 3. Age distribution of operating research reactors worldwide.

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.

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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.

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.

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

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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 number of PACT Model Demonstration Sites (PMDs) grew to seven, with Ghana joining Albania, Nicaragua, Sri Lanka, the United Republic of Tanzania, Vietnam and Yemen. The PMDs 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

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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.

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.

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.

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, 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.

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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 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 attainment⁴ 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.

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.

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

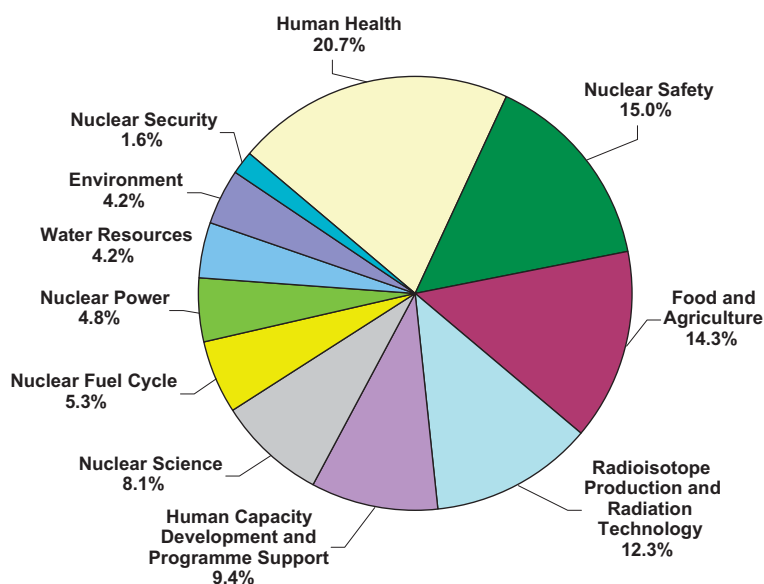


FIG. 6. Distribution of technical cooperation disbursements in 2009 by Agency programme (percentages in this chart may not add up to 100 exactly due to rounding).

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

Safeguards Conclusions for 2009

In 2009, safeguards were applied for 170⁶ 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."

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.

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,

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 anthropogenic⁹ 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.”

⁹ ‘Anthropogenic’ refers to nuclear material that has been produced as a result of chemical processing.

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

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.

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.