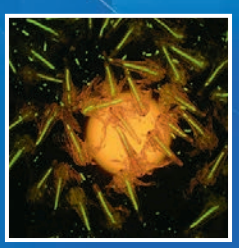
IAEA ANNUAL REPORT 2019









IAEA
International Atomic Energy Agency
Atoms for Peace and Development

IAEA Annual Report 2019

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

This report covers the period 1 January to 31 December 2019.

GC(64)/3

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(as of 31 December 2019)

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UZBEKISTAN
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VENEZUELA, BOLIVARIAN REPUBLIC OF
VIET NAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are located in Vienna.

The Agency

171
Member States

2566
professional and support staff

€ 372.7 million
total Regular Budget for 2019*

extrabudgetary expenditures in 2019
€ 130.2 million

2 **liaison offices**
New York
Geneva

2 **safeguards regional offices**
Tokyo · Toronto

147
countries and territories receiving support through the Agency's technical cooperation programme

including 35 least developed countries

15
international laboratories
Vienna · Seibersdorf · Monaco

11
multilateral conventions
nuclear safety · nuclear security · nuclear liability

* At the United Nations average rate of exchange of US $1.12 to €1.00. The total Regular Budget was €378.0 million at the US $1.00 to €1.00 rate.

at a Glance 2019

141

Revised Supplementary Agreements

governing provision of technical cooperation

122

active coordinated research projects

75 Research Coordination Meetings

184

States with safeguards agreements in force of which

136 **States had additional protocols in force**

43

active **IAEA Collaborating Centres**

11 institutions newly designated

1 centre redesignated

700 000

visitors a month to **iaea.org**
up **17%** since 2018

4.8 million

per month **social media reach**
up **25%** since 2018

over **1 million**

materials available in the IAEA Library

over **8000 visitors** in 2019

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IAEA publications

As of 31 December 2019

The Board of Governors

The Board of Governors oversees the ongoing operations of the Agency. It comprises 35 Member States and generally meets five times a year, or more frequently if required for specific situations.

As a consequence of the passing away of Director General Yukiya Amano in July 2019, the Board designated Cornel Feruta as acting Director General, until a Director General assumed office. In October 2019, the Board appointed Rafael Mariano Grossi by acclamation to the post of Director General of the Agency for a term of office of four years, from 3 December 2019 to 2 December 2023.

In the area of nuclear technologies, in the course of 2019 the Board considered the *Nuclear Technology Review 2019*.

In the area of safety and security, the Board discussed the *Nuclear Safety Review 2019* and the *Nuclear Security Report 2019*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2018*. It approved one safeguards agreement and three additional protocols. The Board considered the Director General's reports on verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015). The Board kept under its consideration the issues of the implementation of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) Safeguards Agreement in the Syrian Arab Republic and the application of safeguards in the Democratic People's Republic of Korea.

The Board discussed the *Technical Cooperation Report for 2018* and approved the Agency's technical cooperation programme for 2020–2021.

The Board approved the recommendations contained in the *Proposal to the Board of Governors by the Co-Chairs of the Working Group on the Programme and Budget and the Technical Cooperation Fund Targets for 2020–2021.*

Composition of the Board of Governors (2019–2020)

Chair:

HE Ms. Mikaela KUMLIN GRANIT
Ambassador
Governor from Sweden

Vice-Chairs:

HE Mr. Galib ISRAFILOV
Ambassador
Governor from Azerbaijan

HE Mr. Omar Amer YOUSSEF
Ambassador
Governor from Egypt

Argentina
Australia
Azerbaijan
Belgium
Brazil
Canada
China
Ecuador
Egypt
Estonia
France
Germany
Ghana
Greece
Hungary
India
Italy
Japan
Kuwait
Mongolia
Morocco
Niger
Nigeria
Norway
Pakistan
Panama
Paraguay
Russian Federation
Saudi Arabia
South Africa
Sweden
Thailand
United Kingdom of Great Britain and Northern Ireland
United States of America
Uruguay

The General Conference

The General Conference comprises all Member States of the Agency and meets once a year in regular session.

The Conference adopted resolutions on the Agency's financial statements for 2018 and budget for 2020; on nuclear and radiation safety; on nuclear security; on strengthening the Agency's technical cooperation activities; on strengthening the Agency's activities related to nuclear science, technology and applications, comprising non-power nuclear applications and nuclear power applications; on strengthening the effectiveness and improving the efficiency of Agency safeguards; on the implementation of the NPT Safeguards Agreement between the Agency and the Democratic People's Republic of Korea; on the application of Agency safeguards in the Middle East; and on personnel matters, comprising the staffing of the Agency's Secretariat and women in the Secretariat. The Conference also adopted decisions on the progress made towards the entry into force of the amendment to Article XIV.A of the Statute of the Agency, approved in 1999; on the report on the promotion of the efficiency and effectiveness of the Agency's decision making process; and on the progress made towards the entry into force of the amendment to Article VI of the Statute of the Agency, approved in 1999.

The Conference paid tribute to the late Director General Yukiya Amano. In December 2019, the Conference in special session approved by acclamation the Board's appointment of Rafael Mariano Grossi as the new Director General of the Agency for a term of office of four years from 3 December 2019 to 2 December 2023.

Notes

- The *Annual Report 2019* aims to summarize only the significant activities of the Agency during the year in question. The main part of the report, starting on page 21, generally follows the programme structure as given in *The Agency's Programme and Budget 2018–2019* (GC(61)/4). The objectives included in the main part of the report are taken from that document and are to be interpreted consistently with the Agency's Statute and decisions of the Policy-Making Organs.
- The introductory chapter, 'Overview', seeks to provide a thematic analysis of the Agency's activities within the context of notable developments during the year. More detailed information can be found in the latest editions of the Agency's *Nuclear Safety Review, Nuclear Security Report, Nuclear Technology Review, Technical Cooperation Report* and the *Safeguards Statement and Background to the Safeguards Statement*.
- Additional information covering various aspects of the Agency's programme is available, in electronic form only, on *iaea.org*, along with the *Annual Report*.
- The designations employed and the presentation of material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.
- The mention of names of specific companies or products (whether or not indicated as registered) does not imply any intention to infringe proprietary rights, nor should it be construed as an endorsement or recommendation on the part of the Agency.
- The term 'non-nuclear-weapon State' is used as in the Final Document of the 1968 Conference of Non-Nuclear-Weapon States (United Nations document A/7277) and in the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The term 'nuclear-weapon State' is as used in the NPT.
- All the views expressed by Member States are reflected in full in the summary records of the June Board of Governors meetings. On 15 June 2020, the Board of Governors approved the Annual Report for 2019 for transmission to the General Conference.

Abbreviations

AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ALMERA	Analytical Laboratories for the Measurement of Environmental Radioactivity
AP	additional protocol
ARASIA	Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology
ARCAL	Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
ARTEMIS	Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation
CLP4NET	Cyber Learning Platform for Network Education and Training
CNS	Convention on Nuclear Safety
CPF	Country Programme Framework
CPPNM	Convention on the Physical Protection of Nuclear Material
CRP	coordinated research project
CSA	comprehensive safeguards agreement
DIRAC	Directory of Radiotherapy Centres
DSRS	disused sealed radioactive source
EPR	emergency preparedness and response
EPREV	Emergency Preparedness Review
EPRIMS	Emergency Preparedness and Response Information Management System
Euratom	European Atomic Energy Community
HEU	high enriched uranium
IACRNE	Inter-Agency Committee on Radiological and Nuclear Emergencies
ICERR	IAEA-designated International Centre based on Research Reactor
ICTP	Abdus Salam International Centre for Theoretical Physics
iNET-EPR	International Network for Education and Training on Emergency Preparedness and Response
INIR	Integrated Nuclear Infrastructure Review
INIS	International Nuclear Information System
INIT	Integrated Nuclear Infrastructure Training
INLEX	International Expert Group on Nuclear Liability
INMA	International Nuclear Management Academy
INPRO	International Project on Innovative Nuclear Reactors and Fuel Cycles
INSSP	Integrated Nuclear Security Support Plan
IPPAS	International Physical Protection Advisory Service
IRIS	Integrated Review of Infrastructure for Safety
IRRS	Integrated Regulatory Review Service

IRRUR	Integrated Research Reactor Utilization Review
JCPOA	Joint Comprehensive Plan of Action
LEU	low enriched uranium
MUPSA	Multi-Unit Probabilistic Safety Assessment
NDT	non-destructive testing
NEA	Nuclear Energy Agency (Organisation for Economic Co-operation and Development)
NEM School	Nuclear Energy Management School (IAEA)
NKM School	Nuclear Knowledge Management School (IAEA)
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OMARR	Operation and Maintenance Assessment for Research Reactors
PACT	Programme of Action for Cancer Therapy (IAEA)
QUATRO	Quality Assurance Team for Radiation Oncology
RANET	Response and Assistance Network
RASIMS	Radiation Safety Information Management System
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ReNuAL/ReNuAL+	Renovation of the Nuclear Applications Laboratories
RSA	Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA
SDG	Sustainable Development Goal
SIT	sterile insect technique
SMR	small and medium sized or modular reactor
SQP	small quantities protocol
SRIS	Spent Fuel and Radioactive Waste Information System
TSR	Technical Safety Review
USIE	Unified System for Information Exchange in Incidents and Emergencies
VETLAB Network	Veterinary Diagnostic Laboratory Network
WHO	World Health Organization

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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10 And Taiwan, China.

11 And Taiwan, China.

12 And Taiwan, China.

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.

Nuclear Technology

Nuclear Power, Fuel Cycle and Nuclear Science

over **650** **on-line training** and **education courses** hosted on **CLP4NET**

33 **coordinated research projects**

4 **Nuclear Knowledge Management** Schools

6 **Nuclear Energy Management** Schools

33 **Integrated Nuclear Infrastructure Training activities**

INPRO **international collaborative projects**

15 **completed**

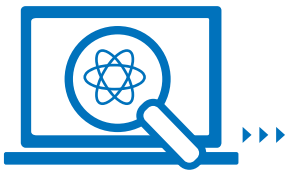
5 **ongoing**

39 **publications**

2019

Internet Reactor Laboratory

4 host institutions



9 guest institutions

18 professional networks

8 missions

5 IAEA-designated International Centres based on Research Reactors

in **5** countries

181 consultancy meetings

2 conferences

74 technical meetings

Nuclear Power

Objective

To support Member States with existing nuclear power plants to enhance performance and ensure safe, secure, efficient and reliable long term operation, including development of human resource capability, leadership and management systems. To assist Member States embarking on new nuclear power programmes in planning and building their national nuclear infrastructures, including development of human resource capability, leadership and management systems. To provide methods and tools to support modelling, analyses and assessments of future NESs [nuclear energy systems] for sustainable development of nuclear energy, and collaborative frameworks and support for technology development and deployment of advanced nuclear reactors and non-electric applications.

Launching Nuclear Power Programmes

The Agency continued to support Member States interested in or embarking on new nuclear power programmes by providing assistance in line with the Milestones Approach documented in *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)). In 2019, 28 Member States were actively considering, planning or embarking on a nuclear power programme (Fig. 1).

The Agency conducted an Integrated Nuclear Infrastructure Review (INIR) Phase 2 mission to Egypt and an INIR Phase 1 follow-up mission to Ghana. The INIR evaluation methodology was tested in Bulgaria to evaluate its use for an expanding nuclear power programme. At the end of 2019, the number of INIR and INIR follow-up missions conducted since 2009 reached 29 missions to 21 Member States.

In 2019, the Agency met with eight Member States to develop or update their Integrated Work Plans and Country Nuclear Infrastructure Profiles.

Nuclear power infrastructure competence building (Fig. 2) included Integrated Nuclear Infrastructure Training (INIT). The Agency conducted 33 interregional training activities in 9 Member States to increase awareness and understanding of the Milestones Approach. Practical training was provided to around 500 participants from 42 Member States.

"The Agency conducted 33 interregional training activities in 9 Member States to increase awareness and understanding of the Milestones Approach."

The Agency conducted six expert missions to five embarking Member States to assist and advise key organizations on the development of leadership, management systems and improved nuclear organizational culture in line with the Agency's safety standards. Six Member States received training on the Nuclear Power Human Resources modelling tool and support in developing their national human resource plans.

The annual Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure was held in Vienna for Member States to share good practices and lessons learned in establishing the infrastructure required for a safe and sustainable nuclear power programme. Meeting participants also discussed ways of financing and contracting for new nuclear power plants as well as infrastructure development for small and medium sized or modular reactors (SMRs).

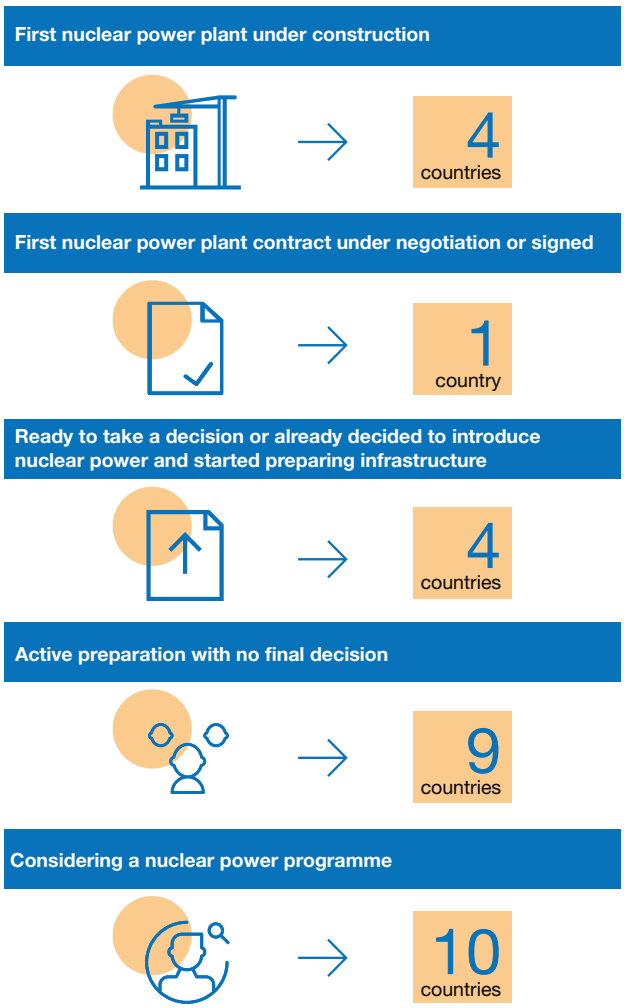


FIG. 1. Number of Member States considering or embarking on a nuclear power programme according to official statements (as of 31 December 2019).

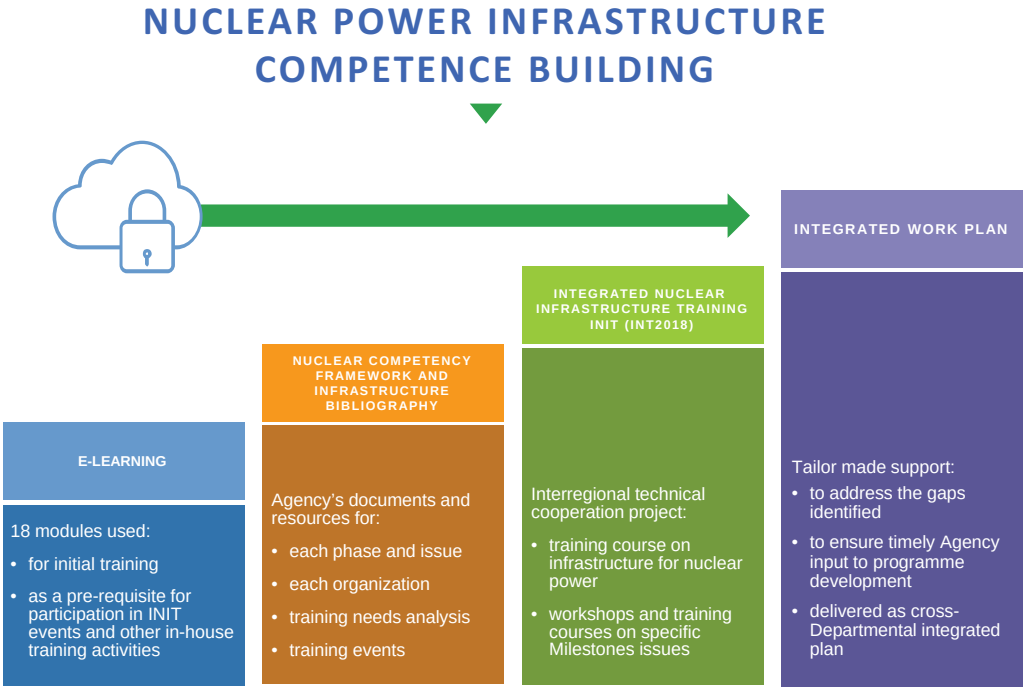


FIG. 2. Overview of the systematic approach to nuclear power infrastructure competence building finalized in 2019.

Operating Nuclear Power Plants and Expanding Nuclear Power Programmes

At the end of 2019, over 66% of the world's 443 operating nuclear power reactors had been in operation for longer than 30 years. At the biannual meeting of the Technical Working Group on Life Management of Nuclear Power Plants, held in Vienna, experts considered relevant operation, maintenance and technical challenges facing the international nuclear power community and identified activities that could assist in overcoming them. This included collaboration for sustained viability of nuclear reactor vessels and internals; for the development of equipment reliability programmes; and for the collection of data on environmental qualification for electrical and instrument and control equipment for beyond the initial design lifetime.

Participants in a Technical Meeting on Challenges in New Build Projects in Countries with Nuclear Power Programmes, held in Vienna, identified potential difficulties in four key areas: the interface between the new project and the country's existing nuclear power programme; the supply chain; project management; and stakeholder involvement.

Recent Agency activities, tools and publications to support Member States were identified at the Technical Meeting on Stakeholder Involvement and Communication for New and Expanding Nuclear Power Programmes. The meeting, held in Vienna, underlined the importance of involving stakeholders at all stages of the development of a nuclear power programme as a crucial element in the decision making process.

The Agency published *Managing Counterfeit and Fraudulent Items in the Nuclear Industry* (IAEA Nuclear Energy Series No. NP-T-3.26) to assist Member State organizations in preventing, detecting and addressing counterfeit and fraudulent items on an ongoing basis. The Agency also issued *A Methodology to Evaluate the Effectiveness of Training in Nuclear Facilities* (IAEA-TECDOC-1893), which provides a set of training standards and conditions that can be used by any nuclear facility to objectively evaluate the quality of its training.

To increase the capacity of Member States in supply chain management, on-line resources such as toolkits were made available and training courses were conducted, including a Pilot Training Course on Nuclear Supply Chain Management and Procurement attended by 30 participants from 26 Member States.

Nuclear Technology Development

Advanced water cooled reactors

A new Agency publication entitled *Classification, Selection and Use of Nuclear Power Plant Simulators for Education and Training* (IAEA-TECDOC-1887) provides information on how to use the Agency's suite of simulators. Another publication, *Nuclear–Renewable Hybrid Energy Systems for Decarbonized Energy Production and Cogeneration* (IAEA-TECDOC-1885), summarizes the findings from a technical meeting on the latest concepts and innovative solutions for addressing the challenges of using a combination of nuclear and renewable energy sources. The Agency also published *Status of Research and Technology Development for Supercritical Water Cooled Reactors* (IAEA-TECDOC-1869).

Seven training courses on advanced water cooled reactor technologies were held; participants received hands-on learning using the Agency's basic principle simulators. Three new Training Course Series publications were issued in support of these courses and the Agency acquired a new basic principle simulator for severe accidents.

SMRs

A Technical Meeting on the Design, Experimental Validation and Operation of SMRs took place in Pakistan. The meeting highlighted the status of SMR technology developments, the

commissioning and operating experience of the four medium sized reactors at Chashma nuclear power plant, and the needs of newcomer countries.

