Overview

In 2019, the Agency continued to pursue the objective of accelerating and enlarging the "contribution of atomic energy to peace, health and prosperity throughout the world" while ensuring that assistance provided by it "is not used in such a way as to further any military purpose." Within the framework of its Statute, the Agency maintained the flexibility to address the evolving needs of Member States and to help them achieve their national development goals.

This chapter provides an overview of some of the programmatic activities that focused, in a balanced manner, on developing and transferring nuclear technologies for peaceful applications, enhancing nuclear safety and security, and strengthening nuclear verification and non-proliferation efforts worldwide.

NUCLEAR TECHNOLOGY

Nuclear Power

Status and trends

At the end of 2019, the world's 443 operational nuclear reactors had a global generating capacity of 392.1 gigawatts (electrical) (GW(e)). During the year, 6 nuclear power reactors were connected to the grid and 13 were permanently shut down. Construction started on 5 reactors, with a total of 54 reactors under construction around the world.

The Agency's 2019 projections offer a mixed picture of nuclear power's future contribution to global electricity generation, depending in part on whether significant new capacity can be added to offset potential reactor retirements. The projections show global installed nuclear power capacity gradually declining until 2040 before rebounding to 371 GW(e) by 2050 in the low case. In the high case, capacity increases 25% by 2030 and 80% by 2050. Nuclear power's share of global electricity production declines to about 6% in the low case and increases to about 12% in the high case by 2050, compared with 10% today.

Major conferences

The Agency organized the International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Learning from the Past, Enabling the Future, to foster exchange of information on national spent fuel management strategies and on the ways a changing energy mix could influence these strategies. At the conference, held in Vienna, participants discussed advances in spent fuel management and explored ways to overcome challenges, including how collaborative research and development can lead to attainable solutions.

The Agency's first International Conference on Climate Change and the Role of Nuclear Power, held in Vienna, attracted more than 500 participants from 79 Member States and

17 international organizations, including heads of several international organizations and high level representatives of 13 Member States. Participants recognized the value of nuclear power in the transition to low carbon energy systems and the importance of considering every option in addressing the climate change challenge.

Climate change and sustainable development

At the 25th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP25), the Director General participated in a high level side event on Sustainable Development Goal (SDG) 7, on access to affordable and clean energy. The Director General emphasized that nuclear energy is part of the solution to the climate change crisis. The Agency also organized a side event on the role of low carbon energy options, including nuclear power, in national decarbonization strategies.

At the 2019 High-level Political Forum on Sustainable Development, the Agency delivered a statement in the plenary session on SDG 13, on climate action, highlighting the contribution of nuclear technology in addressing climate change and the SDGs.

Energy assessment services

"[The Agency] conducted 81 capacity building events, providing training in energy planning to over 730 professionals from over 80 Member States"

The Agency continued updating and enhancing its energy planning tools — in use by 150 Member States and over 20 international and other organizations — as well as related multilingual training materials, including e-learning packages. It conducted 81 capacity building events, providing training in energy planning to over 730 professionals from over 80 Member States in Africa, Asia, eastern Europe, and Latin America and the Caribbean. These activities helped to build their capacity to identify the future energy needs of their countries and the role of different technologies in meeting them.

The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) held its Dialogue Forum in the Republic of Korea. The event focused on opportunities and challenges relating to small and medium sized or modular reactors.

Support to operating nuclear power plants

Agency activities to support Member States in supply chain management included a Pilot Training Course on Nuclear Supply Chain Management and Procurement, and the release of a beta version of associated web tools that can help to identify potential problems as well as suitable solutions.

The Agency also developed new and strengthened existing partnerships. Together with the Electric Power Research Institute (EPRI) (United States of America), the Korea Hydro & Nuclear Power Company (Republic of Korea), the National Nuclear Laboratory (United Kingdom) and the Nuclear Energy Agency (NEA), the Agency organized a Global Forum on Innovation for the Future of Nuclear Energy, held in Gyeongju, Republic of Korea. The forum focused on accelerating the deployment of innovative solutions to help ensure the sustainability of operating nuclear power plants.

Launching nuclear power programmes

The Agency conducted an Integrated Nuclear Infrastructure Review (INIR) Phase 2 mission to Egypt and an INIR Phase 1 follow-up mission to Ghana. It also tested application of the INIR methodology to evaluate an expanding nuclear power programme using the case of Bulgaria.

Six expert missions were conducted to assist and advise key organizations on the development of leadership and management systems and on improving nuclear organizational culture. Through Integrated Nuclear Infrastructure Training (INIT), the

Agency carried out 33 interregional training activities, with around 500 participants, aimed at increasing Member State awareness and understanding of the Milestones Approach to the development of national infrastructure for a nuclear power programme.

Capacity building, knowledge management and nuclear information

The Agency's Nuclear Energy Management (NEM) and Nuclear Knowledge Management (NKM) Schools offer training for professionals in the nuclear field to develop their technical, leadership and knowledge management skills. By the end of 2019, more than 1800 participants from about 80 Member States had participated in the two schools, and their impact was reflected in the reported launch of procedure manuals and knowledge transfer protocols in Member States.

The membership of the International Nuclear Information System (INIS) comprised 132 Member States and 24 international organizations in 2019. The number of bibliographic records grew to 4.3 million, with over 3.6 million page views. The IAEA Library increased the number of electronic journals available by 26% to over 79 000 titles.

Stakeholder involvement

The Agency launched an updated version of the Nuclear Communicator's Toolbox, which provides resources for communicating on the benefits and risks associated with the use of nuclear technologies. The toolbox is intended for scientists, engineers and communication professionals in the field of nuclear science and technology.

A new webinar series was also initiated, to support Member States in engaging with stakeholders when operating, expanding or embarking on a nuclear power programme.