Contributors to the coordinated research project (CRP) entitled 'Development of Approaches, Methodologies and Criteria for Determining the Technical Basis for Emergency Planning Zone for SMR Deployment' reported on different approaches to determining the emergency planning zone and highlighted limitations in the current practices and tools, especially for near field atmospheric dispersion. This information will help to develop methodologies and criteria for determining the technical basis for emergency preparedness and response arrangements for SMRs.

Fast reactors

"the on-line Catalogue of Facilities in Support of Liquid Metal-cooled Fast Neutron Systems….now contains information on some 200 experimental facilities across the world."

Two major studies on benefits and challenges of fast reactors of the SMR type and on structural materials for heavy liquid metal cooled fast reactors were conducted through Agency technical meetings. At the Eighth Joint IAEA–Generation IV International Forum (GIF) Technical Meeting/Workshop on the Safety of Liquid Metal Cooled Fast Reactors, held in Vienna, two GIF reports on safety design guidelines of Generation IV sodium cooled fast reactors were presented for further review.

At a meeting in Vienna, experts updated the on-line Catalogue of Facilities in Support of Liquid Metal-cooled Fast Neutron Systems. The database now contains information on some 200 experimental facilities across the world.

High temperature reactors

The Technical Meeting on the Competitiveness and Early Deployment of SMRs and High Temperature Gas Cooled Reactors (HTGRs) showcased many Member State activities in this area, and in particular novel design and technology enhancements that can increase the competitiveness and attractiveness of SMRs and HTGRs.

The first Joint IAEA–GIF Technical Meeting on the Safety of HTGRs, held in Vienna, presented the outcomes of the four year CRP entitled 'Modular HTGR Safety Design'.

The Joint ICTP–IAEA Workshop on Physics and Technology of Innovative High Temperature Nuclear Energy Systems, held in Trieste, Italy, highlighted the latest technology advancements in HTGRs and molten salt reactors as the basis of non-electric applications such as hydrogen production, including aspects of nuclear energy sustainability.

Non-electric Applications of Nuclear Power

The Agency organized four technical meetings relating to non-electric applications of nuclear energy. The meetings focused on the role of nuclear hydrogen production as part of the whole hydrogen supply chain and life cycle; different aspects of nuclear cogeneration projects; the deployment of nuclear cogeneration using SMRs and HTGRs; and the role of nuclear desalination in the context of climate change mitigation. It also held a Regional Workshop on Non-electric Nuclear Applications: Options, Technology Readiness and Available IAEA Toolkits, in Prague.

A new Agency publication entitled *Guidance on Nuclear Energy Cogeneration* (IAEA Nuclear Energy Series No. NP-T-1.17) introduces the advantages of nuclear cogeneration and addresses issues to be considered for its implementation. The publication also highlights past demonstration projects developed in connection with industrial applications.

Enhancing Global Nuclear Energy Sustainability through Innovation

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) engages in dialogue and outreach through its Dialogue Forums and INPRO schools. In 2019, the INPRO Dialogue Forum on Opportunities and Challenges in SMRs, held in the Republic of Korea, provided a place for experts to interact and discuss cross-cutting issues in nuclear energy systems that include SMRs. Key cross-cutting topics included governmental energy policies in terms of SMRs and nuclear power as a clean energy source, and public and political acceptance of SMRs. In Mexico and the Russian Federation, pilot courses for a new INPRO service (Analysis Support for Enhanced Nuclear Energy Sustainability) trained engineers, scientists and ministry experts in using tools and methods for nuclear energy scenario modelling and systems evaluation.

Nuclear Fuel Cycle and Waste Management

Objective

To raise awareness and promote the implementation of a safe and sustainable fuel cycle and life cycle management for nuclear energy programmes and nuclear applications users, and contingency planning for post-incident situation. To support Member States in strengthening their own capabilities and trained human resources, or having access to the best available knowledge, technologies, services.

Uranium Resources and Processing

The Agency issued two publications on uranium resources and processing. *Uranium Production Cycle: Selected Papers 2012–2015* (IAEA-TECDOC-1873) serves as a record of the work done in Member States and presented at a series of UMREG (Uranium Mining and Remediation Exchange Group) and other technical meetings relating to the uranium production cycle. *Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2014)* presents the outcomes of an Agency symposium covering all areas of the uranium production cycle.

There is also continued interest in the possible use of thorium as a nuclear fuel. A new Agency publication, *World Thorium Occurrences, Deposits and Resources* (IAEA-TECDOC-1877), provides a brief account of the worldwide occurrence of thorium resources based on current knowledge of thorium geology and mineralization. *Thorium Resources as Co- and By-products of Rare Earth Deposits* (IAEA-TECDOC-1892) provides information on the natural occurrence and geology of thorium and an overview of thorium production as a by-product of commodities produced for non-nuclear purposes.

Nuclear Power Reactor Fuel

The new Agency publication *Reliability of Advanced High Power, Extended Burnup Pressurized Heavy Water Reactor Fuels* (IAEA-TECDOC-1865) presents a comprehensive summary of the technical work carried out under a CRP and provides an overview of Member State approaches to mitigating the challenges of deploying advanced fuels for extended burnup to achieve enhanced reliability, sustainability and safety.

In Shenzhen, China, meeting participants discussed national capabilities in modelling and the behaviour of nuclear fuel under accident conditions. Participants in a meeting held in Aix en Provence, France, discussed the latest information on nuclear fuel design, operation, research and development, and licensing in support of flexible operation of nuclear power plants, as well as possible future research and development activities. In Toronto, Canada, meeting participants evaluated the impact on fuel 'fitness for service'

of hot conditioning, refurbishment, outage, operation and normal design life extension of pressurized heavy water reactors.

Two new Agency publications address fuel performance and technology. *Review of Fuel Failures in Water Cooled Reactors (2006–2015)* (IAEA Nuclear Energy Series No. NF-T-2.5) summarizes fuel failure occurrences, their mechanisms and root causes, and fuel failure prevention and management for 97% of light and heavy water cooled nuclear power units operated worldwide between 2006 and 2015. *Fuel Modelling in Accident Conditions (FUMAC): Final Report of a Coordinated Research Project* (IAEA-TECDOC-1889) compiles the results of the research carried out as part of a CRP on the modelling of fuel behaviour in accident conditions.

Management of Spent Fuel from Nuclear Power Reactors

The question of how the management of spent fuel can be affected by the decisions taken in the rest of the nuclear fuel cycle was a focus of the International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Learning from the Past, Enabling the Future, held in Vienna in cooperation with the European Commission, the Nuclear Energy Agency and the World Nuclear Association. The event also gave 35 young professionals the opportunity to participate in a Young Generation Event. Four finalists, who developed the most innovative projects, presented their papers and co chaired various conference sessions (Fig. 1).

At a Technical Meeting on Strategies and Opportunities for the Management of Spent Fuel from Power Reactors in the Longer Timeframe, hosted by the Global Centre for Nuclear Energy Partnership in Bahadurgarh, India, participants identified fuel cycle options and opportunities for recycling valuable fission products for inclusion in guidance on minimizing the waste burden.

The Agency issued four publications on spent fuel management. *Storing Spent Fuel until Transport to Reprocessing or Disposal* (IAEA Nuclear Energy Series No. NF-T-3.3) identifies issues and challenges in developing and implementing options, policies, strategies and programmes for ensuring safe, secure and effective storage of spent fuel. The proceedings of the International Conference on the Management of Spent Fuel from Nuclear Power

FIG. 1. Four finalists selected for having the most innovative projects out of 35 applicants presented their papers during the International Conference on the Management of Spent Fuel from Nuclear Power Reactors.

Reactors: An Integrated Approach to the Back End of the Fuel Cycle, held in June 2015, summarize the conference presentations and session discussions. *Behaviour of Spent Power Reactor Fuel during Storage: Extracts from the Final Reports of Coordinated Research Projects on Behaviour of Spent Fuel Assemblies in Storage (BEFAST I–III) and Spent Fuel Performance Assessment and Research (SPAR I–III) — 1981–2014* (IAEA-TECDOC-1862) provides a consolidated account of 30 years of experience in the storage of spent nuclear fuel from power reactors. *Demonstrating Performance of Spent Fuel and Related Storage System Components during Very Long Term Storage* (IAEA-TECDOC-1878) presents the work carried out during a CRP on safe and reliable management of spent nuclear fuel.

Radioactive Waste Management

Radioactive waste needs to be managed in a way that keeps people and the environment safe over long periods of time. As part of its ongoing support to Member States in this area, the Agency completed three Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) review missions, to Estonia, Germany and Latvia.

It also held a Training Workshop on the Roadmap for a Generic Deep Geological Disposal Programme in Gyeongju-si, Republic of Korea, and a Training Workshop on Planning and Implementing Site Investigations for Geological Disposal in Honorobe, Japan.

Agency networks continued to play an important role in training and communication. The International Predisposal Network provided a forum for experienced Member State representatives involved in industrial-scale utilization of bituminization technologies. Characterization to meet waste acceptance criteria was the focus of the 2019 meeting of LABONET, the Agency's International Network of Laboratories for Nuclear Waste Characterization. As part of the work of DISPONET, the Agency's International Low Level Waste Disposal Network, the Agency held a technical meeting in Cherbourg, France, on lessons in the disposal of low level waste.

At the Technical Meeting on Using Social Media for Public Communication and Stakeholder Involvement for Nuclear Programmes, held in Vienna, 130 participants from 66 Member States explored topics relating to social media and social networking sites (Fig. 2). Input received during the meeting will be used to update the social media section of the Agency's Nuclear Communicator's Toolbox.

FIG. 2. Participants in the Technical Meeting on Using Social Media for Public Communication and Stakeholder Involvement for Nuclear Programmes.

Management of disused sealed radioactive sources

At the request of Member States, the Agency completed assistance for the removal and recycling of three high activity disused sealed radioactive sources (DSRSs). In addition, 11 projects were initiated to support the removal of Category 1 and 2 (higher activity) DSRSs.

The Agency supported the training of 90 participants from 48 Member States in conditioning and safe and secure management of Category 3 to 5 DSRSs, and in searching for and securing orphan sources. Training in conditioning was held in Morocco for 12 participants from 11 Member States. In addition, expert missions were conducted to assist the establishment of national radioactive sealed sources inventories, and in support of nuclear security activities. The Agency launched the DSRS-Net, a web based platform for exchanging experiences in managing DSRSs.

The United States of America provided the Agency with a licensed 435-B Type B container (Fig. 3). The container will be used to support Member States in the transport and repatriation of DSRSs.

FIG. 3. A ribbon cutting ceremony marking the delivery of a 435-B Type B container donated by the United States of America for international transport of DSRSs.

Decommissioning and Environmental Remediation

Decommissioning

The Agency organized an International Workshop on Application of Sustainability and Circular Economy Principles to Nuclear Decommissioning held in Rome and hosted by SOGIN. Participants explored how the principles of a circular economy — based on minimizing waste by design, thus increasing sustainability — can be applied to decommissioning and waste management.

The new Agency publication *Decommissioning after a Nuclear Accident: Approaches, Techniques, Practices and Implementation Considerations* (IAEA Nuclear Energy Series No. NW-T-2.10) describes differences in post accident situations compared with decommissioning after a planned final shutdown under normal conditions and identifies significant factors relevant for decision making.

Environmental remediation

The Agency provides information and training on available remediation strategies and technologies, and management options. It held three technical meetings on different aspects of environmental remediation. Participants in a technical meeting of the CIDER (Constraints to Implementing Decommissioning and Environmental Remediation) Project held in Vienna assessed the results of previous activities of the project and made suggestions regarding strategy development, stakeholder engagement and capacity building.

At a Technical Meeting on the Remediation of Legacy Trenches Containing Radioactive Waste — The LeTrench Project, held in Sydney, Australia, participants shared information and knowledge regarding legacy trench sites. Topics included use of assumptions and constraints, definition of options, and selection of assessment factors and scoring approach.

The Agency held a Technical Meeting on Achieving the Site End State: Characterization Strategies and Instrumentation for Land Contamination, in Dounreay, United Kingdom (Fig. 4). Among the issues discussed were information and data management, the regulatory framework for remediation, modern standards for historical problems, characterization, and statistics and technical support for the selection and use of instrumentation.

FIG. 4. Participants in the Technical Meeting on Achieving the Site End State: Characterization Strategies and Instrumentation for Land Contamination learn about beach monitoring equipment.

Two Agency publications on environmental remediation were issued: *Developing Cost Estimates for Environmental Remediation Projects* (IAEA Nuclear Energy Series No. NW-T-3.8) and *Environmental Impact Assessment of the Drawdown of the Chernobyl NPP Cooling Pond as a Basis for Its Decommissioning and Remediation* (IAEA-TECDOC-1886).

At its annual meeting, held in Vienna, the Agency's Network on Environmental Management and Remediation (ENVIRONET) marked its tenth anniversary by reviewing the achievements and the remaining challenges in environmental remediation.

Capacity Building and Nuclear Knowledge for Sustainable Energy Development

Objective

To support Member States in strengthening their capacities to elaborate robust energy strategies, plans and programmes, and to improve the understanding of nuclear technology's contribution in achieving the SDGs. To support Member States in strengthening their capacities to establish, manage and utilize their nuclear knowledge base by disseminating knowledge management methodologies, guidance and tools. To acquire, preserve and provide information in the area of nuclear science and technology to facilitate sustainable information sharing among Member States.

Energy Modelling, Databanks and Capacity Building

The Agency continued to support national capacity building, conducting 81 related events and providing training in energy planning to over 730 professionals from more than 80 Member States. It updated and enhanced its energy planning tools — in use by 150 Member States and over 20 international organizations.

At the United Nations Workshop on Sustainable Development Goal (SDG) 7 Implementation in Asia and the Pacific, held in Bangkok, the Agency shared its experience in supporting national capacity with energy modelling and planning and further strengthened relations with the Economic and Social Commission for Asia and the Pacific.

The Agency updated its annual publication *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050* (Reference Data Series No. 1), which incorporates recent market and policy developments. The 2019 projections, which offered a mixed picture of nuclear power's future, showed that significant new capacity may be needed to offset possible reactor retirements due to age, reduced economic competitiveness or other factors.

Energy–Economy–Environment (3E) Analysis

The Agency organized the International Conference on Climate Change and the Role of Nuclear Power in cooperation with the Nuclear Energy Agency, attended by more than 500 participants from 79 Member States and 17 international organizations. Participants acknowledged nuclear power's significant role in helping to achieve global climate goals.

In his first official trip, Director General Rafael Mariano Grossi, in December, attended the 25th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP25) in Madrid, where he outlined the importance of nuclear power to the clean energy transition (Fig. 1). The Agency also participated in the 2019 High-level Political Forum on Sustainable Development in New York.

Ahead of COP25 and the International Conference on Climate Change and the Role of Nuclear Power, the Agency issued two publications on the topic: *Adapting the Energy Sector*

"…the International Conference on Climate Change and the Role of Nuclear Power … [was] attended by more than 500 participants from 79 Member States and 17 international organizations."

FIG. 1. The Director General at the 25th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP25), in Madrid.

to Climate Change and *Nuclear–Renewable Hybrid Energy Systems for Decarbonized Energy Production and Cogeneration* (IAEA-TECDOC-1885).

Nuclear Knowledge Management

The Agency delivered six Nuclear Energy Management (NEM) Schools, in Egypt, Italy, Japan, the Russian Federation and the United States of America. A total of 177 participants from 56 Member States attended the NEM School programmes in 2019.

Four Nuclear Knowledge Management (NKM) Schools were conducted, in Italy, the Republic of Korea, Paraguay and the Russian Federation, attended by 106 participants from 35 Member States.

Over 650 on-line training and education courses were hosted on the Agency's Cyber Learning Platform for Network Education and Training (CLP4NET). By December 2019, the number of users in the platform had grown to 27 172.

The Agency conducted four Knowledge Management Assist Visit missions, to Armenia, Brazil, the Republic of Korea and Pakistan. The missions reviewed each country's knowledge management programme and provided recommendations for enhancements.

In 2019, universities in Armenia and Hungary hosted International Nuclear Management Academy (INMA) assessment missions, and universities in Japan and the United States of America attained INMA membership.

Collection and Dissemination of Nuclear Information

At the end of 2019, the membership of the International Nuclear Information System (INIS) comprised 132 Member States and 24 international organizations. INIS reached 4.3 million records, including 1.7 million full texts available through the repository, 575 000 of which are hosted on INIS. The Agency added 82 980 bibliographic records and over 11 000 full texts to the INIS repository, which had over 3.5 million page views.

A total of 75 448 electronic resources were available through the IAEA Library, visited by more than 8 000 people, with over 1 900 items checked out.

Nuclear Science

Objective

To support Member States in strengthening capabilities in the development and application of nuclear science as a tool for their technological and economic development. To assist Member States in enhancing sustainable operation, including effective utilization of research reactors, in implementing new research reactor projects and nuclear capacity building programmes, based on access to research reactors.

Nuclear Data

The Agency released a new neutron metrology library called the International Reactor Dosimetry and Fusion File (IRDFF-II) that supports a broad range of applications — from lifetime management and assessment of nuclear power plants to boron neutron capture therapy, use of medical isotopes, nuclear physics measurements and reactor safety applications. The library includes 119 neutron metrology reactions, for which high quality cross-section data and uncertainties were evaluated.

A new photonuclear data library featuring high quality data for 219 nuclides is one of the main products of a CRP on photon strength functions and photonuclear reactions. The project participants used modern nuclear reaction software, such as the TALYS and CoH3 nuclear model codes, to better describe relevant cross-sections, allowing reactor and Monte Carlo transport software to provide improved estimates on issues such as radiation shielding and transmutation of radioactive waste. Reduced uncertainty margins will allow Member States to make better predictions of isotopic yields during irradiation.

Research Reactors

Utilization and applications of research reactors

The Agency supported interlaboratory proficiency testing of 49 neutron activation analysis laboratories in 36 Member States. The first major update of a neutron activation analysis e-learning course was completed with the development of ten new modules.

Two expert missions to assist Member States with planning were undertaken, to Saudi Arabia and Morocco. E-learning modules for a course entitled 'Strategic Planning for National Nuclear Institutions' were finalized, and two e-learning courses were developed on nuclear analytical techniques for forensic science and introductory training for research reactor personnel, the latter of which is available in both English and Spanish.

The Agency published *Benchmarking against Experimental Data of Neutronics and Thermohydraulic Computational Methods and Tools for Operation and Safety Analysis of Research Reactors* (IAEA-TECDOC-1879), presenting results of a CRP.

Integrated Research Reactor Utilization Review (IRRUR) missions were approved as an official Agency peer review service based on the feedback from a pilot IRRUR mission conducted to the TRIGA research reactor in Italy. These missions provide an assessment of the utilization of a research reactor and identify further utilization areas, research and development, as well as products and services that the research reactor can provide.

New research reactor projects, infrastructure development and capacity building

A Regional Research Reactor School on reactor physics and neutron applications was conducted in Japan for countries in the Asia and the Pacific region and in Africa, aimed at building nuclear competence in those countries. A national workshop on the Milestones Approach for a research reactor programme was conducted in Senegal. Preparations for a future Integrated Nuclear Infrastructure Review for Research Reactors mission were also discussed during the workshop.

Research reactor fuel cycle

Member States are working towards minimizing high enriched uranium (HEU) in civilian use through programmes to reduce enrichment for research and test reactors, and through take-back programmes that return HEU to the countries of origin. The Agency received a request from Kazakhstan for assistance in HEU minimization, for removal of spent HEU from the IVG.1M reactor to the Russian Federation and disposition of HEU from the IGR reactor in Kazakhstan. The Agency initiated procurement of the services for the preparatory work for the return of IVG.1M reactor HEU fuel to the Russian Federation.

Practical Arrangements on cooperation between the Agency and the Sosny Joint Institute for Power and Nuclear Research in Belarus were signed, focused on the use of the institute's critical facilities to characterize advanced reactor fuels, provide benchmarking experiments, study the safety of fuel assemblies, and provide education and training.

Several meetings and workshops focused on improving Member State use and understanding of best practices for research reactors. The Agency organized a Technical Meeting on the Current State of and Developments in the Management of Radioactive Waste from Research Reactors. A Meeting on Lessons Learned from Miniature Neutron Source Reactor (MNSR) Conversion Projects, organized by the Agency and the China Nuclear Energy Industry Corporation, was held in China. A Training Workshop on the Use of Decision Support Tools for Research Reactor Spent Fuel Management was conducted in Vienna. A Technical Meeting on Computational Benchmarks for Research Reactor Fuel Burnup and Activation Codes was conducted in Vienna to review the results of the computational benchmarks that were completed under a related CRP.

Research reactor operation and maintenance

The Agency organized a number of technical meetings and workshops relating to the operation and maintenance of research reactors. At a Technical Meeting on Risk Informed In-Service Inspection and Decision Making for Research Reactors held in Vienna, participants reviewed the current status and practices, and the formulation of the scope and methodology of a CRP on this topic. Participants in a Training Workshop on Integrated Management Systems for Research Reactors and Good Practices, held in Vienna, exchanged knowledge and experiences in the implementation of integrated management systems in research reactors. A Technical Meeting on Digital Instrumentation and Control Systems for Upgrades and New Research Reactors was conducted in Vienna to enable the exchange of information and experiences relating to the technical and managerial aspects of research reactor projects involving the modernization of digital instrumentation and control systems.

A Workshop on Simulation of a Non-Power Reactor for Training Purposes was held in Argentina, in cooperation with the Government of Argentina, to transfer experience in the field of operation and performance analysis of research reactors to contribute to increased technical competence and sustainable development of nuclear technology.

A support mission was conducted to the Democratic Republic of the Congo for non-destructive examination and in-service inspection. During this mission, 75 fuel elements of the TRICO II research reactor were inspected using an underwater radiation resistant camera supplied by the Agency.

Different types of Operation and Maintenance Assessment for Research Reactors (OMARR) missions were conducted to Indonesia, Thailand and Uzbekistan to provide advice and assistance towards improving the performance of research reactors. The main mission for the Indonesian facility was conducted in October and resulted in recommendations for the preparation of an action plan to extend operation of the reactor with enhanced availability and reliability for another 15–20 years. An OMARR follow-up mission to research reactor WWR-SM in Uzbekistan was conducted and the operator was advised on a further plan of action for its continued long term operation.

The Agency published *Material Properties Database for Irradiated Core Structural Components for Lifetime Management for Long Term Operation of Research Reactors* (IAEA-TECDOC-1871), which presents the results of a CRP on the topic. The information provided can be used to support the safe and reliable long term operation of existing research reactors and the design of new research reactors.

Accelerator Technologies and Their Applications

The Accelerator Knowledge Portal updated five of its existing research infrastructures and added one new infrastructure. These updates included electrostatic accelerators, synchrotron light sources, neutron spallation sources, neutron scattering instruments, X ray free electron lasers and the new medical cyclotrons infrastructure. The portal now totals more than 1700 facilities. More than 7000 users from 83 Member States visited the portal, twice as many as in 2018.

"More than 7000 users from 83 Member States visited the [Accelerator Knowledge Portal], twice as many as in 2018."

The Agency publication *Improvement of the Reliability and Accuracy of Heavy Ion Beam Analysis* (Technical Reports Series No. 485) highlights the achievements of a CRP that addressed limitations in the use of heavy ions as an analytical tool. The extensive database of the new stopping cross-sections included in the publication contains new data which will significantly benefit the ion beam community, leading to improved accuracy of quantitative light element analysis worldwide.

A new Partnership Agreement with Elettra Sincrotrone Trieste, Italy, enabled 23 experiments by users from 11 Member States at the X ray fluorescence beam line. The first Joint IAEA–Elettra Sincrotrone Trieste training workshop in synchrotron light experiments was also organized (Fig. 1). Through an existing Partnership Agreement with the Ruđer Bošković Institute, Zagreb, 17 experiments involving 5 Member States were performed at their ion beam. Furthermore, a training workshop for specialists from accelerator facilities was organized.

Upon request, targeted support through expert missions was provided to small accelerator facilities in Bangladesh, Croatia and Greece. As a result, these accelerator facilities were back to operation, their performance was improved or specific recommendations were provided on how to ensure sustainable operation in the future.

Several events were organized over the year; highlights included the Joint ICTP–IAEA Advanced Workshop on Enhancing Accelerator-Based Analytical Techniques for Forensic Science for both analysts and forensic end users, held in Trieste, Italy; a Technical Meeting on Non-spallation Accelerator-based Production of Neutrons, held in Vienna, which culminated in a review of the applications of a variety of accelerator technologies, target

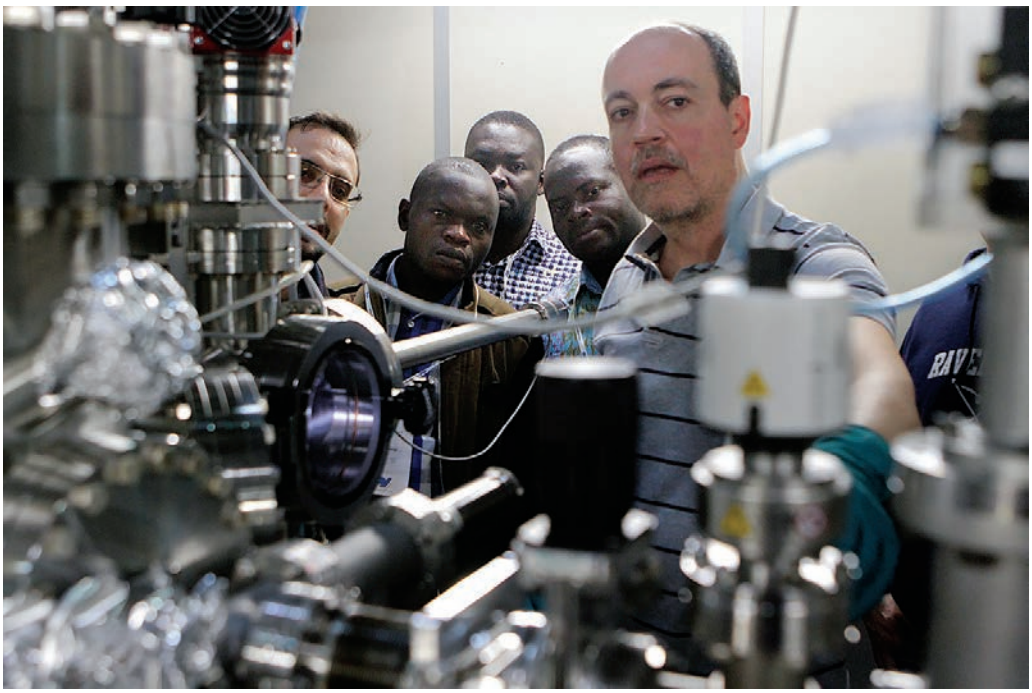


FIG. 1. Participants in an Agency training workshop observe a demonstration of the instrumentation installed at the joint Agency–Elettra X ray fluorescence beam line in Trieste, Italy. (Photograph courtesy of Elettra.)

designs for neutron production and practical aspects of planning and establishment of such facilities, including the required infrastructure, training of personnel, facility cost estimates, licensing safety and security issues; and a Workshop on Financial and Economic Feasibility Analysis for Nuclear and Radiation Technology Projects aimed at facilitating self-reliance and sustainability of national nuclear institutions. This latter workshop introduced and demonstrated the use of the United Nations Industrial Development Organization's Computer Model for Feasibility Analysis and Reporting (COMFAR) and the Agency's Extended Input Output Model for Nuclear Power Plant Impact Assessment (EMPOWER) for modelling macroeconomic effects of projects such as medical cyclotrons and gamma irradiators.

Nuclear Instrumentation

The Nuclear Science and Instrumentation Laboratory in Seibersdorf, Austria, reached several important milestones in establishing a Neutron Science Facility: arrival of a deuterium–tritium based neutron generator; establishment of building refurbishment work requirements; completion of preliminary shielding calculations; installation of a detection system for neutron activation analysis; commissioning of a neutron/gamma radiation monitoring system; and installation and testing of a neutron and X ray imaging system (Fig. 2).

Several workshops and training courses relating to human capacity building in nuclear instrumentation were held during the year. These included a Training Workshop on In Situ Characterisation of Contaminated Sites, held in Pécs, Hungary, in cooperation with the National Food Chain Safety Directorate of Hungary (Fig. 3); a Joint ICTP–IAEA Advanced Workshop on Portable X-Ray Spectrometry Techniques for Characterization of Valuable Archaeological/Art Objects, in Trieste, Italy; a regional training course on radiotracer and sealed source methodology and technology as applied to industry and the environment, in Seibersdorf; an eight week group fellowship training course on X ray fluorescence based analytical techniques and applications, in Seibersdorf; and group fellowship training on

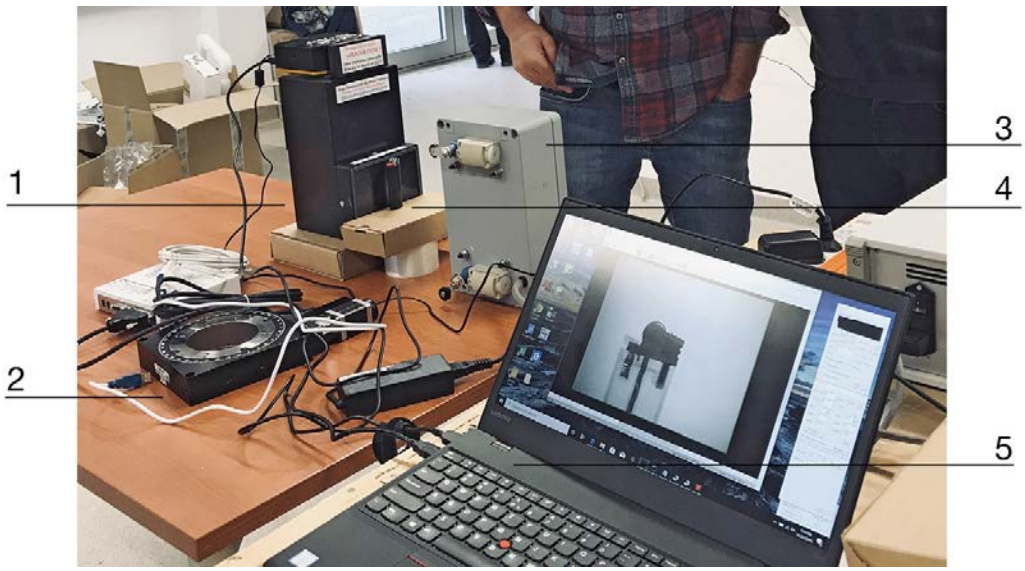


FIG. 2. Testing of the dual neutron/X ray imaging system: (1) camera box; (2) rotating stage (not in use in this image); (3) X ray source; (4) sample; (5) computer control.

nuclear instrumentation at the Birine Nuclear Research Centre in Algeria. The group fellowship events resulted in training for 20 young researchers from 14 Member States.

The Agency provided support to the Fukushima Prefectural Centre for Environmental Creation in Japan in the area of calibration of instrumentation, data collection strategies and interpretation of results for radiological mapping of four different sites. In addition, one member of the Centre's team was trained at the Agency's Seibersdorf laboratories on operation, use and calibration of various instruments; activity to dose rate conversion methodologies; Monte Carlo modelling; use of R code for radiological mapping; and hands-on training for drone flying.

FIG. 3. Trainees equipped with gamma spectrometers and navigation systems undertake field measurements at a former uranium mine in Pécs, Hungary.

Nuclear Fusion

The sixth Demonstration Fusion Power Plant (DEMO) Programme Workshop was held in Moscow. Discussions and information exchange at this year's workshop focused on issues and challenges relating to plasma stability, materials science and the impact of the operational conditions of DEMO.

Over the year, several technical meetings were organized on topics relating to fusion reactors, energetic particle research and plasma physics, including the 12th IAEA Technical Meeting on Control, Data Acquisition and Remote Participation for Fusion Research, held in Daejeon, Republic of Korea; the 16th Technical Meeting on Energetic Particles in Magnetic Confinement Systems — Theory of Plasma Instabilities, in Shizuoka, Japan; and the third Technical Meeting on Divertor Concepts, in Vienna.

A new Agency publication, *Conceptual Development of Steady State Compact Fusion Neutron Sources* (IAEA-TECDOC-1875), highlights the main results and findings of a CRP on the development of conceptual designs for both low and high power compact fusion neutron sources, covering their practical applications and addressing aspects of facility utilization, operation, safety and technology integration.

Support for the Abdus Salam International Centre for Theoretical Physics (ICTP)

The Agency continued to support the ICTP with the aim of enabling young scientists from developing Member States to study, train and build networks in the areas of theoretical physics and applied sciences. A total of 13 co-funded joint events, attended by over 250 participants, were held on topics ranging from medical diagnostic radiology to plasma physics.

Nuclear Techniques for Development and Environmental Protection

3 **conferences** and **symposiums**

51 **technical meetings**

220 **consultancy meetings**

80 **coordinated research projects**

30 **networks** and **portals**

58 **Research Coordination Meetings**

34 **active Collaborating Centres** within the Department of Nuclear Sciences and Applications

2019

Human Health Campus

over

61 000

new users

Directory of Radiotherapy Centres

over

13 000

new users

Nuclear Application Laboratories in Seibersdorf

331
trainees

650
visitors

85
Member States

ReNuAL

330

Agency publications • journal articles

61

e-learning schools and **on-line courses**

Food and Agriculture

Objective

To contribute to the sustainable intensification of agricultural production and the improvement of global food security through capacity building and technology transfer to Member States. To increase the resilience of livelihoods to threats and crises that impact agriculture, including climate change, biothreats, food safety risks, and nuclear or radiological emergencies. To improve efficient agricultural and food systems for sustainable management and conservation of natural resources, and to enhance the conservation and application of plant and animal biodiversity.

Emergency Response to Transboundary Animal Disease Outbreaks

At the request of Member States affected by African swine fever — Cambodia, China, Indonesia, the Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Thailand and Viet Nam — the Agency delivered unprecedented technical assistance and on the ground support to control the spread of the disease. Through the Animal Production and Health Laboratory and the Veterinary Diagnostic Laboratory (VETLAB) Network, it strengthened the affected countries' diagnostic capabilities by providing emergency toolkits and laboratory equipment to detect the virus and related antibodies, training for laboratory technical staff, policy advice and on the ground technical support. The prompt action of the Agency not only helped the swine industry and trade, it also eased the effect of this disease on livelihoods.

In West and Central Africa, several countries were hit by an outbreak of the equine influenza that killed over 300 000 donkeys in the Niger alone. The Agency, through the VETLAB Network, distributed reagents and reference material for rapid diagnosis and surveillance to national laboratories in Burkina Faso, Cameroon, Ghana, Morocco, the Niger, Nigeria and Senegal, strengthening their capacity to detect and monitor the spread of the disease. The Agency also supported Ethiopia and South Africa with up to date laboratory techniques to detect the strain of the avian influenza and determine its pathogenic level for poultry, other animals and humans (Fig. 1). For the first time, the Animal Production and Health Laboratory developed an irradiated vaccine prototype against avian influenza, which compares favourably with vaccines developed through traditional methods.

"For the first time, the Animal Protection and Health Laboratory developed an irradiated vaccine prototype against avian influenza"

Food Safety

The Agency, through the Food and Environmental Protection Laboratory, continued to develop, test and validate advanced nuclear and related analytical methods for the detection and control of chemical residues and contaminants in various food resources. These research activities led to the elaboration of international standards for the determination

FIG. 1. The IAEA VETLAB Network helps scientists in Cameroon to prevent and control African Swine fever in small commercial pig farms.

of pesticide residues, environmental pollutants, aflatoxin and other contaminants in commercially important food and plants. Major achievements included the development and validation of a multicontaminant analysis method for *Curcuma longa* (turmeric) — an economically important food and medicinal spice. The method was also adapted to determine pesticide residues in the leaves of a medicinal and herbal plant widely used in Latin America, *Peumus boldus* (boldo). The availability of efficient methods to determine contaminants known for their carcinogenicity, such as harmful pesticides and dyes, is a key contribution to food safety and food quality. The Agency also supported Member States to streamline the use of analytical and biomonitoring methodologies targeting high impact pesticides in food and the environment. As a result, Member States enhanced their testing capabilities for emerging contaminants in food and agriculture such as nicotine and drug residues. In July, the Agency launched a new CRP to support Member States' generation of scientific evidence for safe levels of veterinary drug residues in food products.

Sterile Insect Technique to Control Human Disease Vectors

The Agency, through the Insect Pest Control Laboratory, has furthered the testing, validation and operationalization of the sterile insect technique (SIT) to control disease-transmitting mosquitoes such as *Aedes aegypti* and *A. albopictus*, the vectors for dengue, chikungunya, Zika and yellow fever. Activities focused on moving from small-scale validation field trials in Greece and Italy to large-scale operational field trials in China, Mexico and Singapore. The Agency developed innovative operational solutions, including enhanced efficiency of the drone system used to release sterile male mosquitoes, improved quality control of the sterile male mosquitoes for flight ability, and the adaptation of a phased conditional approach for SIT deployment. This adapted approach ensures that SIT projects progress through a series of steps, starting with baseline data collection, followed by small-scale field trials, pre-operational testing and operational intervention. To strengthen joint actions on SIT against human disease vector mosquitoes,

the Agency signed a memorandum of understanding with WHO to intensify collaboration on the development and use of SIT against *Aedes* mosquitoes. This led to a joint mission to Bangladesh to assess a dengue outbreak and develop a plan to test a nuclear technique to suppress the mosquitoes responsible for the disease upsurge.

Addressing Crop Diseases with Mutation Breeding

The Agency facilitated important research and development advances to identify disease resistant crops using mutation breeding techniques. Key developments included the confirmation of rice mutant lines with resistance to the parasitic weed *Striga asiatica* and the identification of banana with resistance to Fusarium wilt caused by the tropical race 4 (TR4) strain of *Fusarium oxysporum* f. sp. *cubense*. The former was achieved through the use of laboratory and greenhouse based precision phenotyping protocols developed at the Agency's Plant Breeding and Genetics Laboratory, while the latter was the result of the combination of tissue culture and efficient disease screening procedures conducted at the Guangdong Academy of Agricultural Sciences in China under the CRP entitled 'Efficient Screening Techniques to Identify Mutants with Disease Resistance for Coffee and Banana'. This TR4 resistant banana variety is now being multiplied for field trials across TR4 infected banana growing regions in China (Fig. 2). This unprecedented breakthrough against transboundary plant diseases is a crucial milestone in improving mutation induction in coffee and banana, which are key for the economies and food security of many Member States.

FIG. 2. Mutation breeding is helping to combat Fusarium wilt (TR4), a disease that is wiping out swathes of banana plantations in Asia, Africa and more recently Latin America.

Human Health

Objective

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

Roadmap for Cancer Care and Control

Governments worldwide face the challenge of providing quality care to address the growing burden of cancer. The Agency and WHO jointly developed the Roadmap towards a National Cancer Control Programme to help countries set milestones for establishing nuclear medicine, diagnostic imaging and radiotherapy services. The Roadmap draws on the Agency's nuclear and radiation related expertise and WHO's guidance on developing blueprints for effective programmes on the ground. It provides guidance on implementing services relating to cancer prevention, diagnosis, treatment and palliative care. Along with guiding Member States on the establishment of radiation medicine services and providing guidance documents, the Roadmap also covers questions relating to nuclear safety and legal considerations.

New Linear Accelerator Facility at the Dosimetry Laboratory

A clinical linear accelerator (linac) was installed at the Agency's Dosimetry Laboratory in Seibersdorf, Austria (Fig. 1). In December, a customized robotic arm was installed in the linac bunker, to be used as a platform for performing calibrations. The linac facility will be used for training, audits, calibration of ionization chambers, and research and development in dosimetry.

International Virtual Conference on Theranostics

Recent developments in positron emission tomography, especially the use of fluorine-18 fluorodeoxyglucose and new approaches to targeted radionuclide therapies, have paved the way for more personalized cancer management. The first International Virtual Conference on Theranostics discussed how the integration of diagnostic molecular imaging with radionuclide therapies is key to individualized management of disease. Over 1000 participants from 104 Member States participated remotely, and 393 participants from 79 Member States completed the requirements necessary to be awarded continuing medical education credits. This was the first time that the European Union of Medical Specialists awarded credits to participants of a virtual initiative.