Assurance of supply

With LEU Delivery, IAEA LEU Bank Became Operational in 2019

The IAEA Low Enriched Uranium Bank in Kazakhstan became operational on 17 October when the Agency took delivery of a shipment of low enriched uranium (LEU) at a purpose-built facility. A second and final shipment of LEU arrived on

10 December, completing the stock at the IAEA LEU Bank, established to provide assurance to countries about the supply of nuclear fuel.

Owned by the Agency and hosted by Kazakhstan, the IAEA LEU Bank is one of the Agency's most ambitious undertakings since the organization was founded in 1957. The project, launched in 2010, required concerted efforts spanning the Agency's activities, including negotiating a legal framework with Kazakhstan, transit agreements and transport contracts, designing and building a storage facility and acquiring 90 tonnes of LEU in what was the Agency's largest single procurement.

The IAEA LEU Bank now has enough material for approximately one complete core for a 1000 MW(e) pressurized water reactor. Its operations are fully funded for at least 20 years by voluntary contributions totalling US $150 million. Donors include Kazakhstan, Kuwait, Norway, the United Arab Emirates, the United States of America, the European Union and the Nuclear Threat Initiative. Kazakhstan also contributed in kind by hosting the IAEA LEU Bank.

An LEU reserve in Angarsk, established following the Agreement of February 2011 between the Government of the Russian Federation and the Agency, remained operational.

Fuel cycle

The Agency published the results of a series of coordinated research projects (CRPs) on the management of spent nuclear fuel. The results of the research — spanning almost four decades — are available in the Agency publication *Behaviour of Spent Power Reactor Fuel during Storage* (IAEA-TECDOC-1862), which includes relevant data, observations and recommendations by experts on this topic. Twelve Agency publications on fuel cycle related topics were issued — two IAEA Nuclear Energy Series publications, two conference proceedings and eight IAEA Technical Documents (TECDOCs).

Technology development and innovation

The Agency expanded its partnerships in the area of nuclear technology development and innovation. The Swiss Federal Institute of Technology Lausanne (EPFL) was designated as a Collaborating Centre to support Member States in increasing their modelling and simulation capabilities in the field of advanced reactors. The agreement envisages the creation of an international network under the Agency's aegis for the development and application of open source multi-physics simulation techniques in support of research, development, education and training in nuclear science and technology.

The Pakistan Institute of Engineering and Applied Sciences (PIEAS) was designated as a Collaborating Centre in the area of research, development and capacity building in the application of advanced and innovative nuclear technologies. This collaboration will help Member States to strengthen their capacities in reactor technology design, nuclear–renewable hybrid energy systems, and numerical modelling and simulations.

Research reactors

The Agency developed and launched a new peer review service called Integrated Research Reactor Utilization Review (IRRUR) to support Member States in assessing and enhancing the utilization of their research reactors. A pilot mission was conducted to the TRIGA research reactor at the University of Pavia, Italy.

The Korea Atomic Energy Research Institute became an IAEA-designated International Centre based on Research Reactor (ICERR), joining ICERRs in Belgium, France, the Russian Federation and the United States of America.

Radioactive waste management, decommissioning and environmental remediation

The Agency completed the development of the Spent Fuel and Radioactive Waste Information System (SRIS). The system provides a single, authoritative view of national spent fuel and radioactive waste management programmes, spent fuel and radioactive waste inventories and facilities, and relevant laws and regulations, policies, plans and activities, as well as of global inventories of spent nuclear fuel and radioactive waste. SRIS was developed in close cooperation with the European Commission and the NEA.

Two Collaborating Centres on decommissioning were designated in 2019: Norway's Institute for Energy Technology (IFE), in the field of digitalization of knowledge management for nuclear decommissioning; and SOGIN, the State owned company responsible for Italy's decommissioning and radioactive waste management programme, focusing on knowledge transfer and training in nuclear decommissioning.

Nuclear fusion

The Agency continued to foster international collaboration, coordination and exchange of scientific and technical results among some 50 Member States to help close existing gaps in physics, technology and regulation for the development of future fusion power technologies.

The Agency and the ITER Organization agreed to strengthen cooperation, signing Practical Arrangements under which ITER will share its nuclear fusion safety and radiation protection experience with the Secretariat and Member States, including those that are not members of ITER. The two organizations will also implement educational initiatives on plasma physics and fusion engineering, coordinate public outreach activities, and cooperate in knowledge management and human resources development.

Nuclear data

The Agency launched a new Medical Isotope Browser that enables medical scientists and the radiopharmaceutical industry to identify unexplored radioisotope production routes. The tool is expected to facilitate direct access to relevant data for researchers and professionals in the radiopharmaceutical industry to help fight cancer and other diseases.

Accelerator technology and its applications

The Agency signed a new partnership agreement with Elettra Sincrotrone Trieste. The agreement covers access to and use of the Agency's end station at the IAEA–Elettra Sincrotrone Trieste X ray fluorescence beamline, and supports travel for scientists from developing countries with approved experiments as well as associated annual training workshops.

Within the framework of a new CRP entitled 'Facilitating Experiments with Ion Beam Accelerators', arrangements were made with nine well established accelerator facilities on different continents. These facilities agreed to provide access to their infrastructure to scientists from Member States that lack such infrastructure.

Nuclear instrumentation

The Agency procured and set up a wavelength dispersive X ray fluorescence spectrometer at its Nuclear Science and Instrumentation Laboratory in Seibersdorf, Austria, enabling interested trainees from Member States to conduct practical activities as part of their training. The laboratory's capabilities were further enhanced with the installation and

testing of a variable pressure scanning electron microscope. The instrument is accessible to Member States upon request and is available to other Seibersdorf laboratories.

The establishment of the Neutron Science Facility in Seibersdorf proceeded with the installation of a deuterium–tritium based neutron generator.