FIG. 1. The new linear accelerator facility at the Dosimetry Laboratory, visit by the Director General.

Transforming Health Care with Nuclear Techniques

Tissue engineering is poised to revolutionize the field of regenerative medicine by shifting the treatment focus from mitigating symptoms or causes to repairing and regenerating tissue — leading to full recovery. The Agency completed a five year CRP entitled 'Instructive Surfaces and Scaffolds for Tissue Engineering Using Radiation Technology'. The main aim of the project, which succeeded in producing both the surfaces and scaffolds and artificial tissue for use in regenerative medicine, was to make this technology available worldwide (Fig. 2). The 15 institutions from 14 Member States that participated in the CRP are now ready to implement the new technology.

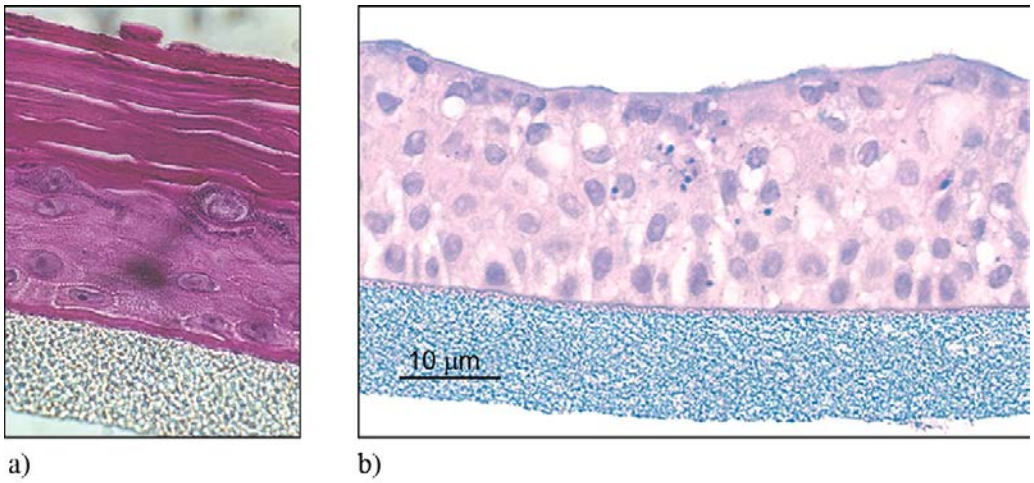


FIG. 2. Artificial skin human tissue system (a) and artificial tracheal/bronchial epithelial human tissue system (b) produced as part of a CRP aimed at making tissue engineering technology available worldwide.

Directory of Radiotherapy Centres (DIRAC) Update

Created by the Agency in 1959, DIRAC is the world's most comprehensive database on radiotherapy resources. It comprises current and historical global data on radiotherapy centres, teletherapy machines, brachytherapy units, treatment planning systems, computed tomography systems and simulators. Quality Assurance Team for Radiation Oncology (QUATRO) missions, coordinated research and technical cooperation projects, educational resources, partnerships and the results of surveys are linked in DIRAC. DIRAC is now also fully integrated with the International Dose External Audits database, a resource that maintains data on dose quality audits for hospitals. The newly developed option to add comments will help the Agency retain historical data, contacts and valuable metadata.

Water Resources

Objective

To enable Member States to use isotope hydrology for the assessment and management of their water resources, including the characterization of climate change impacts on water availability.

Conserving and Protecting Fossil Groundwater Supplies

The IAEA Isotope Hydrology Laboratory developed new capacities to assess groundwater overexploitation and to determine non-renewable fossil groundwater. Through projects under the technical cooperation programme, noble gas isotopes dissolved in groundwater were used to assess water age and aquifer replenishment rates that feed into effective protection and conservation strategies for fossil groundwater resources (Fig. 1).

FIG. 1. Groundwater sampling for age dating purposes.

The Laboratory also completed the installation of a high sensitivity mass spectrometer with an integrated sample extraction and processing system to analyse noble gases in environmental groundwater samples from Member States, including routine capacities for extracting krypton-81 to age fossil groundwater to over one million years in age. This groundwater age information is critical for water management in Member States, as it helps to determine the rate of groundwater replenishment for sustainable extraction.

Evaluating Nitrogen Contamination of Surface Water and Groundwater

A new, low cost method to routinely test for dissolved nitrogen and to determine the source of this contaminant through fingerprinting was developed. The new method uses an inexpensive titanium (III) reagent to directly convert nitrate to nitrous oxide gas for isotope analyses and replaces time consuming and labour intensive conventional methods that are only available in a few developed Member State laboratories. The titanium method was adopted in 17 developing Member States through a CRP and as a service by the IAEA Isotope Hydrology Laboratory to assist projects under the technical cooperation programme aimed at helping water managers to better address serious water pollution from nutrients and to help inform effective remediation strategies (Fig. 2).

FIG. 2. Preparation of water samples for tritium analyses to be used for groundwater age dating purposes.

Environment

Objective

To support Member States in identifying environmental problems caused by radioactive and non-radioactive pollutants and climate change, using nuclear, isotopic and related techniques, and to propose mitigation and adaptation strategies and tools. To enhance the capability to develop strategies for the sustainable management of terrestrial, marine and atmospheric environments and their natural resources in order to address effectively and efficiently their environment related development priorities.

Support in Radiological and Nuclear Emergencies

The sustainable management of environmental resources requires fact based policies firmly rooted in scientific knowledge and reliable data. Nuclear analytical techniques can be used to monitor environmental contaminants such as radionuclides, toxic trace elements and persistent organic pollutants (POPs), but it is the quality of laboratory analyses that ultimately determines the reliability of results. In 2019, 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 radionuclides and trace elements in the environment (Fig. 1).

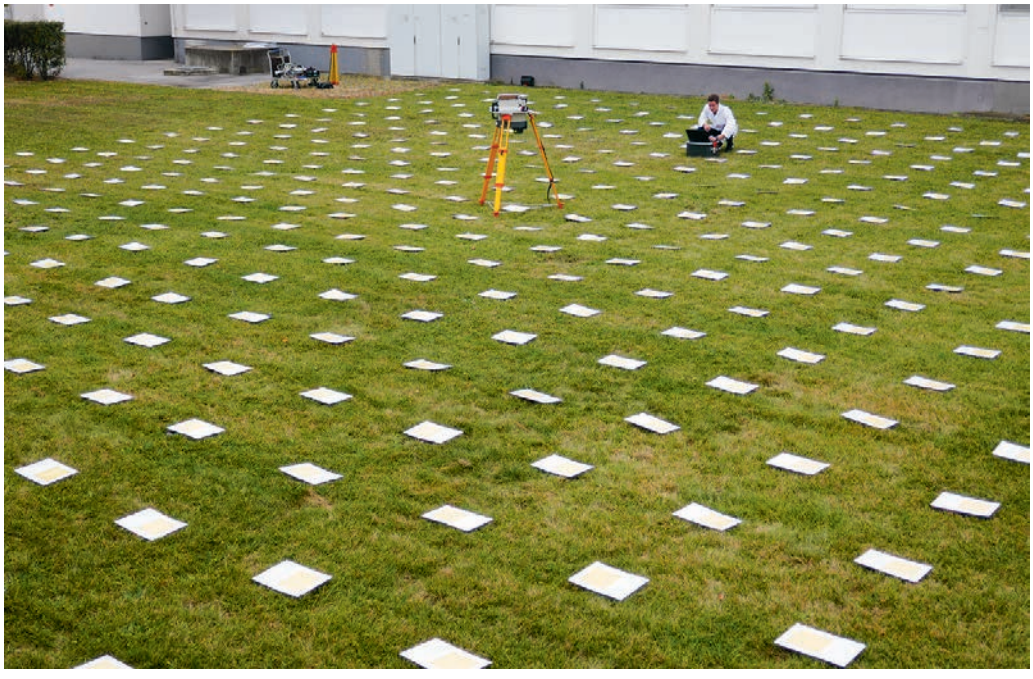


FIG. 1. Field calibration of gamma spectrometers using a novel technique of imprinting paper sheets with radionuclides; the technique, developed at the Agency, is now also used for proficiency testing.

During a radiological or nuclear emergency, many environmental samples — composed of unknown and unquantified mixtures of contaminants — need to be analysed in a very short time to support rapid emergency response decisions. The reliability of these data is critical, as their use could lead to decisions that may have significant socioeconomic implications and that may affect the well-being of humans and the environment. In an emergency, laboratories may face exceptional challenges. Adapted methodologies — from sample collection and preparation for testing to results analysis and reporting — are required to ensure rapid analysis. The Agency's worldwide network of Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA), currently comprising 186 laboratories in 89 Member States, participated in the development and validation of rapid analysis methods. Through training, proficiency testing and coordination, the Agency supports ALMERA to develop and maintain excellence in the rapid reporting of reliable measurement results in the case of a nuclear or radiological emergency. In 2019, 106 ALMERA laboratories took part in an intercomparison exercise for fast and reliable screening of radionuclides on airborne particles, helping to refine atmospheric transport models.

"The IAEA Environment Laboratories designed and carried out a series of challenging proficiency tests….including an unprecedent integration of a test into a Level 3 Convention Exercise (ConvEx-3)."

The IAEA Environment Laboratories designed and carried out a series of challenging proficiency tests to support the reliability of worldwide radionuclide measurements reported by laboratories during hypothetical radiological or nuclear emergencies, including an unprecedented integration of a test into a Level 3 Convention Exercise (ConvEx-3). The test samples used corresponded to typical emergencies that laboratories might face, including testing for a series of short-lived fission radionuclides and activation products that could be released to the environment from a damaged nuclear reactor. Over 450 laboratories participated in this series of tests. The test responses highlighted the need for further targeted testing, and led to the development of several training courses and workshops, held in 2019, that addressed gaps identified by Member States, including sampling, laboratory based analytical techniques and in situ measurements.

Understanding Our Oceans

The ocean currently contains a broad spectrum of plastic particles whose impact is still mostly unknown. Plastic particles are exposed to the corrosive force of seawater and release a suite of co-contaminants, such as plastics additives or select organics and trace elements. Isotopic and nuclear techniques are being developed at the IAEA Environment Laboratories in Monaco to reliably assess the environmental consequences of marine plastic particles. Current research activities are focused on studying the transport and fate of marine plastics in coastal and marine ecosystems and the secondary effects from sorbed co-contaminants (Fig. 2).

The IAEA Environment Laboratories are also developing new analytical procedures for Member States to extract and measure plastic-derived contaminants. In one experiment, corals showed an adverse effect when exposed in a laboratory setting to microplastic particles commonly found along most beaches (Fig. 3). Laboratory experiments that examine the cumulative effects of complex multi-stressors such as ocean warming, ocean acidification and marine plastics can accurately simulate processes that occur in nature. Such data can provide meaningful information to resource managers tasked with developing science based decisions to protect marine ecosystems.

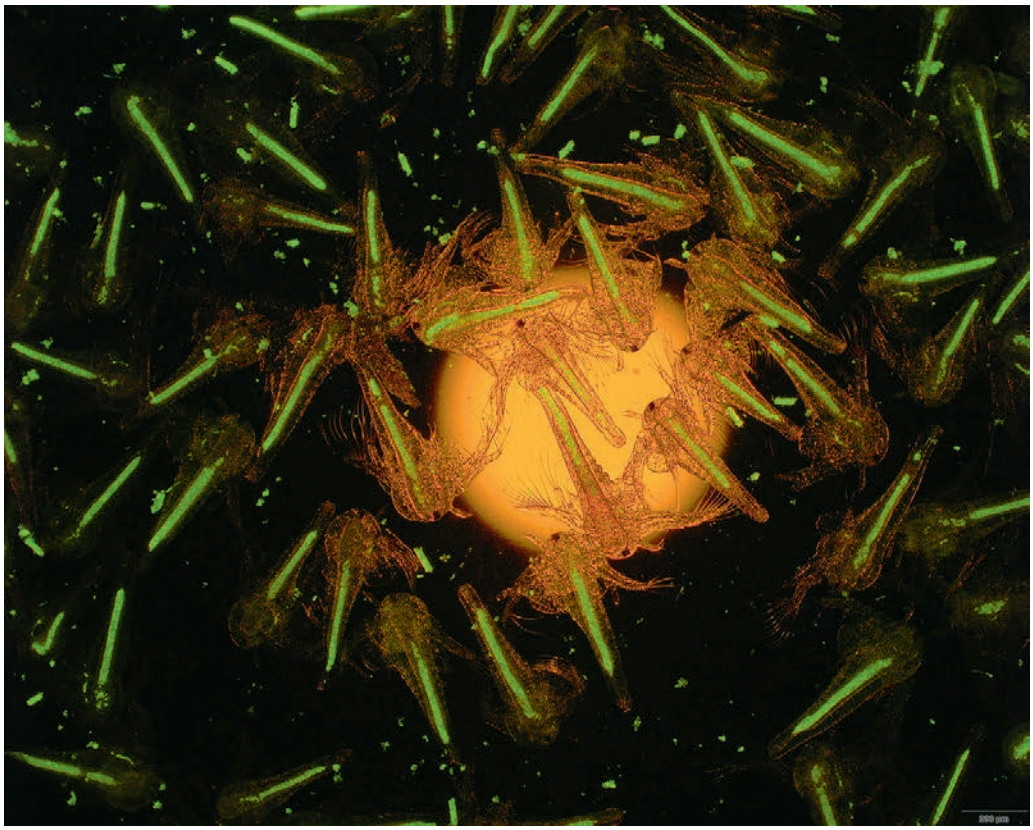


FIG. 2. Fluorescent microplastic particles line the stomach of artemia (small aquatic crustaceans) that are used as food for fish in experimental exposure studies.

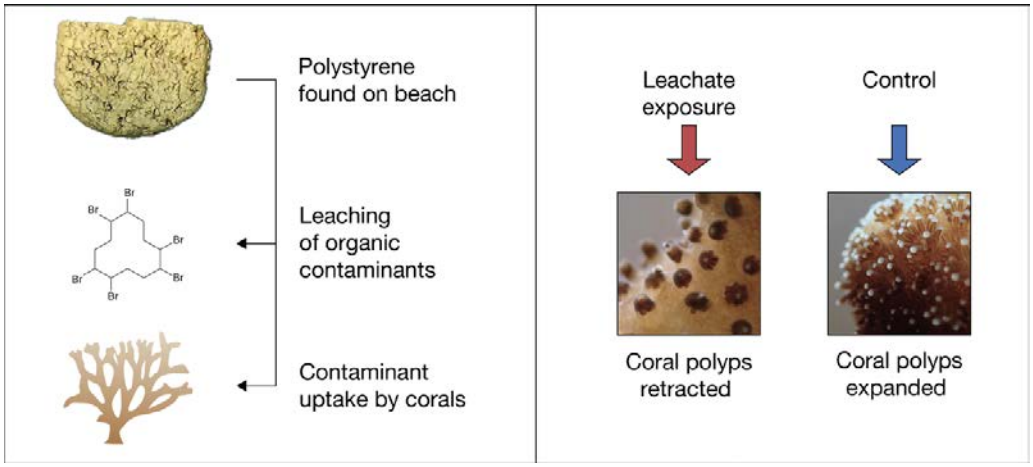


FIG. 3. Some organic contaminants leached out of strongly weathered polystyrene found on beaches cause coral to retract their polyps.

Radioisotope Production and Radiation Technology

Objective

To strengthen Member State capability to produce radioisotope products and radiopharmaceuticals and to apply radiation technology, thus contributing to improved health care, sustainable industrial development and cleaner environment in Member States.

International Symposium on Trends in Radiopharmaceuticals

The International Symposium on Trends in Radiopharmaceuticals, held in Vienna, attracted over 450 professionals from 94 countries to discuss cutting edge advancements in the production of radioisotopes and radiopharmaceuticals. The symposium highlighted trends in the development of new radiopharmaceuticals and efficient production of therapeutic radioisotopes, and emphasized the need to address regulatory issues and education.

Among the tools and resources launched during the symposium was a new Agency database, the Directory of Cyclotrons used for Radionuclide Production in Member States, that includes information on more than 1300 cyclotrons active in the production of medical radioisotopes in 76 countries on 5 continents. An innovative Medical Isotope Browser web tool was also launched. The new tool will be used to study production routes for medical isotopes that may significantly contribute to the development of radioisotope production and radiopharmaceuticals of high clinical significance. Steps were taken towards establishing a network to support career advancement for female professionals in the radiopharmaceutical sciences, including an event on the margins of the symposium that addressed the challenges and opportunities for women in the field.

Assessing Civil Structures to Save Lives

Non-destructive testing (NDT) is a crucial tool for assessing the integrity of buildings and infrastructure during the recovery stage after a natural event, such as an earthquake. In November, two Agency experts were deployed to Albania following a 6.4 magnitude earthquake to assist in the evaluation of infrastructure and provide training on NDT (Fig. 1). The Agency is working to identify NDT centres in Member States for a global network of emergency preparedness and response centres to enable rapid response to similar events in the future.

FIG. 1. Inspection of structures in Albania using NDT equipment.

The Agency worked with Member States to develop radiation-source-free NDT methods using muon radiography. At a Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications, held in Vienna, experts focused on developing industrial applications of muon radiography and tomography, and identified topics to be covered through a future CRP.

Nuclear Safety and Security

Nuclear Safety and Security

842

capacity building events
in nuclear and radiation safety

104
security related training activities

63
peer review and
advisory service missions

20 years EPREV

15
national donors to the voluntary

Nuclear Security Fund

Integrated Nuclear Security Support Plans

3
INSSPs approved
bringing the total to 84

2
international conferences

2019

emergency preparedness and response exercises

12 ConvEx

1 RANET – Joint Assistance Team

26 national exercises supported

100 exercises used USIE

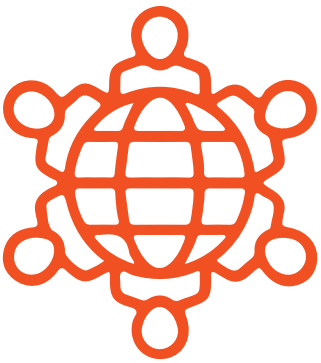
5 Regulatory Cooperation Forum support plan missions

Convention on Nuclear Safety

3 new Parties **88** total

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

2 new Parties **82** total



Convention on the Physical Protection of Nuclear Material

2 new Parties **159** total

Amendment to the Convention on the Physical Protection of Nuclear Material

4 new Parties **122** total

Incident and Emergency Preparedness and Response

Objective

To maintain and further enhance efficient Agency, national and international EPR [emergency preparedness and response] capabilities and arrangements for effective response to nuclear or radiological incidents and emergencies independent of the triggering events. To improve exchange of information on nuclear or radiological incidents and emergencies among Member States, international stakeholders and the public and media in the preparedness stage and during the response to nuclear or radiological incidents and emergencies, independent of the triggering events.

Strengthening Emergency Preparedness Arrangements

At the Technical Meeting on Twenty Years of EPREV: Building on Two Decades of Experience, held in Vienna, participants shared their experiences and proposed further improvements. The Agency and WHO took the opportunity to discuss coordination between EPREV and the WHO Joint External Evaluation service's module on radiation emergencies.

The Agency also developed new technical guidance and conducted capacity building activities to support implementation of the EPR related safety requirements established in *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GSR Part 7). A total of 55 training events were held, with 1368 participants from 133 Member States.

Innovation in EPR technology used by first responders was one of the topics discussed at the Technical Meeting on Advances in Emergency Preparedness and Response Technology and Arrangements, held in Vienna. Participants shared developments in technology and advances in operational arrangements, tools for accident simulation and atmospheric dispersion modelling, and techniques for handling data.

At the Workshop on Capacity Building Centres on Emergency Preparedness and Response, held in Vienna, the Agency launched the International Network for Education and Training on Emergency Preparedness and Response (iNET-EPR). The network will support national and regional EPR capacity building and educational activities in EPR.

Member State use of the Emergency Preparedness and Response Information Management System (EPRIMS) has increased notably. The Agency conducted seven webinars to support users in the application of the system.

The Agency launched a new CRP entitled 'Effective Use of Dose Projection Tools in the Preparedness and Response to Nuclear and Radiological Emergencies'.

FIG. 1. A member of the RANET Joint Assistance Team 'sweeps' a stadium in Las Vegas (United States of America) to detect any hidden radioactive sources before a simulated major sport event. (Photograph courtesy of S. Carragher.)

Response Arrangements with Member States

The Agency held a Response and Assistance Network (RANET) Joint Assistance Team exercise in Las Vegas, United States of America (Fig. 1) where participants managed and resolved matters that might arise during an Assistance Mission.

Two ConvEx-1 exercises and ten ConvEx-2 exercises were conducted. In October, the Agency held a 36 hour ConvEx-2d exercise, based on a national exercise in Sweden. In response to a request for assistance during that exercise, it coordinated a RANET Joint Assistance Team mission to Forsmark, Sweden, in the week following the exercise, to assess the radiological situation in the environment. It also piloted the first ConvEx-2g exercise testing Member States' emergency response arrangements for communicating effectively with the public during a nuclear or radiological emergency, which included the use of the Agency's social media simulator.

"[The Agency] piloted the first ConvEx-2g exercise testing Member States' emergency response arrangements for communicating effectively with the public during a nuclear or radiological emergency"

The Agency participated in, and supported Member States in conducting and evaluating, 26 national emergency exercises. Member States used the Unified System for Information Exchange in Incidents and Emergencies (USIE) Exercise web site for 100 of their exercises in 2019.

Response to Events

The Agency was informed, or became aware, of 245 events involving or suspected to involve ionizing radiation (Fig. 2).

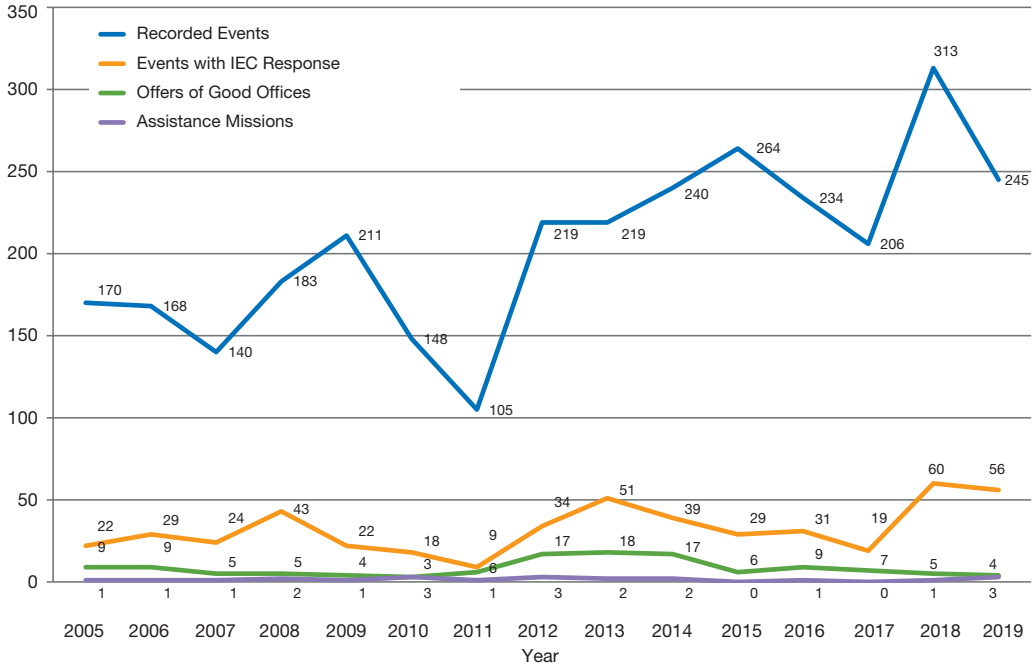


FIG. 2. Number of events involving or suspected to involve nuclear or radiological facilities or activities, about which the Agency was informed by the competent authorities, or became aware through earthquake alerts or media reports.

Inter-Agency Coordination

The Agency convened the 27th regular meeting of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE) in Geneva, Switzerland, hosted by WHO to discuss preparedness and response activities in all participating and corresponding organizations and the IACRNE work programme for the next two year period.

The interface for automatic exchange of information from European Union member countries between the Agency and the European Commission emergency web sites was made operational.

In-house Preparedness and Response

Almost 200 Agency staff are certified emergency responders in the Incident and Emergency System. Throughout 2019, the Agency organized training classes and exercises — including four full response exercises (Fig. 3) — to ensure that the staff are prepared to respond. In addition, 700 external visitors learned about the Centre during presentations and tours of its operational area.

FIG. 3. Agency staff participate in a full response exercise at the Incident and Emergency Centre in Vienna.

Safety of Nuclear Installations

Objective

To support Member States in improving the safety of nuclear installations during site evaluation, design, construction and operation through the development of safety standards and providing for their application. To support Member States in establishing and strengthening the safety infrastructure including through safety reviews and advisory services. To assist adherence to, and facilitate implementation of, the CNS and the Code of Conduct on the Safety of Research Reactors. To support Member States in capacity building through education and training, encouraging the exchange of information and operating experience as well as international cooperation including the coordination of research and development activities.

Regulatory Infrastructure for Safety

The Agency promotes the sharing of regulatory knowledge and experience to help Member States fulfil their responsibilities. In this regard, it organized the annual plenary meeting of the Regulatory Cooperation Forum (RCF), held in Vienna, and conducted five missions, to Bangladesh, Belarus, Morocco, Nigeria and Poland, to review the current status of regulatory infrastructure development for a new nuclear power programme and to identify RCF support plans (Fig. 1).

Participants in a technical meeting on building a regulatory framework for the oversight of new nuclear power plants, held in Vienna, shared national experience. The Agency also held a regional workshop on the Integrated Review of Infrastructure for Safety (IRIS) self-assessment methodology and software tool, in Hanoi, and an Interregional Training

FIG. 1. Participants in the Regulatory Cooperation Forum meeting with the Bangladesh Atomic Energy Regulatory Authority.

Course on Promoting Effective Interaction Among Nuclear Industry, Regulatory Body and Stakeholders in Countries Introducing or Expanding Nuclear Power Programmes, in Tokyo and Tsuruga, Japan.

Two workshops organized for the Europe region were aimed at developing facility inspection skills. Participants in the first workshop, held in Vienna, evaluated a project on enhancing inspection capabilities. The second workshop, held in Skopje, focused on conducting interviews during inspections. The Agency also held a Workshop on Safety Review and Inspection Methodologies for Quality Assurance for the Asia and the Pacific region, in Daejeon, Republic of Korea.

Other activities organized during the year included two regional workshops held in Jakarta: on the establishment of an integrated management system in regulatory bodies, and on the management of training systems for nuclear and radiological safety. In addition, the Agency conducted a workshop in Vienna to develop a nuclear safety knowledge management programme for regulatory bodies.

Technical meetings held focused on developing case studies and country specific examples on the safety and security interface for the oversight of nuclear power plants, and stakeholder involvement and communication for new and expanding nuclear power programmes. The Agency also organized the CANDU Senior Regulators' Meeting, in China, and a meeting of the Steering Committee on Regulatory Capacity Building and Knowledge Management, in Vienna.

Convention on Nuclear Safety

Officers of the Seventh Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS) shared experience and feedback on the preparations and conduct of the previous review meetings with the Officers elected for the CNS Eighth Review Meeting, scheduled for 2020.

At an additional CNS Officers' Meeting, held in Vienna, Officers discussed the organization of topical sessions on safety culture and aging management, and considered the possibility of using an electronic tool for handling questions.

Design Safety and Safety Assessment

The Agency issued revised Technical Safety Review (TSR) service guidelines, developed to consolidate the services provided and to streamline, harmonize and formalize the process of conducting TSRs.

At a Technical Meeting on Multi-Unit Probabilistic Safety Assessment (MUPSA), held in Vienna, participants exchanged information regarding current practices and provided feedback on a draft Safety Report on the MUPSA methodology. The Safety Report was finalized in December.

The Agency also held a Technical Meeting on the Safety Demonstration and Licensing of Passive Safety Features in Water Cooled Reactors in Vienna.

Participants in a technical meeting on the management of direct current power systems in safety electrical systems for nuclear power plants, held in Vienna, exchanged experiences on their operation, maintenance and use. The Agency also held a regional workshop on the application of digital instrumentation and control systems at nuclear power plants in Bucharest. Participants shared experiences in design modifications, ageing management, obsolescence and operating experience.

At a technical meeting on safety assessment of small modular reactors, held in Vienna, participants shared experiences and provided feedback for the development of a Safety Report. A workshop on design, safety assessment and site evaluation of small modular

reactors was held for the Europe region in Vienna. The Agency also facilitated two meetings of the Small Modular Reactor Regulators' Forum; the Forum approved the interim reports of the working groups on licensing issues, design and safety analysis, manufacturing, commissioning and operation.

Safety and Protection against External Hazards

The Agency held an Asian Nuclear Safety Network Regional Meeting on Seismic Hazard Analysis for Nuclear Installation Sites in Hanoi and a Technical Meeting on Safety in Site Evaluation and Design to Protect Nuclear Installations against External Hazards in Vienna.

At a technical meeting held in Vienna, participants provided feedback for the revision of the publication *External Human Induced Events in Site Evaluation for Nuclear Power Plants* (IAEA Safety Standard Series No. NS G 3.1).

Operational Safety of Nuclear Power Plants

In cooperation with the Nuclear Energy Agency, the CANDU Owners Group and the World Association of Nuclear Operators, the Agency held a technical meeting on sharing operating experience and highlighting lessons from events reported through the Incident Reporting System in Paris. Also, with the CANDU Owners Group, the Agency held a technical meeting on exchange of operational safety experience of pressurized heavy water reactors in Gyeongju, Republic of Korea.

To support operators, regulators and other organizations in ageing management and long term operation, the Agency conducted 3 technical meetings, 22 workshops and supporting missions, as well as 8 meetings in the framework of the International Generic Ageing Lessons Learned (IGALL) programme.

Other technical meetings addressed current practices in the transition from emergency operating procedures to severe accident management guidelines and strengthening leadership and management for the safety of nuclear facilities and regulatory bodies.

A joint course with the Abdus Salam International Centre for Theoretical Physics, held in Trieste, Italy, explored scientific novelties in the phenomenology of severe accidents in water cooled reactors.

Safety of Research Reactor and Fuel Cycle Facilities

The Agency continued to help Member States in fulfilling their safety obligations through activities aimed at sharing information and experience. This included the organization of a meeting on the application of the Code of Conduct on the Safety of Research Reactors for the Europe region, held in Brussels. The Agency also organized the International Conference on Research Reactors, held in Buenos Aires. The conference provided a forum for sharing information on the effectiveness and sustainability of research reactors.

Five Agency technical meetings held in Vienna addressed topics relating to the safety of research reactors and fuel cycle facilities. Among them were meetings on digital instrumentation and control systems for research reactors, and for the national coordinators of the Incident Reporting System for research reactors. At a meeting on the safety of research reactors, participants discussed safety performance indicator reports and explored options to enhance safety. Another meeting focused on areas where safety and security aspects need to be managed at different phases in a nuclear fuel cycle facility's lifetime, and shared national experience in regulatory capabilities. Participants in a meeting on ageing

management for nuclear fuel cycle facilities discussed safety aspects and shared national experience on the establishment of systematic programmes.

The Agency held the annual meeting of the Regional Advisory Safety Committee for Research Reactors in the Asia and the Pacific region, in Sydney, Australia, and the annual meeting of the European Advisory Safety Committee for Research Reactors in Warsaw. It also organized an Asian Nuclear Safety Network regional meeting on periodic safety reviews for research reactors, in Chicago, United States of America, and a regional meeting on self-assessment of research reactor safety, in Cairo.

Radiation and Transport Safety

Objective

To support Member States in improving radiation safety of people and the environment through the development of safety standards and providing for their application. To support Member States in establishing the appropriate safety infrastructure through support and implementation of the Code of Conduct on the Safety and Security of Radioactive Sources, and through safety reviews and advisory services. To support Member States in capacity building through education and training, and in encouraging the exchange of information and experience.

Radiation Safety and Monitoring

Five Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources were conducted, in English, French and Spanish, at Agency affiliated regional training centres. The Agency held three train the trainers workshops for radiation protection officers: in Lebanon (in Arabic and English); in Peru (in Spanish); and in Estonia (in English and Russian). A regional workshop was conducted in Mexico City to share experiences on the progress made in establishing national strategies for education and training in radiation, transport and waste safety.

At a technical meeting, experts discussed recent documents by the International Commission on Radiological Protection and the United Nations Scientific Committee on the Effects of Atomic Radiation on exposure to radon, and considered whether the organizations' recommendations should be incorporated into *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (IAEA Safety Standards Series No. GSR Part 3). The experts concluded that no changes were needed and suggested that a position paper be developed on the use of dose conversion factors.

Participants in a Technical Meeting on Radiation Exposure of Patients from Recurrent Radiological Imaging Procedures agreed on several steps for improving protection of patients, including the development of professional guidelines. The Agency also held a Technical Meeting on Experience and Results in Implementing the Safety in Radiation Oncology Reporting and Learning System (SAFRON).

A total of 48 regional and national training courses and workshops on radiation protection of patients, with 1450 participants, were organized. The Agency conducted ten webinars on specialized topics in radiation protection in medicine, including one in cooperation with the European Society of Radiology and five with the International Organization for Medical Physics. These webinars were delivered in English, Russian and Spanish, with 1500 participants from 100 countries.

The Agency launched Spanish versions of two e-learning courses on the Radiation Protection of Patients web site, on safety and quality in radiotherapy and on radiation dose management in computed tomography. More than 3330 certificates of completion

"The Agency launched Spanish versions of two e-learning courses on the Radiation Protection of Patients web site, on safety and quality in radiotherapy and on radiation dose management in computed tomography."

for e-learning courses in English and Spanish on topics relating to radiation protection of patients were issued.

The steering group for the project on developing guidance on radioactivity in food and drinking water in non-emergency situations agreed to write a literature review on radiation doses from 'total diet' studies. The group also approved the statistical approach to managing data and proposed the development of a technical report summarizing the output from the project.

Regulatory Infrastructure

Through 75 national and 15 regional technical cooperation projects, and through the extrabudgetary Regulatory Infrastructure Development Project, the Agency supported the establishment, development, implementation and strengthening of regulatory infrastructure for radiation safety (Fig. 1).

FIG. 1. Participants search for radioactive sources in the field in Kenya, an activity organized as a part of the IAEA Regulatory Infrastructure Development Project.

The Agency promoted the Code of Conduct on the Safety and Security of Radioactive Sources and supplementary Guidance documents, and assisted Member State efforts to build capacity to implement their provisions. At the Open-ended Meeting of Technical and Legal Experts to Share Information on States' Implementation of the Code of Conduct and its Supplementary Guidance, participants discussed, inter alia, transboundary movement of radioactive material inadvertently incorporated into scrap metal and semi-finished products of the metal recycling industries. The Chair's report recommended that States that had not yet made a political commitment to the Code of Conduct and/or its supplementary Guidance should consider doing so.

Two regional training courses focused on establishing a national registry of radiation sources using the Regulatory Authority Information System (RAIS), one for the Africa region in Rabat and one for the Latin America and the Caribbean region in San Salvador.

Two Regional Schools for Drafting Regulations on Radiation Safety and Nuclear Security, one held for the African region and one for the Asia and the Pacific region, were the first drafting schools to combine the two topics.

Transport Safety

The Agency launched its modular e-learning platform on the safe transport of radioactive material. Modules 1 to 4 cover the regulatory framework, radiation protection and requirements for transport safety. Modules 5 to 9 include guidance on developing and implementing a compliance assurance programme for competent authorities for the safe transport of radioactive material (Fig. 2). Regional training courses were held in Burkina Faso and Rwanda (Fig. 3).

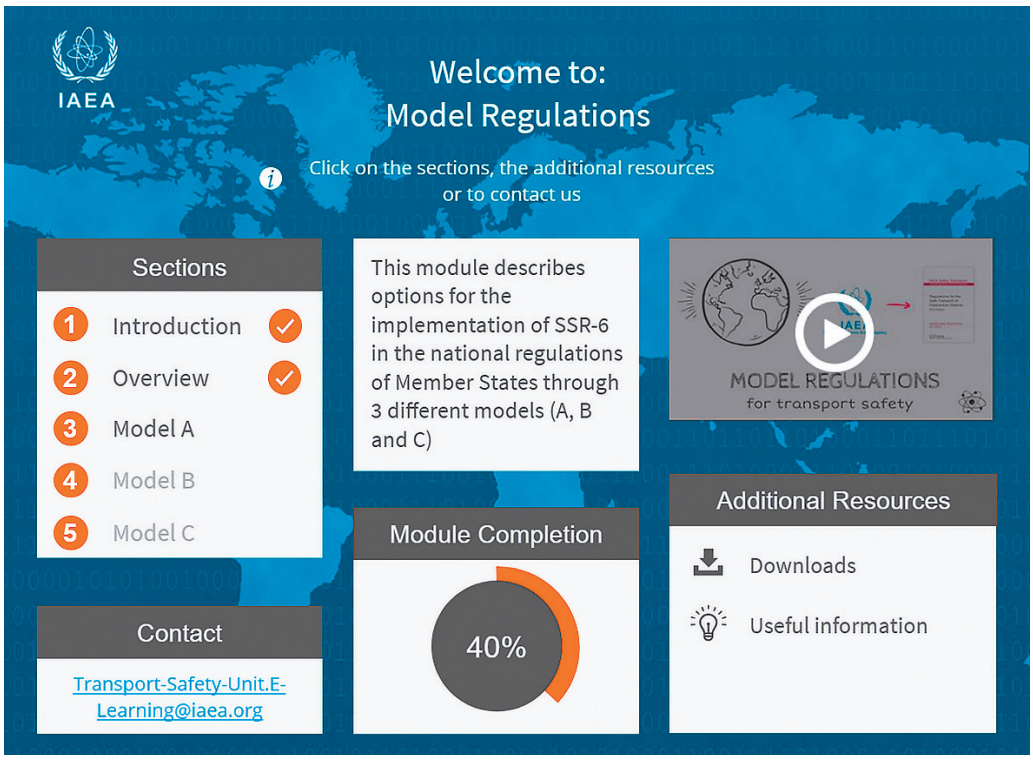


FIG. 2. Transport safety e-learning available on the new modular platform launched in 2019.

FIG. 3. Participants in a training course based on the Agency's new transport safety e-learning platform, held in Kigali.

The Agency established a group to coordinate all the Secretariat's activities on small and medium sized or modular reactors. The coordination group will also address transportable nuclear power plants, when relevant.

Radiation Safety Information Management System

The Agency held six interregional workshops in Vienna to assist Radiation Safety Information Management System (RASIMS) national coordinators in using RASIMS 2.0. By the end of 2019, 70% of RASIMS national coordinators had been trained to use the new platform.

Radioactive Waste Management and Environmental Safety

Objective

To support Member States in improving the safety of radioactive waste and spent fuel management, including geologic repositories for HLW [high level waste], decommissioning, remediation and environmental releases, through the development of safety standards and providing for their application. To support Member States in improving the safety of radioactive waste and spent fuel management, including geological repositories for HLW, decommissioning, remediation and environmental releases through peer reviews and advisory services. To support Member States in capacity building through education and training, and encouraging the exchange of information and experience.

Radioactive Waste and Spent Fuel Management

The Agency established a working group to take forward the 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), which took place in 2018. The working group's findings are being considered in the development of guidance on combined missions.

In addition, the Agency held a training course for experts taking part in ARTEMIS missions. At a feedback workshop, participants shared their experiences and identified areas for further development.