NUCLEAR SCIENCES AND APPLICATIONS

The Agency continued to foster the development of innovative nuclear technology to support its peaceful use in food and agriculture, human health, water resources, environment, and radiopharmaceutical and radioisotope production, and to help Member States achieve the SDGs. It provided technical support to transfer validated technologies to Member States through its 12 research laboratories in Vienna, Monaco and Seibersdorf and its global network of 34 Collaborating Centres, and through 80 active CRPs.

Renovation of the Nuclear Applications Laboratories (ReNuAL/ReNuAL+)

The ReNuAL/ReNuAL+ project made significant progress: the new linear accelerator facility was opened in the Agency's Dosimetry Laboratory and the Insect Pest Control Laboratory completed its move to the new building — three months ahead of schedule — and is now fully operational. Fifteen Member States contributed a total of €3.5 million for the laboratories' modernization during the year, including six new contributors: Argentina, the Islamic Republic of Iran, Kenya, the Netherlands, Nigeria and Viet Nam. By the end of 2019, 41 Member States had made financial or in-kind contributions totalling more than €38 million and additional contributions totalling €0.9 million were announced by China, Germany and Montenegro. The project target budget of €57.8 million was achieved in November.

Major conferences

At the International Symposium on Isotope Hydrology: Advancing the Understanding of Water Cycle Processes, held in Vienna, delegates reviewed state-of-the-science isotope applications in hydrology and helped to identify new research, analytical and

training requirements to support wider adoption of isotope hydrology for sustainable development. Because groundwater depletion poses a significant threat to water security, the Agency focused on groundwater age dating using noble gas isotopes such as helium-3 and krypton-81 to map water resource availability, sustainability and vulnerability to overexploitation and pollution.

The Agency also organized the International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry (IDOS 2019), highlighting the advances in radiation dosimetry, radiation medicine, radiation protection and associated standards made over the past decade. The symposium, held in Vienna, allowed the exchange of scientific knowledge and facilitated interaction between radiation metrologists, clinical medical physicists and scientists, encouraging collaboration in the field.

The International Virtual Conference on Theranostics, the Agency's first virtual conference, focused on theranostic approaches — those that use molecular diagnostic imaging to optimize treatment decisions for individual patients — for the management of patients with neuroendocrine, thyroid and prostate cancers. The conference, held in Vienna, was livestreamed globally and attended remotely by over 1000 participants in 104 countries.

"The International Virtual Conference on Theranostics…was livestreamed globally and attended remotely by over 1000 participants in 104 countries."

Food and Agriculture

Emergency response to transboundary animal disease outbreaks

Member State requests for assistance to combat multiple outbreaks of transboundary animal diseases worldwide increased in 2019. In response, the Agency stepped up its emergency and capacity building assistance to several countries in Asia — Cambodia, China, Indonesia, the Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Thailand and Viet Nam — to fight the emerging, unparalleled outbreak of African swine fever, as well as to countries in Africa to control avian influenza (Ethiopia and South Africa) and equine influenza (Burkina Faso, Cameroon, Ghana, Morocco, the Niger, Nigeria and Senegal). The Agency's continuous active support through missions, technical guidance and the deployment of emergency toolkits to affected countries helped to mitigate the devastating impact of these diseases on producer livelihoods and on the regions' pork and poultry industries and trade.

Sterile insect technique to control human disease vectors

Building on developments in the sterile insect technique (SIT) package to control disease-transmitting mosquitoes such as *Aedes aegypti* and *A. albopictus*, the vectors for dengue, chikungunya, Zika and yellow fever, the Agency transferred the technology for operational field trials in Member States. Pilot projects to supress vector populations are now under way in China, Mexico and Singapore.

Addressing crop diseases with mutation breeding

With the Agency's technical support through CRPs, Member States are using mutation breeding to develop improved rice, banana and coffee varieties with increased yield, tolerance to drought and heat, and resistance to diseases and pests. As part of a CRP, researchers in China developed a new variety of banana with resistance to the devastating disease Fusarium wilt of banana caused by tropical race 4 (TR4) of *Fusarium oxysporum* f. sp. *cubense*. The breakthrough is leading the way to more varieties resistant to TR4 that are suited for specific climatic and soil conditions.

Food safety

Technical support through CRPs and applied research and development in the laboratory have enabled Member States to integrate nuclear and related analytical methods in their testing and monitoring processes for the determination of multiple contaminants known for their carcinogenicity in food and agricultural products. Member States can now determine the presence of pesticide residues and dyes in food and medicinal and herbal products such as *Curcuma longa* (turmeric) and *Peumus boldus* (boldo). They can also use integrated analytical approaches to detect harmful pesticides in food, surface water and sediments.

Human Health

Directory of Radiotherapy Centres (DIRAC) update

DIRAC is the world's most comprehensive database on radiotherapy resources, containing current and historical global data on radiotherapy centres, teletherapy machines, brachytherapy units, treatment planning systems, and computed tomography systems and simulators. Created in 1959, DIRAC has evolved significantly to become a central database of key information on radiotherapy centres. In 2019, a mechanism was developed to link other Agency activities (e.g. research contracts for a CRP) to each radiotherapy centre in DIRAC.

Transforming health care with nuclear techniques

Interest in the use of radiation technology in the production of artificial tissues continues to grow. In 2019, the Agency concluded a five year CRP aimed at bringing this new technology, used in medicine to repair and replace tissues and organs, to all regions of the world. The project, entitled 'Instructive Surfaces and Scaffolds for Tissue Engineering Using Radiation Technology', provided a framework for experts worldwide to advance the engineering of artificial tissues using nuclear techniques and to identify the tools necessary for the transition to regenerative medicine. The 15 participating institutions from 14 Member States are now pioneering the technology's use in the field.

New linear accelerator facility at the Dosimetry Laboratory

A clinical linear accelerator was installed and commissioned at the Agency's Dosimetry Laboratory in Seibersdorf. This enables the Agency to expand its calibration and audit services, and to provide Member States with research and training opportunities on equipment that closely resembles that found in many radiotherapy departments.