Assessment and Management of Environmental Releases

The Agency held the final technical meeting of the second phase of the Modelling and Data for Radiological Impact Assessments (MODARIA II) programme (Fig. 1). The meeting focused on building experience, transferring knowledge and developing approaches to assist Member States in the assessment of radiation doses to the public and the environment from radionuclides being released into or existing in the environment.

Decommissioning and Remediation Safety

The annual Technical Meeting of the Coordination Group for Uranium Legacy Sites (CGULS) was held in Issyk-Kul, Kyrgyzstan. The meeting provided an opportunity for participants to visit the first modern remediation project to be completed in Central Asia, at Kadji Sai.

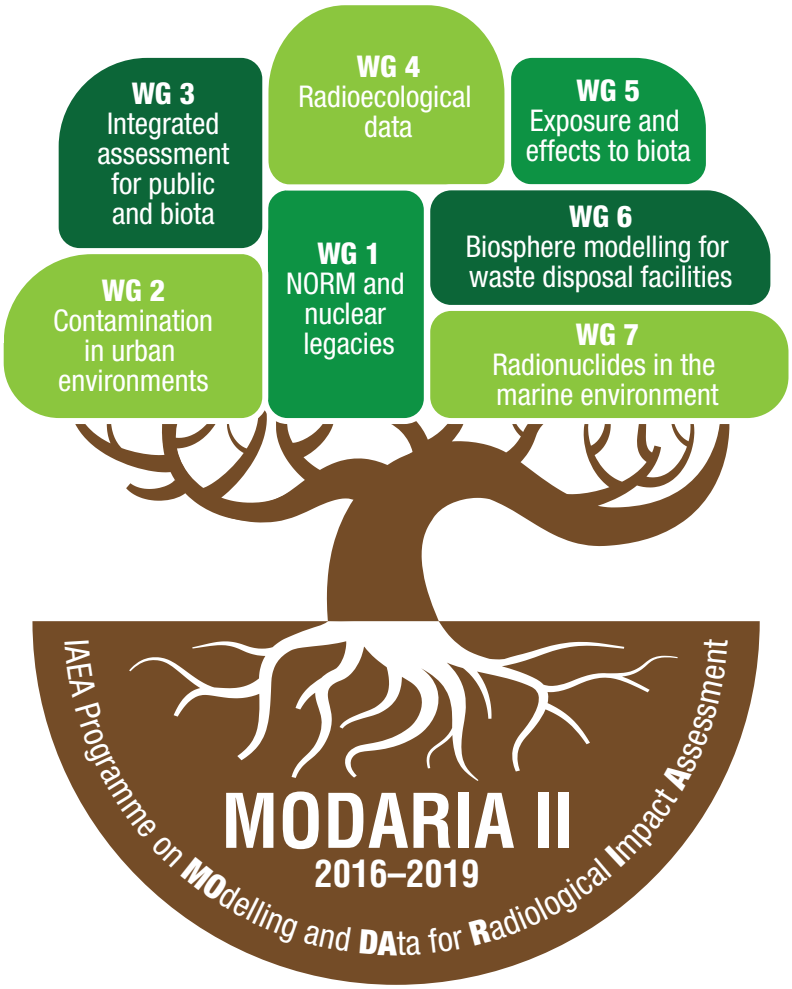


FIG.1. Structure of the MODARIA II programme.

The Agency completed two instructor-led training modules for decommissioning: the Basic Training Course on the Safe Decommissioning of Facilities and the Specialized Training Module on Regulatory Control of the Decommissioning of Facilities. Field-testing at events organized in Member States provided valuable feedback and lessons that were subsequently incorporated into the training materials. Both modules are available for use through the Agency's technical cooperation programme for training courses and are available, on request, to Member States for their own use if qualified personnel are available.

Joint Convention

In preparation for the Fourth Extraordinary Meeting of the Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention), scheduled for 2020, a working group was established by the Contracting Parties to the Convention. The working group was mandated to initiate a discussion on proposals for improving procedural mechanisms, and to further develop and elaborate them in order to facilitate consensus building on them at the Fourth Extraordinary Meeting. Proposals for amendments of the Joint Convention itself were excluded from the scope of the working group.

The Agency facilitated two meetings of the working group, where participants discussed actions to improve the peer review process, including measures in response to the increased number of Contracting Parties, as well as possible amendments to the Joint Convention guidance documents. Draft working papers and the Chairperson's summary report on the main meeting outcomes were made available to all Contracting Parties.

The Agency held a regional workshop to promote the Joint Convention in Centurion, South Africa.

Nuclear Security

Objective

To contribute to global efforts to achieve effective nuclear security, by establishing comprehensive nuclear security guidance and promoting its use through peer reviews and advisory services and capacity building, including education and training. To assist in adherence to, and implementation of, relevant international legal instruments, and in strengthening the international cooperation and coordination of assistance in a manner that underpins the use of nuclear energy and applications. To play the central role and enhance international cooperation in nuclear security, in response to General Conference resolutions and Board of Governors directions.

International Conference on Nuclear Security: Sustaining and Strengthening Efforts (ICONS 2020)

The Agency organized the third and final Programme Committee meeting, co-chaired by Bulgaria and Egypt, in preparation for ICONS 2020. It also facilitated consultations on the Ministerial Declaration expected to result from the conference, a process initiated by the co-chairs from Panama and Romania that included six informal open-ended consultations and three drafting sessions.

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

Two regional events were convened on this topic, one for English-speaking African countries and one for Latin American countries, and an international seminar on the CPPNM and its Amendment was held in Vienna. The Agency organized the fifth Technical Meeting of Representatives of States Parties to the Convention on the Physical Protection of Nuclear Material (CPPNM) and the CPPNM 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 Convention on the Physical Protection of Nuclear Material. The aim was to facilitate the review, at the 2021 Conference, of the implementation of the amended CPPNM and its adequacy as concerns the preamble, the whole of the operative part and the annexes in the light of the then prevailing situation, as foreseen in Article 16.1 thereof.

Nuclear Security Guidance

Five new IAEA Nuclear Security Series guidance publications and one revision of an existing publication were issued. At the end of 2019, the Nuclear Security Series comprised

37 publications. New publications addressed topics including developing a nuclear security contingency plan for nuclear facilities; security during the lifetime of a nuclear facility; establishing a system for control of nuclear material for nuclear security purposes at a facility during use, storage and movement; preventive measures for nuclear and other radioactive material out of regulatory control; and planning and organizing nuclear security systems and measures for nuclear and other radioactive material out of regulatory control.

Needs Assessment and Capacity Building

Three Member States approved Integrated Nuclear Security Support Plans, bringing the total number of approved plans to 84. The Agency conducted 104 security related training activities with more than 2500 participants from 143 States (Figs 1 and 2). In addition, 1972 users from 164 States completed 4692 e learning modules.

FIG. 1. Participants in the Regional Training Course on Basic Aspects of the Design of Physical Protection Systems for Radioactive Sources held in Obninsk, Russian Federation.

FIG. 2. Participants in the workshop on Managing Radiological Crime Scenes: Learning through Practice photograph the contaminated evidence for crime scene reconstruction.

"In 2019, three Category 1 and 2 disused sealed sources were removed from two European countries, and the removal of 11 sources was initiated from five countries in Africa, Latin America and the Middle East."

Risk Reduction

The Agency continued to support Member States to protect radioactive material during and after use. In 2019, three Category 1 and 2 disused sealed sources were removed from two European countries, and the removal of 11 sources was initiated from five countries in Africa, Latin America and the Middle East. A new physical protection laboratory was established in Malaysia. The Agency also provided assistance in implementing nuclear security systems and measures for major public events to 12 States.

Incident and Trafficking Database

In 2019, States reported 189 national incidents to the Incident and Trafficking Database: 182 involved radioactive sources and radioactively contaminated material, and 12 involved nuclear material. Eight reported incidents involved acts of trafficking or malicious use.

Nuclear Security Fund

The Agency accepted extrabudgetary pledges to the Nuclear Security Fund amounting to €33.3 million from 15 Member States and other contributors in 2019.

Nuclear Verification

Nuclear Verification

184

States with safeguards agreements in force of which

136 **States had additional protocols in force**

2953 **inspections, design information verifications and complementary access requiring over**

13 000 **days in the field**

1324

nuclear facilities and locations outside facilities

over 215 000 significant quantities of nuclear material

€ 142.9 million

regular budget +

€ 20.2 million extrabudgetary

20

Member State Support Programmes

1 **multinational support programme**

European Commission

Conclusions

69 States
all nuclear material remained in peaceful activities

106 States
declared nuclear material remained in peaceful activities

3 States
nuclear material, facilities or other items to which safeguards had been applied remained in peaceful activities

5 States
nuclear material in selected facilities to which safeguards had been applied remained in peaceful activities

Nuclear Verification [1,2]

Objective

To deter the proliferation of nuclear weapons by detecting early the misuse of nuclear material or technology and by providing credible assurances that States are honouring their safeguards obligations, and, in accordance with the Agency's Statute, assist with other verification tasks, including in connection with nuclear disarmament or arms control agreements, as requested by States and approved by the Board of Governors.

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 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.

For those States for which the broader conclusion has been drawn, the Agency is able to implement integrated safeguards: an optimized combination of measures available under CSAs and APs to maximize effectiveness and efficiency in fulfilling the Agency's

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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.

safeguards obligations. Integrated safeguards were implemented for the whole of 2019 or part thereof for 67 States[7,8].

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 five 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 for in the agreements.

For three States not parties to the NPT the Agency implemented safeguards 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 (Fig. 1), and the amendment or rescission of small quantities protocols (SQPs)[9]. 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[10]. 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.

The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*[11], which was updated in September 2019.

During 2019, SQPs were amended for Cameroon, Ethiopia, France[12] 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.

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7 Albania, Andorra, Armenia, Australia, Austria, Bangladesh, Belgium, Botswana, Bulgaria, Burkina Faso, Canada, Chile, Croatia, Cuba, Czech Republic, Denmark, Ecuador, Estonia, Finland, Germany, Ghana, Greece, Holy See, Hungary, Iceland, Indonesia, Ireland, Italy, Jamaica, Japan, Kazakhstan, Republic of Korea, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Madagascar, Mali, Malta, Mauritius, Monaco, Montenegro, Netherlands, New Zealand, North Macedonia, Norway, Palau, Peru, Philippines, Poland, Portugal, Romania, Seychelles, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Tajikistan, Ukraine, United Republic of Tanzania, Uruguay, Uzbekistan and Viet Nam.

8 And Taiwan, China.

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

10 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.

11 Available at: *https://www.iaea.org/sites/default/files/19/09/sg-plan-of-action-2018-2019.pdf*

12 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.

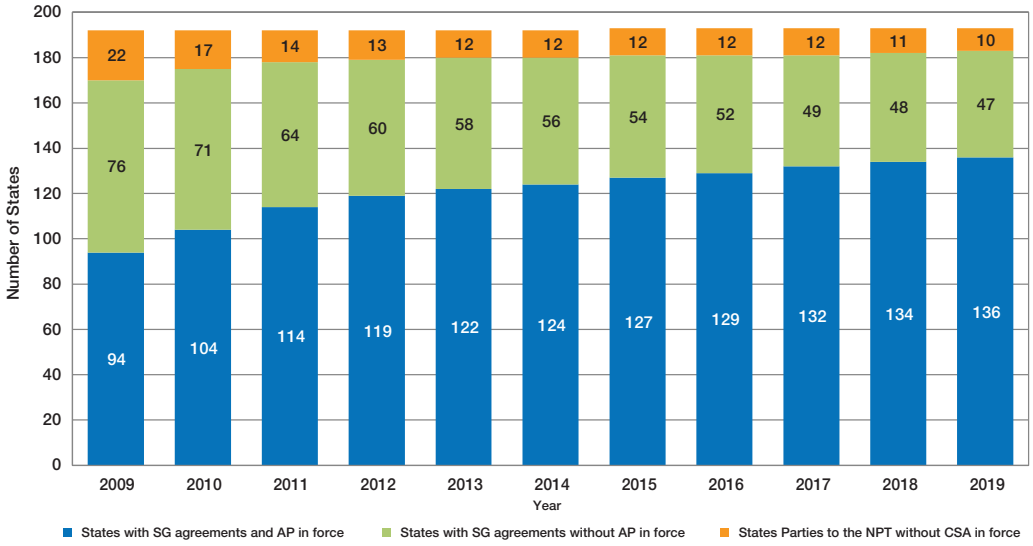


FIG. 1. Number of APs for States with safeguards agreements in force, 2009–2019 (the Democratic People's Republic of Korea is not included).

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 in between 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)* (GOV/2019/10, GOV/2019/21, GOV/INF/2019/8, GOV/INF/2019/9, GOV/INF/2019/10, GOV/2019/32, GOV/INF/2019/12, GOV/INF/2019/16, GOV/INF/2019/17 and GOV/2019/55).

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* (GOV/2019/34) covering relevant developments since the previous report in August 2018 (GOV/2018/35). The Acting Director General informed the Board of Governors that no new information had come to the knowledge of the Agency that would have an impact on the Agency's assessment that it was very likely that a building destroyed at the Dair Alzour site was a nuclear reactor that should have been declared to the Agency by Syria[13]. 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.

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

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* (GOV/2019/33–GC(63)/20), which provided an update of developments since the Director General's report of August 2018 (GOV/2018/34-GC(62)/12). 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 evaluate all safeguards relevant information available to it. Some of the DPRK's nuclear facilities appeared not to be operating, while activities at some other facilities appeared to continue or were developed further. The Agency has not had access to the Yongbyon site or to other locations in the DPRK. Without such access, the Agency cannot confirm either the operational status or configuration/design features of the facilities or locations, or the nature and purpose of the activities conducted therein. 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

Evolving safeguards implementation

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. For those States where SLAs are not implemented, in-field safeguards activities are based on the Safeguards Criteria, and new techniques and technologies are implemented, as applicable, to strengthen effectiveness and improve efficiency.

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 the State and regional systems of accounting for and control of nuclear material. In total, approximately 300 participants from some 50 countries were trained on safeguards related topics. The Agency, upon request, conducted two IAEA State System of Accounting for and Control of Nuclear Material Advisory Service (ISSAS) missions in the year. It also participated in more than 15 other training activities organized by Member States on a bilateral basis. All of these activities were supported financially or in kind through Member State Support Programmes.

Safeguards equipment and tools

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. At the end of 2019, 1708 unattended safeguards data

streams were collected remotely from 140 facilities in 30 States[14]. The Agency also had 1425 cameras operating at 261 facilities in 37 States[15]. The Agency is completing the transition to the next generation surveillance system (NGSS) by replacing the camera systems that are reaching their end of life cycle. By the end of 2019, 1031 NGSS cameras had been installed in 33 States[16].

In 2019, Member State Support Programmes were essential to enabling the evaluation, design, testing and preparation of new safeguards technology to address new verification challenges. These innovative systems include the prototype unattended verification system for uranium hexafluoride cylinders; the fast neutron coincidence collar system for measuring new fresh fuel with burnable poison rods; and the authorized passive gamma emission tomography (PGET) system for verifying spent fuel in closed containers in spent fuel ponds.

The Agency continued to undertake activities aimed at identifying and evaluating emerging instrumentation technologies that could support safeguards implementation. In 2019, further work was conducted on the next generation Cerenkov viewing device used for the verification of spent fuel, and a second technology challenge was organized to compare possible alternatives for post-processing PGET data.

After completing the modernization of safeguards information technology (IT) under the MOSAIC project, in 2019 the Agency focused on enhancing existing and developing new safeguards software capabilities in line with the Departmental strategic priorities.

Safeguards analytical services

The Agency's Network of Analytical Laboratories consists of the Agency's Safeguards Analytical Laboratory and 23 other qualified laboratories (Fig. 2). During the year, five additional laboratories for sample analysis and reference material provision were in the process of qualification.

FIG. 2. The Agency's Environmental Sample Laboratory in Seibersdorf, Austria.

[14] And Taiwan, China.

[15] And Taiwan, China.

[16] And Taiwan, China.

In 2019, the Agency collected 492 nuclear material samples that were analysed by the Agency's Nuclear Material Laboratory. The Agency also collected 405 environmental samples, which resulted in analysis of 918 subsamples; a total of 104 of these subsamples were analysed at the Agency's Environmental Sample Laboratory and the Nuclear Material Laboratory, with the remainder analysed by other laboratories in the Network of Analytical Laboratories.

Support

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. To enhance practical competencies for safeguards implementation in the field, a number of courses were held at nuclear facilities to train safeguards staff in a realistic environment for effective and integrated training (Fig. 3). These training courses provide participants with the understanding and skills necessary to prepare, conduct and report on inspections, and to conduct design information verification activities and complementary accesses. New training courses were also delivered in 2019, including an industrial safety course for inspectors and a criticality check refresher course.

FIG. 3. Using a Cerenkov viewing device, Agency inspectors verify the presence of spent nuclear fuel at a research reactor.

Preparing for the Future

The Agency prepared the *Development and Implementation Support Programme for Nuclear Verification 2020–2021* (STR-393) in 2019 (Fig. 4). At the end of the year, the Development and Implementation Support Programme for Nuclear Verification comprised 250 discrete support programme tasks in 25 projects, and 20 Member States[17] and the European Commission had formal support programmes with the Agency.

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

FIG. 4. An Agency safeguards inspector reviewing settings on a handheld unit of the Backpack Radiation Monitor, part of the Extended Multi-Component Inspector Kit (MCIK). The deployment of the MCIK was part of the Development and Implementation Support Programme for Nuclear Verification 2020–2021 (STR-393).

Technical Cooperation

Management of Technical Cooperation for Development

147

countries and territories receiving support through the Agency's technical cooperation programme

including 35 least developed countries

220 **regional and interregional training courses**

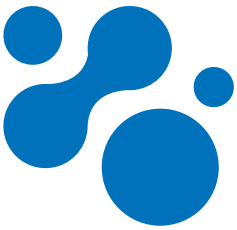
Technical Cooperation Fund

€86.2 million

target for voluntary contributions

€81 million received

94% rate of attainment



5 imPACT review missions

2081

fellows and scientific visitors

3440

training course participants

2019

837
active projects

689
projects closed or in closure at the end of 2019

110 Country Programme Frameworks valid

2132
purchase orders issued

value of purchase orders issued
€51.1 million

Management of Technical Cooperation for Development

Objective

To develop and implement a needs based, responsive technical cooperation programme in an effective and efficient manner to strengthen technical capacities of Member States in the peaceful application and safe use of nuclear technologies for sustainable development.

The Technical Cooperation Programme

Programme delivery

The technical cooperation programme is the Agency's major vehicle for transferring nuclear technology and building capacity in nuclear applications in Member States. It supports national efforts to achieve development priorities, including Sustainable Development Goal (SDG) targets, and encourages cooperation between Member States and with partners.

The main areas of IAEA technical cooperation in 2019 were health and nutrition, safety and security, and food and agriculture (Fig. 1).

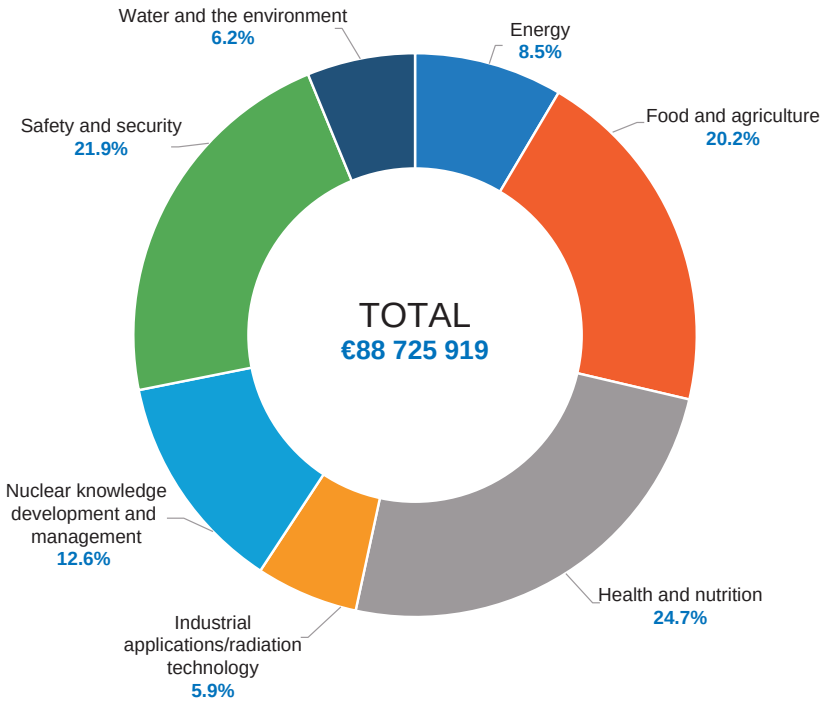


FIG. 1. Technical cooperation programme disbursements (actuals) by technical field for 2019. (Percentages do not add up to 100% owing to rounding.)