Roadmap for cancer care and control

Tackling the burden of cancer requires complex preventive, diagnostic, therapeutic and supportive care services. A new Roadmap towards a National Cancer Control Programme developed jointly by the Agency and the World Health Organization (WHO) brings together the technical knowledge and information about the services that countries require when designing and establishing a comprehensive national cancer control programme. The Roadmap provides information on available tools and resources for implementing services relating to cancer prevention, diagnosis and treatment, as well as palliative care, with a focus on diagnostic imaging, nuclear medicine and radiotherapy.

Water Resources

Conserving and protecting fossil groundwater supplies

Efforts to assess water resource availability and quality focused on nuclear technologies for dating fossil groundwater supplies and evaluating contamination of fresh water. The Agency continued to develop analytical capacities for measuring groundwater noble gas isotopes to assess aquifer replenishment rates, which are needed to protect non-renewable groundwater resources. In Argentina and Brazil, isotopes of two noble gases — helium-4 and krypton-81 — are being used in the large transboundary Guarani Aquifer to help water managers to implement sustainable water extraction practices.

Evaluating nitrogen contamination of surface water and groundwater

Widespread nitrogen contamination of fresh water is a growing global problem. To assess nitrogen pollution of surface and groundwater, the Agency developed a new low cost technique for routine fingerprinting of dissolved nitrogen isotope sources and processes. The new method will help water managers better address nitrogen pollution of fresh water and develop remediation strategies. In Mauritius, as part of the technical cooperation programme, nitrogen isotopes were used to distinguish between illegal sewage disposal and agricultural sources of pollution contaminating the urban waterways around Port Louis.

Environment

Support to radiological and nuclear emergencies

Monitoring of environmental contaminants — including toxic trace elements such as mercury, cadmium, lead, organic compounds such as persistent organic pollutants (POPs), and radionuclides — requires carefully developed best practices and suitable instrumentation. The Agency's proficiency tests enabled over 600 analytical laboratories in more than 70 Member States to assess the quality and reliability of their results on a suite of radionuclides and trace elements in environmental sample matrices. Sophisticated tests were also designed and conducted to prepare Member States for radiological and nuclear emergencies.

"The Agency's proficiency tests enabled over 600 analytical laboratories in more than 70 Member States to assess the quality and reliability of their results on a suite of radionuclides and trace elements"

Understanding our oceans

The world ocean contains a broad spectrum of plastic debris ranging from visible macroscale to invisible nanoscale plastic particles. The life cycle and impact of these marine plastics are still unknown. The Agency, through the IAEA Environment Laboratories in Monaco, is developing isotopic and nuclear techniques to reliably assess the environmental consequences of the plastic present in the world ocean. The Agency developed a new multi-diagnostic approach incorporating several nuclear techniques, including nuclear magnetic resonance spectroscopy, to determine how microplastics affect the biology and stress levels of marine fish.

Radioisotope Production and Radiation Technologies

International Symposium on Trends in Radiopharmaceuticals

The latest advances in radioisotope and radiopharmaceutical production for early diagnosis and more efficient treatment of cancer and other diseases were highlighted at the International Symposium on Trends in Radiopharmaceuticals, held in Vienna, the first such

symposium in almost 15 years. The need to address health regulatory issues relating to the production of radiopharmaceuticals and education in radiopharmacy was emphasized for developing Member States.

Assessing civil structures to save lives

Non-destructive testing (NDT) methods are crucial for establishing the integrity of buildings and infrastructure following a natural catastrophe. The Agency provided NDT support to Albania following a 6.4 magnitude earthquake on its coast. This support, and similar past support responses in Ecuador, Japan, Mexico and Nepal, have lent impetus to establishing a global network of rapid response NDT centres. As part of its work with Member States to develop radiation-source-free NDT methods, the use of which can help speed up the response by an NDT centre, the Agency held a Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications.

NUCLEAR SAFETY AND SECURITY

Nuclear Safety

Safety standards and their application

The Agency completed its set of Safety Requirements publications with the release of *Site Evaluation for Nuclear Installations* (IAEA Safety Standards Series No. SSR-1). The Nuclear Safety and Security Online User Interface was updated to include SSR-1, and all other IAEA Safety Standards Series and IAEA Nuclear Security Series publications issued in 2019, bringing the total number of publications available to users through this platform to 157. Forty-one Member States received support in applying the Agency's safety standards through 58 safety related peer review and advisory service missions.

Strengthening technical and scientific expertise

The International Conference on Effective Nuclear and Radiation Regulatory Systems: Working Together to Enhance Cooperation, held in The Hague, the Netherlands, highlighted the need to improve the management of cross-cutting regulatory areas.

Safety of nuclear power plants, research reactors and fuel cycle facilities

The Agency peer review and advisory services conducted in 2019 resulted in many findings which continued to identify opportunities for improvements in nuclear safety. The setting and implementation of corrective measures by Member States led to enhanced safety of nuclear installations, as reflected in the high number of findings assessed by the Agency to be addressed during follow-up missions.

To support Member State efforts towards ageing management and long term operation of nuclear power plants, the Agency held 3 technical meetings, and 22 workshops and support missions, as well as 8 meetings in the framework of the International Generic Ageing Lessons Learned programme. The Agency also continued to support Member States through technical meetings that addressed specific safety assessment and design safety aspects including multi-unit considerations, aggregation of various risk contributors, human reliability assessment, reliability of passive systems, safety assessment of industrial digital devices and analysis of design extension conditions. Participants at a technical meeting held in Vienna also discussed approaches to and national experiences with the safety and security interface for fuel cycle facilities.

The Agency organized the latest in a series of international conferences on topics of interest to the research reactor community. The conference, held in Argentina, provided a forum for exchange of knowledge and experience, with a focus on addressing challenges and opportunities to ensure effectiveness and sustainability.

Small and medium sized or modular reactors

The Agency held meetings and workshops on topics of interest to Member States relating to small and medium sized or modular reactors. These ranged from design safety, safety assessment and site evaluation, to emergency preparedness and response and use of the logical framework approach to illustrate the development of regulatory safety requirements. The Agency also facilitated two meetings of the Small Modular Reactor Regulators' Forum in Vienna.

Incident and emergency preparedness and response

The year 2019 marked the 20th anniversary of the Emergency Preparedness Review (EPREV) service. In connection with this milestone, the Agency held a technical meeting in Vienna for participants to share their experiences and lessons identified from using the service. To date, 48 EPREV missions have been conducted to 42 Member States.

Radioactive waste management, environmental assessments and decommissioning of nuclear facilities

The Agency established a working group to compile lessons from the first combined mission of the Integrated Regulatory Review Service (IRRS) and the Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS), conducted in 2018. The group's findings were used to refine the dedicated guidelines to increase the efficiency of combined missions.

The Agency completed the revision of the Basic Training Course on the Safe Decommissioning of Facilities and finalized the development of the Specialized Training Module on Regulatory Control of the Decommissioning of Facilities. These training materials were tested at a training event in Vilnius.

Radiation protection

Nineteen radiation protection webinars were organized, engaging some 7000 medical professionals and other experts from 141 States. The Agency also launched two e-learning courses on radiation protection of patients in Spanish, with 1300 participants enrolled by the end of 2019.

"Nineteen radiation protection webinars were organized, engaging some 7000 medical professionals and other experts from 141 States."

Capacity building in nuclear, radiation, transport and waste safety, and in emergency preparedness and response

Over 840 capacity building activities were conducted on nuclear, radiation, transport and waste safety, and emergency preparedness and response. The Agency held four International Schools of Nuclear and Radiological Leadership for Safety and developed two new case studies for the school.

The Agency also held four Schools for Drafting Regulations on Radiation Safety, developed modules for the thematic areas of the schools and increased access to the school's on-line platform by making it available on the NUCLEUS learning management system.

To support national and regional emergency preparedness and response capacity building activities and promote cooperation, the Agency launched the International Network for Education and Training on Emergency Preparedness and Response (iNET-EPR).

Safety conventions and Codes of Conduct

The Agency organized a meeting to enable Officers of the Seventh and the Eighth Review Meetings of the Contracting Parties to the Convention on Nuclear Safety (CNS) to share information on the Review Meeting process, including key documents, and on obligations of the CNS, its processes and the role of the Officers. In a second meeting, Officers discussed and approved the templates to be used in preparation for and during the Eighth Review Meeting.

Two working group meetings were held to prepare for the Fourth Extraordinary Meeting of Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention). Participants discussed possible improvements to the peer review process and amendments to the Joint Convention guidance documents.

The Agency continued to promote the Code of Conduct on the Safety and Security of Radioactive Sources and its Supplementary Guidance, and assisted Member States in implementing their provisions, for example at an open-ended meeting of technical and legal experts to share information on States' implementation.

The Agency's Radiation Safety and Nuclear Security Regulator

The focus of the Agency's internal regulatory programme was on the nuclear applications laboratories in Seibersdorf, particularly activities related to the ReNuAL/ReNuAL+ project. The safety and security of the laboratories were reviewed and their operation authorization renewed, where applicable. In the first half of the year, preparations began for a self-assessment and peer review of the Agency's internal regulatory system.

Civil liability for nuclear damage

The International Expert Group on Nuclear Liability (INLEX), an expert group providing advice to the Director General and the Director of the Office of Legal Affairs on issues relating to civil liability for nuclear damage, held its 19th regular meeting in Vienna. The Group concluded its discussions on transportable nuclear power plants and also discussed, inter alia, liability issues concerning cyberattacks, jurisdiction under the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, and the different amounts of compensation available under the various nuclear liability conventions.

A Workshop on Civil Liability for Nuclear Damage for European Countries was held in Bucharest, at which participants were given an overview of the international nuclear liability regime and of its implementation in national laws. The Secretariat also conducted an IAEA–INLEX mission to Saudi Arabia.

Nuclear Security

The Convention on the Physical Protection of Nuclear Material (CPPNM) and its Amendment

The Agency continued to promote universal adherence to the Amendment to the CPPNM through technical meetings, regional workshops and other activities. This included the fifth Technical Meeting of the Representatives of States Parties to the Convention on the Physical Protection of Nuclear Material (CPPNM) and the CPPNM Amendment, aimed at increasing understanding of, and sharing experiences in implementing, the enhanced commitments and responsibilities of Parties under the Amendment.

The Agency also convened two meetings of legal and technical experts in preparation for the 2021 Conference of the Parties to the Amendment to the CPPNM, with the aim of

facilitating the review by the Parties at the 2021 Conference of the implementation and adequacy of the amended Convention, as foreseen in Article 16.1 thereof.

Capacity building

To support Member State capacity building, the Agency provided security related training to more than 2500 participants from 143 States. In addition, the Agency prioritized the development and implementation of Integrated Nuclear Security Support Plans (INSSPs) to assist Member States, upon request, in applying a systematic and comprehensive approach to enhancing their nuclear security regimes. Three Member States approved their INSSPs, bringing the total number of approved INSSPs to 84. The Agency conducted International Physical Protection Advisory Service (IPPAS) missions to five States — Belgium, Lebanon, Madagascar, Paraguay and Uruguay — to assist with enhancing national physical protection regimes. It also provided assistance to 12 States to strengthen the implementation of nuclear security measures before and during major public events.

"the Agency provided security related training to more than 2500 participants from 143 States."