Financial highlights

Payments to the 2019 Technical Cooperation Fund totalled €82 million (including National Participation Costs, assessed programme cost arrears and miscellaneous income), against the target of €86.2 million. The rate of attainment on payments at the end of 2019 reached 94% (Fig. 2). The Technical Cooperation Fund implementation rate was 89.1%.

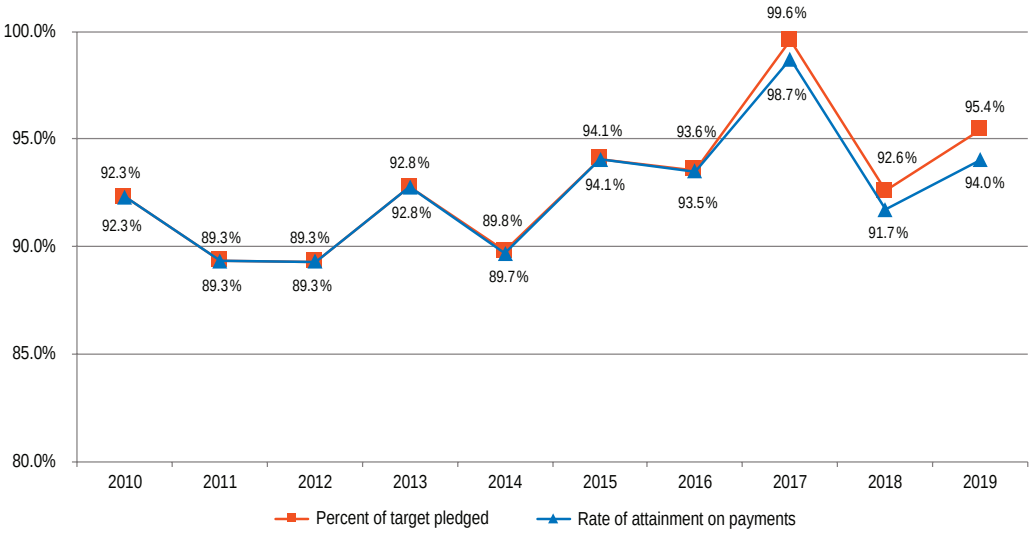


FIG. 2. Trends in the rate of attainment, 2010–2019.

Country Programme Frameworks and Revised Supplementary Agreements

The number of valid Country Programme Frameworks (CPFs) reached 110 by the end of 2019, an increase of 10%.

Revised Supplementary Agreements Concerning the Provision of Technical Assistance by the International Atomic Energy Agency (RSAs) entered into force for Eritrea, Guyana, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago in 2019. The total number of RSAs is now 141.

25 CPFs were signed in 2019

Afghanistan	Eritrea	Lithuania	South Africa
Angola	Eswatini	Mozambique	Sri Lanka
Belize	Guyana	Namibia	Syrian Arab Republic
Brazil	Kuwait	North Macedonia	
Cameroon	Latvia	Pakistan	Uganda
Dominica	Liberia	Romania	
El Salvador	Libya	Sierra Leone	

Regional Cooperative Agreements and Regional Programming

Africa

The African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) celebrated its 30th anniversary in 2019. The agreement has intensified collaboration and South–South cooperation among African Member States supported by the Agency, and advanced the peaceful application of nuclear science and technology on the continent.

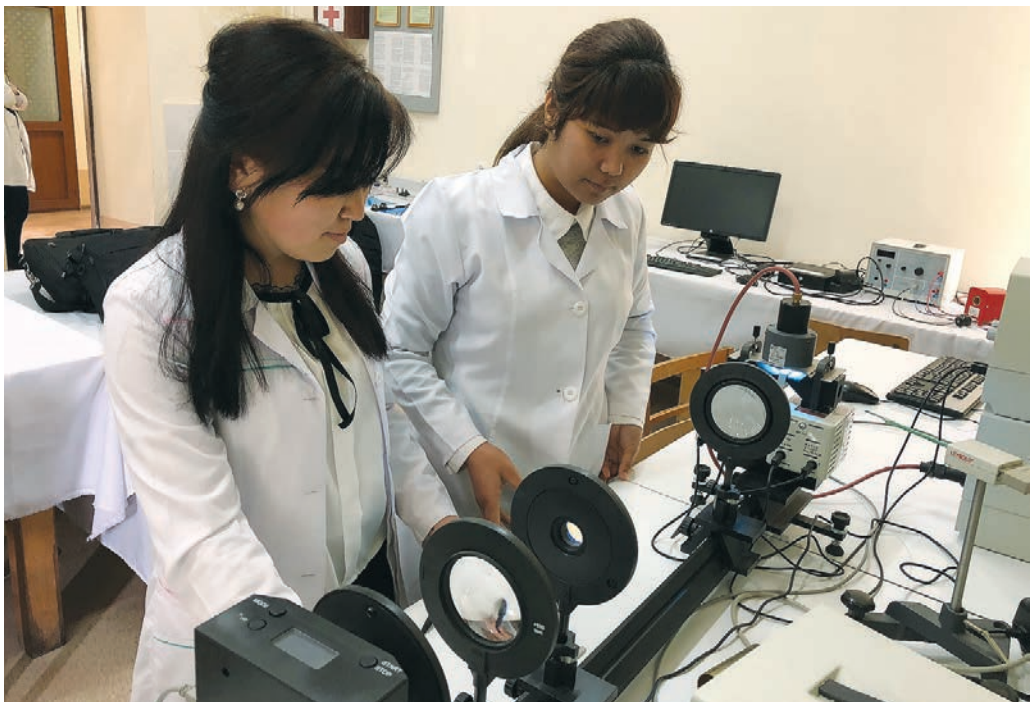


FIG. 3. The Agency strongly encourages the expansion of female participation in the technical cooperation programme, and Member States are encouraged to nominate female National Liaison Officers, counterparts, meeting and workshop participants, fellows and scientific visitors.

Fifty-five regional training courses, 19 regional workshops and 40 expert missions were implemented under AFRA. A two year master's degree programme in radiopharmacy for French-speaking countries was launched in Morocco, hosted by the Mohammed V University in Rabat in partnership with the National Centre for Nuclear Energy, Sciences and Technology.

Asia and the Pacific

In 2019, the Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) Board of Representatives established the ARASIA Programme Committee to enhance the efficiency and effectiveness of the ARASIA technical cooperation programme, and developed a resource mobilization action plan for the agreement.

Thirty e-learning modules on nuclear medicine, covering neurology, oncology, endocrinology, cardiopulmonary medicine and physics, were developed for the State Parties of the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) in 2019.

A methodology for assessing the economic impact of RCA projects was developed during the year and will be piloted in mutation breeding projects beginning in 2020.

Fourteen regional training courses, two regional workshops and seventeen expert missions were carried out under RCA.

Europe

The Europe region has no formal regional cooperative agreement but has a mechanism for regional programming that enables countries in the region to work together. For example, six regional projects on radiation processing have promoted the safe, efficient use of nuclear techniques in Europe, including the disinfection of cultural heritage artefacts by irradiation. The number and types of cultural heritage artefacts analysed and treated in the region over the past ten years has increased significantly as a result.

A four year regional technical cooperation project that drew to a close in 2019 enhanced the knowledge of 226 nuclear power plant regulators, operators and technical support organization staff from 16 countries in the Europe region. The project focused on nuclear power infrastructure and on safety assessment of pressurized water reactors.

Latin America and the Caribbean

The Regional Strategic Framework for technical cooperation with Agency Member States and Caribbean Community (CARICOM) member countries for 2020–2026, endorsed in 2019, outlines common challenges facing CARICOM member countries and presents a method and timeline for addressing them using nuclear science and technology.

The Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) celebrated its 35th anniversary. Achievements made under the Regional Strategic Profile for the period 2016–2021 were evaluated, and an action plan to develop a new Regional Strategic Profile, 'Agenda ARCAL 2030', was agreed.

ARCAL supported the preparation of 10 of the 25 new regional projects for the 2020–2021 technical cooperation cycle (Fig. 4). Training in the logical framework approach for project counterparts emphasized the design of new radiation safety projects.

A meeting of the Quadripartite Forum of the four cooperative agreements, AFRA, ARASIA, ARCAL and RCA, was held to share regional achievements and projects. Delegates discussed participation in the human resource development activities of the four agreements and the expansion of this mechanism to include meetings and workshops.

Programme of Action for Cancer Therapy (PACT)

Armenia, Burkina Faso, Ecuador, Seychelles and Sri Lanka received imPACT (integrated missions of PACT) Review missions. imPACT Reviews cover comprehensive cancer control and draw on the experience of international experts nominated by the Agency, WHO and the International Agency for Research on Cancer (Fig. 5).

FIG. 4. Young professional women at an ARCAL workshop, which aimed to provide scientists in nuclear related areas with necessary leadership skills.

FIG. 5. imPACT experts review cancer treatment planning with medical staff at the Teaching Hospital Karapitiya, Sri Lanka.

In cooperation with WHO, expert advisory assistance was provided to Panama to support the development of its 2019–2029 national cancer control plan.

Chad, Eswatini, Kenya, Liberia and Sierra Leone received Agency support to develop bankable documents for establishing nuclear medicine and radiotherapy services.

Key partners in cancer control, including representatives of WHO, the International Agency for Research on Cancer, the United Nations Office on Drugs and Crime, and the Union for International Cancer Control, met to finalize revisions to the current imPACT Review methodology, strengthen the planning and delivery of joint activities, and improve coordination at the country level.

The Russian Federation extended support to PACT up to 2023 for a regional project in Europe designed to strengthen the knowledge of radiotherapy professionals.

Strengthening the Quality of the Technical Cooperation Programme

Quality assurance activities for the 2020–2021 programme cycle followed a two step mechanism: feedback and guidance was provided on developing projects, and a final quality review of all projects was conducted. The process adopted a country portfolio approach, and assessed how projects addressed the technical cooperation central criterion and how their design complied with the logical framework approach.

The platform for electronic submission of Project Progress Achievement Reports has increased communication with Member States, contributing to more effective project implementation, sharing of good practices, assessment of results and the integration of project level reporting mechanisms with CPFs.

Outreach and Communication

The Agency raised awareness of its development work at the Global Conference on Strengthening Synergies between the Paris Agreement and the 2030 Agenda for Sustainable Development in Denmark, and the annual Multi-stakeholder Forum on Science, Technology

and Innovation for the Sustainable Development Goals and the High-level Political Forum on Sustainable Development (SDG Summit) in New York.

Agency assistance in the fight against cancer was highlighted at key global health events, including the 44th Annual General Meeting of the Islamic Development Bank Group in Marrakech, Morocco, the World Health Summit in Berlin, the 2019 World Cancer Leaders' Summit in Nur-Sultan, the 12th International Conference on Cancer in Africa in Maputo, and the World Health Organization Global Meeting to Accelerate Progress on SDG Target 3.4 on Noncommunicable Diseases and Mental Health in Muscat.

Cooperation with the United Nations System

The United Nations' common programming instrument, the United Nations Sustainable Development Cooperation Framework (Cooperation Framework), aims to ensure that the United Nations system is better positioned to deliver on the 2030 Agenda for Sustainable Development and to support partner governments to achieve their development goals. The Agency co-signed a Cooperation Framework with Sierra Leone in 2019, bringing the total number of valid United Nations Development Assistance Frameworks and Cooperation Frameworks co-signed by the Agency to 53.

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'.

The Agency's support to Member States in their efforts to achieve the SDGs was highlighted at a series of events in and around the SDG Summit, the United Nations' main mechanism for follow-up and review of the 2030 Agenda. Agency good practices and success stories were presented at a video exhibit during the week of high level meetings of the United Nations General Assembly.

For the third consecutive year, the Agency participated in the dialogue leading to the publication of the annual Financing for Sustainable Development Report, a joint product of the Inter-Agency Task Force on Financing for Development. The Report issued in 2019 noted that the Agency's work in science, technology and innovation helps countries to address key development priorities, and assists in the establishment of national legal frameworks for the safe, secure and peaceful use of nuclear science and technology.

Partnership Agreements and Practical Arrangements

The Agency concluded 12 new partnerships related to technical cooperation. A new monitoring framework was launched to assess the contribution of partnerships to the work of the technical cooperation programme.

The partnership with the Islamic Development Bank was further strengthened through the launch of the Women's Cancers Partnership Initiative at the 2019 Scientific Forum. The Bank announced a plan to mobilize an initial US $10 million in grant funding in support of unfunded technical cooperation activities related to women's cancer. Plans to support activities to address women's cancer were also announced by France, Monaco, the Russian Federation, Sweden and the United States of America, as well as by the private sector.

Other Practical Arrangements signed in 2019 included those with the Italian Society for Non-Destructive Testing Monitoring Diagnostics on the application of non-destructive testing, the Kuwait Institute for Scientific Research to address marine environmental monitoring, and St. Jude Children's Research Hospital to combat childhood cancer in developing countries.

The Agency also signed two Practical Arrangements on enhancing technical cooperation among developing countries and strengthening South–South cooperation, one with Viet Nam and Cambodia and another with Viet Nam and Lao People's Democratic Republic. The cooperation includes provision of education and training on radiation applications in several sectors, including food and agriculture, industry and non-destructive testing, radiation and nuclear safety, regulatory infrastructure, and radiation medicine.

At the close of the year, the Agency and the European Union reached a new €2.8 million Delegation Agreement under the framework of the Instrument for Nuclear Safety Cooperation, €1.2 million of which was assigned to the technical cooperation programme. Under the 2016 Agreement, which will run until the end of 2020, nine e-learning modules on predisposal, disposal and other aspects of radioactive waste management, accessible to all Agency Member States, were produced in 2019.

Activities and actions under existing Practical Arrangements

A fact-finding mission to China, carried out within the framework of existing Practical Arrangements between China and the Agency, aimed to strengthen South–South cooperation with the Africa region. Potential partnerships were explored, as well as additional training opportunities at Tsinghua University and Harbin Engineering University, which are currently hosting fellows from Africa.

The Agency participated in the 10th General Meeting of CARICOM and the United Nations in Guyana. The text of the joint statement adopted at the meeting acknowledges the Agency's key contributions to health system development in the Caribbean region. The Agency worked closely with the Pan American Health Organization to support improved quality of radiation medicine services.

Practical Arrangements with the International Center for Biosaline Agriculture were extended in 2019 to include capacity building for women in agriculture and nutrition.

Legislative Assistance

The Agency continued to provide legislative assistance to Member States through its technical cooperation programme. Country specific bilateral legislative assistance was provided to 17 Member States through written comments and advice on drafting national nuclear legislation. The Agency also reviewed the legal framework of several newcomer countries as part of the Integrated Nuclear Infrastructure Review missions.

The ninth session of the Nuclear Law Institute in Vienna enabled participants to acquire a solid understanding of all aspects of nuclear law, and to draft, amend or review their national nuclear legislation (Fig. 6).

The first meeting of legal advisers of regulatory bodies, organized in Vienna, provided a forum to share experiences and information on the role of the legal adviser in supporting the exercise of regulatory functions.

Two regional workshops on nuclear law were conducted for Member States in Asia and the Pacific, in Jakarta and in Vienna. National workshops on different aspects of nuclear law were organized in Bolivia, Costa Rica, Egypt, Kuwait, the Philippines, Rwanda and Saudi Arabia.

FIG. 6. Participants in the ninth session of the Nuclear Law Institute.

Treaty Event

The Agency's ninth Treaty Event took place during the 63rd regular session of the Agency's General Conference, providing Member States with an opportunity to deposit their instruments of ratification, acceptance or approval of, or accession to, the treaties deposited with the Director General. The event focused on the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and the Convention on the Physical Protection of Nuclear Material and its Amendment.

Annex

Note: Tables A34–A39 are available on-line only at *www.iaea.org/publications/reports*.

Table A1. Regular Budget allocation and utilization of resources in 2019 by Programme and Major Programme (in euros)

Major Programme (MP)/Programme	Original budget US $1/€1	Adjusted budget US $1/€0.893	Expenditure	Resource utilization	Balances
	a*	b**	c	d = c/b	e = b - c
MP1 — Nuclear Power, Fuel Cycle and Nuclear Science					
Overall management, coordination and common activities	3 184 785	3 129 881	3 144 260	100.5%	(14 379)
Nuclear Power	8 841 191	8 687 257	8 789 805	101.2%	(102 548)
Nuclear Fuel Cycle and Materials Technologies	7 467 818	7 344 036	7 235 956	98.5%	108 080
Capacity Building and Nuclear Knowledge for Sustainable Energy Development	10 473 766	10 318 073	10 300 619	99.8%	17 454
Nuclear Science	10 494 976	10 376 158	10 326 169	99.5%	49 989
Total Major Programme 1	**40 462 536**	**39 855 405**	**39 796 809**	**99.9%**	**58 596**
MP2 — Nuclear Techniques for Development and Environmental Protection					
Overall management, coordination and common activities	7 978 595	7 912 219	7 909 592	100.0%	2 627
Food and Agriculture	11 817 017	11 681 915	11 699 785	100.2%	(17 870)
Human Health	8 666 935	8 549 474	8 543 384	99.9%	6 090
Water Resources	3 666 420	3 625 316	3 615 692	99.7%	9 624
Environment	6 557 374	6 475 741	6 467 165	99.9%	8 576
Radioisotope Production and Radiation Technology	2 421 962	2 393 810	2 395 692	100.1%	(1 882)
Total Major Programme 2	**41 108 303**	**40 638 475**	**40 631 310**	**100.0%**	**7 165**
MP3 — Nuclear Safety and Security					
Overall management, coordination and common activities	3 978 652	3 906 865	3 850 072	98.5%	56 793
Incident and Emergency Preparedness and Response	4 393 537	4 326 546	4 300 355	99.4%	26 191
Safety of Nuclear Installations	10 524 029	10 325 001	10 303 267	99.8%	21 734
Radiation and Transport Safety	7 536 756	7 401 694	7 583 163	102.5%	(181 469)
Radioactive Waste Management and Environmental Safety	3 800 859	3 737 355	3 593 682	96.2%	143 673
Nuclear Security	5 934 522	5 813 509	5 853 278	100.7%	(39 769)
Total Major Programme 3	**36 168 355**	**35 510 970**	**35 483 817**	**99.9%**	**27 153**
MP4 — Nuclear Verification					
Overall management, coordination and common activities	14 273 041	14 106 398	13 788 091	97.7%	318 307
Safeguards Implementation	124 751 186	122 703 636	122 942 062	100.2%	(238 426)
Other Verification Activities	2 843 747	2 771 619	2 791 445	100.7%	(19 826)
Development	3 428 805	3 365 367	3 405 004	101.2%	(39 637)
Total Major Programme 4	**145 296 779**	**142 947 020**	**142 926 602**	**100.0%**	**20 418**
MP5 — Policy, Management and Administration Services					
Policy, Management and Administration Services	79 978 272	79 158 647	79 155 330	100.0%	3 317
Total Major Programme 5	**79 978 272**	**79 158 647**	**79 155 330**	**100.0%**	**3 317**
MP6 — Management of Technical Cooperation for Development					
Management of Technical Cooperation for Development	25 941 045	25 543 049	25 525 507	99.9%	17 542
Total Major Programme 6	**25 941 045**	**25 543 049**	**25 525 507**	**99.9%**	**17 542**
Total Operational Regular Budget	**368 955 290**	**363 653 566**	**363 519 375**	**100.0%**	**134 191**
Major Capital Investment Funding Requirements* **					
MP1 — Nuclear Power, Fuel Cycle and Nuclear Science	–	–	–	–	–
MP2 — Nuclear Techniques for Development and Environmental Protection	2 051 956	2 051 956	1 176 306	57.3%	875 650
MP3 — Nuclear Safety and Security	308 146	308 146	178 288	57.9%	129 858
MP4 — Nuclear Verification	1 027 152	1 027 152	–	–	1 027 152
MP5 — Policy, Management and Administration Services	2 827 614	2 827 614	426 210	15.1%	2 401 404
MP6 — Management of Technical Cooperation for Development	–	–	–	–	–
Total Capital Regular Budget	**6 214 868**	**6 214 868**	**1 780 804**	**28.7%**	**4 434 064**
Total Agency Programmes	**375 170 158**	**369 868 434**	**365 300 179**	**98.8%**	**4 568 255**
Reimbursable Work for Others	2 835 725	2 835 725	3 267 443	115.2%	(431 718)
Total Regular Budget	**378 005 883**	**372 704 159**	**368 567 622**	**98.9%**	**4 136 537**