NUCLEAR VERIFICATION[1,2]

Implementation of safeguards in 2019

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

In 2019, safeguards were applied for 183 States[3,4] with safeguards agreements in force with the Agency. Of the 131 States that had both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force[5] the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 69 States[6] (for 67 of which[7] integrated safeguards were implemented during the whole of 2019 or part thereof); for the remaining 62 States, as the necessary evaluation regarding the absence of undeclared nuclear material and activities for each of these States remained ongoing, the Agency concluded only that *declared* nuclear material remained in peaceful activities. For 44 States with a CSA but with no AP in force, the Agency concluded only that *declared* nuclear material remained in peaceful activities.

Safeguards were also implemented with regard to nuclear material in selected facilities in the five nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) under their respective voluntary offer agreements. For these States, the Agency concluded that nuclear material in selected facilities to which safeguards had been applied remained in peaceful activities or had been withdrawn from safeguards as provided

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1 The designations employed and the presentation of material in this section, including the numbers cited, do not imply the expression of any opinion whatsoever on the part of the Agency or its Member States concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

2 The referenced number of States Parties to the Treaty on the Non-Proliferation of Nuclear Weapons is based on the number of instruments of ratification, accession or succession that have been deposited.

3 These 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 conclusion.

4 And Taiwan, China.

5 Or an AP being provisionally applied, pending its entry into force.

6 And Taiwan, China.

7 And Taiwan, China.

for in the agreements. The Agency also implemented safeguards for three States not parties to the NPT pursuant to item-specific safeguards agreements based on INFCIRC/66/Rev.2. For these States, the Agency concluded that nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities.

As of 31 December 2019, 10 States Parties to the NPT had yet to bring CSAs into force pursuant to Article III of the Treaty. For these States Parties, the Agency could not draw any safeguards conclusions.

Conclusion of safeguards agreements and APs, and amendment and rescission of small quantities protocols

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of small quantities protocols (SQPs). The status of safeguards agreements and APs as of 31 December 2019 is shown in Table A6 in the Annex to this report. During 2019, a CSA with an SQP and an AP entered into force for Benin. A CSA with an SQP was signed for the State of Palestine[8]. In addition, the Board of Governors approved a CSA with an SQP and an AP for Sao Tome and Principe. An AP entered into force for Ethiopia. An AP was signed for the Plurinational State of Bolivia. During 2019, SQPs were amended for Cameroon, Ethiopia, France[9] and Papua New Guinea. By the end of 2019, 68 States had accepted the revised SQP text (which was in force for 62 of these States) and 8 States had rescinded their SQPs.

Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)

Throughout 2019, the Agency continued to verify and monitor the nuclear-related commitments of the Islamic Republic of Iran (Iran) under the Joint Comprehensive Plan of Action (JCPOA). During the year, four quarterly reports and six reports providing updates on developments since the issuance of quarterly reports were submitted to the Board of Governors and in parallel to the United Nations Security Council entitled *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015).*

Syrian Arab Republic (Syria)

In August 2019, the Acting Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic*. In 2019, the Director General and Acting Director General renewed calls on Syria to cooperate fully with the Agency in connection with unresolved issues related to the Dair Alzour site and other locations. Syria has yet to respond to these calls.

Democratic People's Republic of Korea (DPRK)

In August 2019, the Acting Director General submitted a report to the Board of Governors and the General Conference entitled *Application of Safeguards in the Democratic People's Republic of Korea*. In 2019, no verification activities were implemented in the field, but the Agency continued to monitor developments in the DPRK's nuclear programme and to

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[8] The designation employed does not imply the expression of any opinion whatsoever concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

[9] The SQP to the safeguards agreement reproduced in INFCIRC/718 between France, the European Atomic Energy Community and the Agency pursuant to Additional Protocol I of the Treaty of Tlatelolco, covering France's Protocol I territories, was amended.

evaluate all safeguards relevant information available to it. The Agency has not had access to the Yongbyon site or to other locations in the DPRK. The Secretariat intensified efforts to enhance the Agency's readiness to play its essential role in verifying the DPRK's nuclear programme once a political agreement has been reached among the countries concerned. The continuation of the DPRK's nuclear programme is a clear violation of relevant United Nations Security Council resolutions and is deeply regrettable.

Enhancing safeguards

During 2019, the Agency developed a State-level safeguards approach (SLA) for one State with a CSA. This brings the total number of States with a CSA for which an SLA has been developed to 131. These 131 States hold 97% of all nuclear material (by significant quantity) under Agency safeguards in States with a CSA and include 67 States with a CSA and an AP in force for which the broader conclusion has been drawn; 37 States with a CSA and an AP in force for which the broader conclusion was not drawn for 2019; and 27 States with a CSA but no AP in force.

Cooperation with State and regional authorities

To assist States in building capacity for implementing their safeguards obligations, the Agency conducted 12 international, regional and national training courses for those responsible for overseeing and implementing State and regional systems of accounting for and control of nuclear material. The Agency, upon request, conducted two IAEA State System of Accounting for and Control of Nuclear Material Advisory Service (ISSAS) missions during the year.

Safeguards equipment and tools

Throughout 2019, the Agency ensured that the instrumentation and monitoring equipment installed in nuclear facilities around the world, which is vital to effective safeguards implementation, continued to function as required. By the end of the year, the Agency had installed a total of 162 unattended monitoring systems in 23 States. It also had 1425 cameras operating or ready to use at 261 facilities in 37 States[10]. By the end of 2019, remote data transmission infrastructure ensured the collection of 1708 unattended safeguards data streams from 140 facilities in 30 States[11]. The Agency continued to upgrade the surveillance with the next generation surveillance system (NGSS), and by the end of 2019, 1031 NGSS cameras had been installed in 33 States[12].

Safeguards analytical services

The Agency's Network of Analytical Laboratories consists of the Agency's Safeguards Analytical Laboratories and 23 other qualified laboratories. In 2019, the Agency collected 492 nuclear material samples and 405 environmental samples for analysis.

Developing the safeguards workforce

In 2019, the Agency conducted 103 safeguards training courses to provide safeguards inspectors and analysts with the necessary technical and behavioural competencies.

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New training courses delivered included an industrial safety course for inspectors and a criticality check refresher course.

Preparing for the future

The Agency prepared the *Development and Implementation Support Programme for Nuclear Verification 2020–2021* (STR-393), comprising 250 discrete support programme tasks in 25 projects. In 2019, 20 Member States, as well as the European Commission, had formal support programmes with the Agency.

MANAGEMENT OF TECHNICAL COOPERATION FOR DEVELOPMENT

The technical cooperation programme in 2019

The technical cooperation programme is the Agency's major vehicle for transferring technology and building capacities in the peaceful use of nuclear science and technology in Member States. Health and nutrition accounted for the highest proportion of actuals (disbursements) delivered through the programme, at 24.7%. This was followed by safety and security at 21.9%, and by food and agriculture at 20.2%. By the end of the year, financial implementation of the Technical Cooperation Fund stood at 89.1%. The programme supported, inter alia, 3843 expert and lecture assignments, 220 regional and interregional training courses, and 2081 fellowships and scientific visits.

Overview of regional activities

Africa

The technical cooperation programme assisted 45 Member States in Africa, of which 26 are classified as least developed countries. Approximately 70% of this assistance was delivered in the key areas of food and agriculture, health and nutrition, nuclear and radiation safety, and human resource development.

Building human capacity in Member States remained the most important component of the technical cooperation programme in Africa. Greater emphasis was placed on medium and long term training leading to professional and academic qualification in nuclear science and technology. Member States also received assistance to strengthen their analytical capabilities in areas including food safety, animal health and water resource management.

One hundred and eighty-one national project designs were formulated for the 2020–2021 technical cooperation cycle. Twenty additional regional projects were developed under the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) for the new cycle.

Asia and the Pacific

Thirty-eight of the 41 Member States and territories in Asia and the Pacific receive technical assistance through the technical cooperation programme, eight of which are least developed countries, and five of which are small island developing States. Technical assistance to the region focused on food and agriculture, human health, and nuclear and radiation safety. Special attention was given to building human capacity, particularly in least developed countries and small island developing States, where efforts included training in the development of more resilient plant varieties, to mitigate the effects of climate change on food security and agriculture.

The State Parties to the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA), in cooperation with the

Agency, developed a methodology for a pilot assessment of the economic impact of the RCA programme in a number of thematic areas.

The decision taken in 2019 by the Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) to expand its resource centres will enhance access to nuclear technology among ARASIA States Parties. The new ARASIA resource mobilization action plan finalized in 2019 is expected to contribute to strengthened partnerships and the mobilization of extrabudgetary funding for technical cooperation activities.

One hundred and thirty-four national projects were developed for the region for the 2020–2021 technical cooperation cycle The regional programme developed according to the Regional Programme Framework of ARASIA consists of seven new projects, while for the RCA, eight new projects have been prepared based on its Medium Term Strategy. An additional seven non-agreement projects were developed according to the Regional Programme Framework.

Europe

The technical cooperation programme provided technical assistance to 33 Member States in Europe and Central Asia. Throughout the year, the programme focused on the thematic areas of nuclear and radiation safety, and human health, with more than 70% of the core budget dedicated to projects in these areas.

The National Liaison Officers of participating countries in the region adopted a Strategic Framework for Technical Cooperation in the Europe region for 2019–2025. This framework, together with Country Programme Frameworks, provides high level strategic guidance for enhanced, coherent delivery of the national and regional technical cooperation programme in the Europe region through continued joint efforts to address Member State priorities, to enhance regional cooperation and use of regional capabilities, and to facilitate partnership building.

Seventy-eight national project designs were formulated for the 2020–2021 technical cooperation cycle. Fifteen additional regional projects were developed for the new cycle.

Latin America and the Caribbean

The Agency provided technical assistance to 31 Member States in Latin America and the Caribbean, focused mainly on human health, nuclear and radiation safety, food and agriculture, and water and the environment.

The Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) continued to be the main mechanism to promote South–South cooperation in the region. Work began on the successor document to the 2016–2021 Regional Strategic Profile.

The 2020–2026 Regional Strategic Framework for technical cooperation between the Agency and the Member States of the Caribbean Community was endorsed by National Liaison Officers and the Caribbean regional organizations working with the technical cooperation programme, to guide future programming in the region.

One hundred and four national project designs were formulated for the 2020–2021 technical cooperation cycle. Twenty-five additional regional projects were developed for the new cycle. They address priorities established in the ARCAL Regional Strategic Profile 2016–2021, as well as the need to create synergies among the new Caribbean Member States.

Programme of Action for Cancer Therapy (PACT)

Through PACT, the Agency focused on reviewing national capacities for cancer control, addressing funding gaps in cancer related activities and mobilizing additional resources. It

established new partnerships with the Islamic Development Bank and St. Jude Children's Research Hospital, while strengthening existing partnerships to further enhance cancer control activities.

Five Member States — Armenia, Burkina Faso, Ecuador, Seychelles and Sri Lanka — received imPACT (integrated missions of PACT) Review missions to provide governments with recommendations on addressing their cancer burden. In addition, the imPACT Review methodology was revised to improve its effectiveness, and collaboration with WHO, the International Agency for Research on Cancer and the Union for International Cancer Control was strengthened.

Technical cooperation and the global development context

The Agency attended the Second High-level United Nations Conference on South–South Cooperation (BAPA+40), in Buenos Aires, and, jointly with the United Nations Office for South–South Cooperation, launched a special edition of 'South–South in Action', focusing on the contribution of nuclear science and technology in sustainable development.

The Agency's participation in key 2019 United Nations sustainable development events culminated in the presentation of good practices and success stories in technical cooperation at the United Nations System video exhibition on the occasion of the High-level Political Forum, held under the auspices of the United Nations General Assembly.

Legislative assistance

The Agency continued to provide legislative assistance to its Member States through the technical cooperation programme. Country specific bilateral legislative assistance was provided to 17 Member States, while two regional workshops on nuclear law and the first meeting of legal advisers of regulatory bodies were organized during the year. The Agency also organized the ninth session of the Nuclear Law Institute, in Vienna.

Technical cooperation programme management: Quality assurance activities, reporting and monitoring

The Agency continued to develop and improve processes and tools to increase the programme quality of current and future technical cooperation cycles. The platform for electronic submission of Project Progress Assessment Reports has become a key tool for effective implementation of technical cooperation projects and has increased communication with Member States. The submission rate for Project Progress Assessment Reports has grown steadily since the platform was introduced in 2017.

Financial resources

The technical cooperation programme is funded by contributions to the Technical Cooperation Fund, as well as through extrabudgetary contributions, government cost sharing and contributions in kind. Overall, new resources reached a total of some €94.6 million in 2019, with approximately €82.0 million for the Technical Cooperation Fund (including assessed programme costs arrears, National Participation Costs and miscellaneous income), €12.3 million in extrabudgetary resources, and about €0.3 million representing in kind contributions.

The rate of attainment for the Technical Cooperation Fund stood at 94% on payments and 95.4% on pledges at the end of 2019. Payment of National Participation Costs totalled €0.4 million.

Actuals

In 2019, approximately €88.7 million was disbursed to 147 countries or territories, of which 35 were least developed countries.

MANAGEMENT ISSUES

Gender equality and gender mainstreaming

The proportion of women in the professional and higher categories was at 30.44% at the end of 2019, while considering only senior management positions (D level or higher) the percentage of women was 31.25%. A revised internal Gender Action Plan that elaborates tasks and milestones towards achieving gender balance in the Secretariat, as well as steps to more systematically mainstream gender concerns in programmatic activities, was promulgated to support the implementation of the Agency's Gender Equality Policy.

Upon taking office, Director General Rafael Mariano Grossi introduced a new policy to achieve gender parity in all levels of the Professional and higher categories throughout the Agency by 2025. To this end, the Director General expressed his intention to provide new guidelines to managers with the aim of attracting more women candidates to the Agency, and, in doing so, giving more opportunities to women in the recruitment process. These measures would include monitoring mechanisms to assess progress in reaching the Director General's goal of 50–50 gender parity. He also underlined the collaboration of the Secretariat and Member States in increasing joint efforts to reach out to talented women in the nuclear field. In addition, the Director General set out to establish a new initiative to provide scholarships to young women as another measure to, inter alia, support the pipeline of women candidates focused on nuclear sciences and technologies and non-proliferation studies.

Managing for results

The Agency's results based management approach to programme planning, monitoring and reporting is focused on achieving results, improving performance, integrating lessons learned into management decisions, and monitoring and reporting on performance. In preparing the Agency's Programme and Budget 2020–2021, specific emphasis was placed on a more thorough application of the results based approach that has allowed a better definition of clear, outcome oriented results and indicators, while also mainstreaming cross-cutting issues. Priority was given to developing necessary tools and capacity building activities on accountability for results, to support operationalization of the Accountability Framework.

Partnerships and resource mobilization

In 2019, Agency efforts focused on deepening and broadening the scope of existing collaboration arrangements and developing new partnerships, particularly with Member State institutions, universities and research organizations to promote technology transfer, as well as with non-traditional partners. In addition, the Agency expanded its partnerships with international financial institutions to support Member States and placed specific emphasis on partnerships of a cross-cutting nature such as with the Association of Southeast Asian Nations (ASEAN) and with the African Commission on Nuclear Energy (AFCONE).

Upon taking office, Director General Grossi introduced measures to mobilize new streams of public and private finance for Agency activities, and to expand partnerships towards this end. The Secretariat started a comprehensive exercise to identify activities that would benefit from resource mobilization efforts. The aim is not only to increase the

amount of resources mobilized, but also to align Departments so as to avoid duplication and disparity in Agency efforts. Examples include operationalizing the Memorandum of Understanding signed with the Islamic Development Bank to provide cancer care to women in low and middle income countries'; reaching out to new partners such as the World Bank; increasing engagement with United Nation system partners such as WHO, the Food and Agriculture Organization of the United Nations (FAO), the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the United Nations Industrial Development Organization (UNIDO), for example on climate change; and targeting the private sector.

IT information security

In addition to addressing ongoing cyber threats as part of its regular IT operations, the Agency continued to strengthen its information and IT security by decommissioning legacy systems and technologies and by reducing the risk posed by phishing through information security awareness campaigns and phishing simulation testing.

Multilingualism

Within available resources, the Agency expanded its multilingual outreach by regularly posting new content on its Arabic, Chinese, French, Russian and Spanish web sites. More than 100 news and feature articles were posted in each of these languages during the year, attracting 75 000 visitors per month to these pages. The web content for translation was selected for its relevance and interest to the respective language communities. The Agency continued to post four times a week on its Facebook accounts in Arabic, French, Russian and Spanish, which had a combined monthly reach of 240 000 readers by the end of the year.

IAEA Scientific Forum

The 2019 IAEA Scientific Forum, held during the 63rd General Conference in September, reviewed progress in cancer control over the past decade and discussed how the Agency can further assist Member States in addressing the growing burden of the disease. High level speakers included HRH Princess Chulabhorn, Princess of Thailand and President of the Chulabhorn Research Institute, ministers and health experts. The speakers also highlighted technological advances in nuclear and radiation medicine and the role of partnerships in supporting cancer control programmes.