* General Conference resolution GC(62)/RES/2 of September 2018 original budget at US $1/€1.
** Original budget revalued at the United Nations operational average rate of exchange of €0.893 to US $1 in 2019.
*** Additional information about the Major Capital Investment Fund can be found in note 39d of *The Agency's Financial Statements for 2019.*

Table A2. Extrabudgetary regular programme fund resource utilization in 2019 by Programme and Major Programme (in euros)

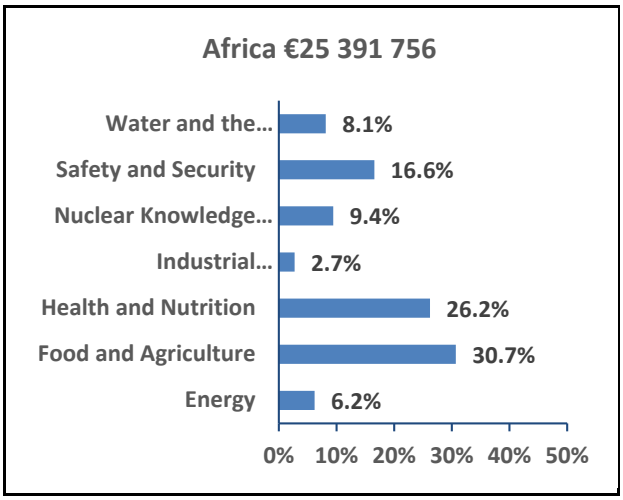
Major Programme (MP)/Programme	2019 net expenditure
MP1 — Nuclear Power, Fuel Cycle and Nuclear Science	
Overall management, coordination and common activities	79 168
Nuclear Power	3 685 827
Nuclear Fuel Cycle and Materials Technologies	60 722 878
Capacity Building and Nuclear Knowledge for Sustainable Energy Development	1 056 765
Nuclear Science	786 548
Total Major Programme 1	**66 331 186**
MP2 — Nuclear Techniques for Development and Environmental Protection	
Overall management, coordination and common activities	733 290
Food and Agriculture	3 858 265
Human Health	367 295
Water Resources	41 337
Environment	1 565 511
Radioisotope Production and Radiation Technology	335 288
Total Major Programme 2	**6 900 986**
MP3 — Nuclear Safety and Security	
Overall management, coordination and common activities	4 308 923
Incident and Emergency Preparedness and Response	1 561 277
Safety of Nuclear Installations	4 504 077
Radiation and Transport Safety	1 959 595
Radioactive Waste Management and Environmental Safety	1 279 657
Nuclear Security	21 738 722
Total Major Programme 3	**35 352 251**
MP4 — Nuclear Verification	
Overall management, coordination and common activities	626 500
Safeguards Implementation	13 378 525
Other Verification Activities	5 403 083
Development	747 617
Total Major Programme 4	**20 155 725**
MP5 — Policy, Management and Administration Services	
Policy, Management and Administration Services	1 231 413
Total Major Programme 5	**1 231 413**
MP6 — Management of Technical Cooperation for Development	
Management of Technical Cooperation for Development	251 308
Total Major Programme 6	**251 308**
Total extrabudgetary programme funds	**130 222 869**

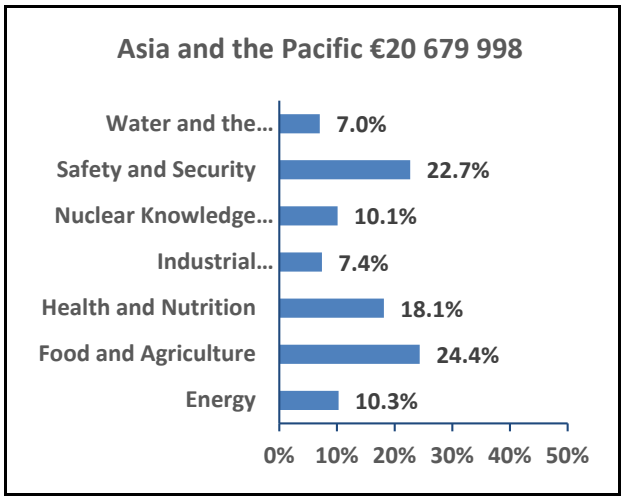
Table A3(a). Disbursements (actuals) of the Technical Cooperation Fund by technical field and region in 2019

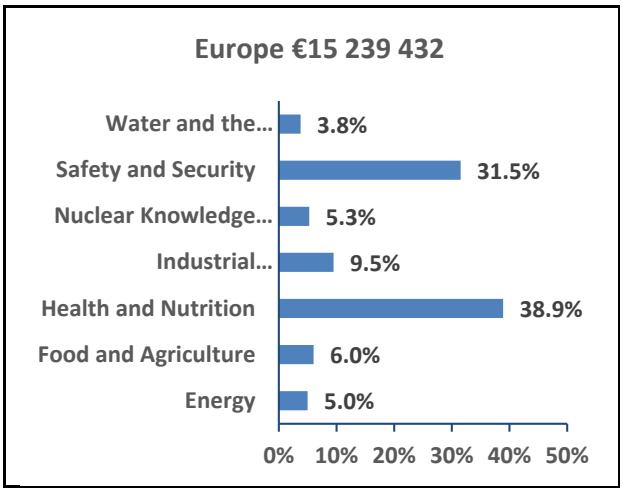
Summary of all regions (in euros)							
Technical field	**Africa**	**Asia and the Pacific**	**Europe**	**Latin America and the Caribbean**	**interregional and miscellaneous**	**PACT[a]**	**Total**
Energy	1 573 629	2 125 923	762 164	407 457	2 683 879	0	**7 553 052**
Food and Agriculture	7 792 518	5 035 682	919 239	3 294 191	840 887	0	**17 882 518**
Health and Nutrition	6 657 846	3 748 716	5 928 045	4 498 798	630 329	465 512	**21 929 247**
Industrial Applications/ Radiation Technology	696 979	1 527 119	1 446 549	1 538 162	0	0	**5 208 809**
Nuclear Knowledge Development and Management	2 398 243	2 092 727	803 879	2 585 139	3 316 819	0	**11 196 808**
Safety and Security	4 206 728	4 695 657	4 806 253	4 567 315	1 177 375	0	**19 453 329**
Water and the Environment	2 065 812	1 454 173	573 303	1 313 209	95 659	0	**5 502 156**
Total	**25 391 756**	**20 679 998**	**15 239 432**	**18 204 272**	**8 744 948**	**465 512**	**88 725 919**

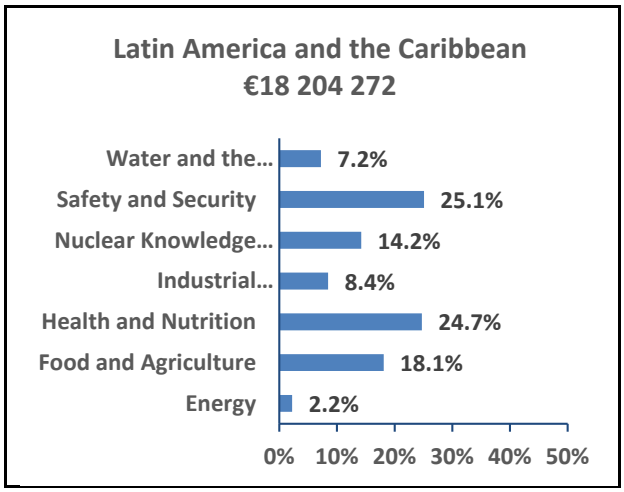
[a] PACT: Programme of Action for Cancer Therapy.

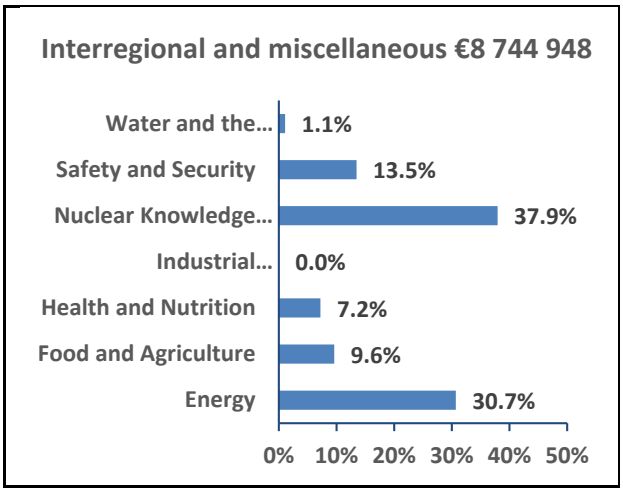
Table A3(b). Graphical representation of the information in Table A3(a)

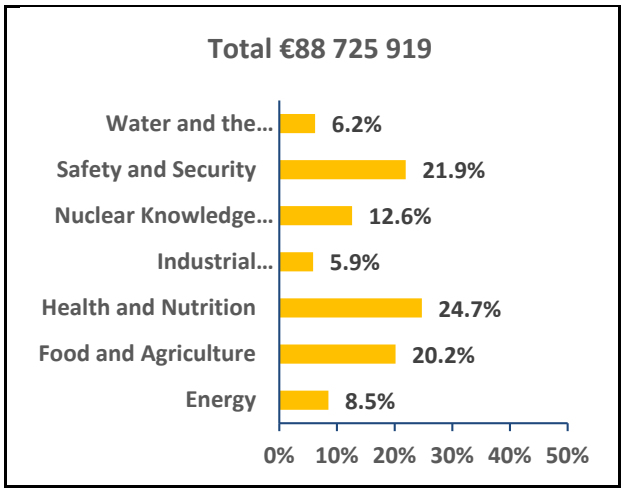












Note: See Table A3(a) for the full titles of the technical fields.

Table A4. Amount of nuclear material under Agency safeguards at the end of 2019 by type of agreement

Nuclear material	Comprehensive safeguards agreement[a]	INFCIRC/66-type agreement	Voluntary offer agreement	Quantity in significant quantities (SQs)
Plutonium[b] contained in irradiated fuel and in fuel elements in reactor cores	144 507	2 892	20 273	167 672
Separated plutonium outside reactor cores	1 131	5	10 941	12 077
High enriched uranium (equal to or greater than 20% U-235)	154	2	0	156
Low enriched uranium (less than 20% U-235)	19 247	358	1 240	20 845
Source material[c] (natural and depleted uranium and thorium)	11 644	1 308	2 728	15 680
U-233	18	0	0	18
Total SQs of nuclear material	**176 701**	**4 565**	**35 182**	**216 448**

Amount of heavy water under Agency safeguards at the end of 2019 by type of agreement				
Non-nuclear material[d]	**Comprehensive safeguards agreement**	**INFCIRC/66-type agreement**	**Voluntary offer agreement**	**Quantity in tonnes**
Heavy water (tonnes)		**429.5**		**430.2[e]**

[a] Includes nuclear material under Agency safeguards in Taiwan, China; excludes nuclear material in the Democratic People's Republic of Korea.

[b] The quantity includes an estimated amount (9 000 SQs) of plutonium in fuel elements loaded into reactor cores and plutonium in other irradiated fuel, which has not yet been reported to the Agency under agreed reporting procedures.

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

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

[e] Includes 0.7 tonnes of heavy water under Agency safeguards in Taiwan, China.

Table A5. Number of facilities and material balance areas outside facilities under Agency safeguards during 2019

Type	Comprehensive safeguards agreement[a]	INFCIRC/66-type agreement[b]	Voluntary offer agreement	Total
Power reactors	241	17	1	**259**
Research reactors and critical assemblies	146	3	1	**150**
Conversion plants	17	0	0	**17**
Fuel fabrication plants	38	2	1	**41**
Reprocessing plants	10	0	1	**11**
Enrichment plants	16	0	3	**19**
Separate storage facilities	136	2	4	**142**
Other facilities	78	0	0	**78**
Facility subtotals	**682**	**24**	**11**	**717**
Material balance areas containing locations outside facilities[c]	606	1	0	**607**
Total	**1288**	**25**	**11**	**1324**

[a] Covering safeguards agreements pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons and/or the Treaty of Tlatelolco and other comprehensive safeguards agreements; includes facilities in Taiwan, China.

[b] Covering facilities in India, Israel and Pakistan.

[c] Includes 64 material balance areas in States with amended small quantities protocols.

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (as of 31 December 2019)

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Afghanistan	Amended: 28 Jan. 2016	In force: 20 Feb. 1978	257	In force: 19 Jul. 2005
Albania[1]		In force: 25 Mar. 1988	359	In force: 3 Nov. 2010
Algeria		In force: 7 Jan. 1997	531	Signed: 16 Feb. 2018
Andorra	Amended: 24 Apr. 2013	In force: 18 Oct. 2010	808	In force: 19 Dec. 2011
Angola	In force: 28 Apr. 2010	In force: 28 Apr. 2010	800	In force: 28 Apr. 2010
Antigua and Barbuda[2]	Amended: 5 Mar. 2012	In force: 9 Sep. 1996	528	In force: 15 Nov. 2013
Argentina[3]		In force: 4 Mar. 1994	435	
Armenia		In force: 5 May 1994	455	In force: 28 Jun. 2004
Australia		In force: 10 Jul. 1974	217	In force: 12 Dec. 1997
Austria[4]		Accession: 31 Jul. 1996	193	In force: 30 Apr. 2004
Azerbaijan		In force: 29 Apr. 1999	580	In force: 29 Nov. 2000
Bahamas[2]	Amended: 25 Jul. 2007	In force: 12 Sep. 1997	544	
Bahrain	In force: 10 May 2009	In force: 10 May 2009	767	In force: 20 Jul. 2011
Bangladesh		In force: 11 Jun. 1982	301	In force: 30 Mar. 2001
Barbados[2]	X	In force: 14 Aug. 1996	527	
Belarus		In force: 2 Aug. 1995	495	Signed: 15 Nov. 2005
Belgium		In force: 21 Feb. 1977	193	In force: 30 Apr. 2004
Belize[5]	X	In force: 21 Jan. 1997	532	
Benin	In force: 17 Sep. 2019	In force: 17 Sep. 2019	930	In force: 17 Sep. 2019
Bhutan	X	In force: 24 Oct. 1989	371	
Bolivia, Plurinational State of [2]	X	In force: 6 Feb. 1995	465	Signed: 18 Sep. 2019
Bosnia and Herzegovina		In force: 4 Apr. 2013	851	In force: 3 Jul. 2013
Botswana		In force: 24 Aug. 2006	694	In force: 24 Aug. 2006
Brazil[6]		In force: 4 Mar. 1994	435	
Brunei Darussalam	X	In force: 4 Nov. 1987	365	
Bulgaria[7]		Accession: 1 May 2009	193	Accession: 1 May 2009
Burkina Faso	Amended: 18 Feb. 2008	In force: 17 Apr. 2003	618	In force: 17 Apr. 2003

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Burundi	In force: 27 Sep. 2007	In force: 27 Sep. 2007	719	In force: 27 Sep. 2007
Cabo Verde	*Amended: 27 Mar. 2006*	*Signed: 28 Jun. 2005*		*Signed: 28 Jun. 2005*
Cambodia	Amended: 16 Jul. 2014	In force: 17 Dec. 1999	586	In force: 24 Apr. 2015
Cameroon	Amended: 15 Jul. 2019	In force: 17 Dec. 2004	641	In force: 29 Sep. 2016
Canada		In force: 21 Feb. 1972	164	In force: 8 Sep. 2000
Central African Republic	In force: 7 Sep. 2009	In force: 7 Sep. 2009	777	In force: 7 Sep. 2009
Chad	In force: 13 May 2010	In force: 13 May 2010	802	In force: 13 May 2010
Chile[8]		In force: 5 Apr. 1995	476	In force: 3 Nov. 2003
China		In force: 18 Sep. 1989	369*	In force: 28 Mar. 2002
Colombia[8]		In force: 22 Dec. 1982	306	In force: 5 Mar. 2009
Comoros	In force: 20 Jan. 2009	In force: 20 Jan. 2009	752	In force: 20 Jan. 2009
Congo	In force: 28 Oct. 2011	In force: 28 Oct. 2011	831	In force: 28 Oct. 2011
Costa Rica[2]	Amended: 12 Jan. 2007	In force: 22 Nov. 1979	278	In force: 17 Jun. 2011
Côte d'Ivoire		In force: 8 Sep. 1983	309	In force: 5 May 2016
Croatia[9]		Accession: 1 Apr. 2017	193	Accession: 1 Apr. 2017
Cuba[2]		In force: 3 Jun. 2004	633	In force: 3 Jun. 2004
Cyprus[10]		Accession: 1 May 2008	193	Accession: 1 May 2008
Czech Republic[11]		Accession: 1 Oct. 2009	193	Accession: 1 Oct. 2009
Democratic Republic of the Congo		In force: 9 Nov. 1972	183	In force: 9 Apr. 2003
Denmark[12]		In force: 1 Mar. 1972 In force: 21 Feb. 1977	176 193	In force: 22 Mar. 2013 In force: 30 Apr. 2004
Djibouti	In force: 26 May 2015	In force: 26 May 2015	884	In force: 26 May 2015
Dominica[5]	X	In force: 3 May 1996	513	
Dominican Republic[2]	Amended: 11 Oct. 2006	In force: 11 Oct. 1973	201	In force: 5 May 2010
Democratic People's Republic of Korea		In force: 10 Apr. 1992	403	
Ecuador[2]	Amended: 7 Apr. 2006	In force: 10 Mar. 1975	231	In force: 24 Oct. 2001
Egypt		In force: 30 Jun. 1982	302	
El Salvador[2]	Amended: 10 Jun. 2011	In force: 22 Apr. 1975	232	In force: 24 May 2004

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Equatorial Guinea	*Approved: 13 Jun. 1986*	*Approved: 13 Jun. 1986*		
Eritrea				
Estonia[13]		Accession: 1 Dec. 2005	193	Accession: 1 Dec. 2005
Eswatini	Amended: 23 Jul. 2010	In force: 28 Jul. 1975	227	In force: 8 Sep. 2010
Ethiopia	Amended: 2 Jul. 2019	In force: 2 Dec. 1977	261	In force: 18 Sep. 2019
Fiji	X	In force: 22 Mar. 1973	192	In force: 14 Jul. 2006
Finland[14]		Accession: 1 Oct. 1995	193	In force: 30 Apr. 2004
France	Amended: 25 Feb. 2019	In force: 12 Sep. 1981 In force: 26 Oct. 2007[15]	290* 718	In force: 30 Apr. 2004
Gabon	Amended: 30 Oct. 2013	In force: 25 Mar. 2010	792	In force: 25 Mar. 2010
Gambia	Amended: 17 Oct. 2011	In force: 8 Aug. 1978	277	In force: 18 Oct. 2011
Georgia		In force: 3 Jun. 2003	617	In force: 3 Jun. 2003
Germany[16]		In force: 21 Feb. 1977	193	In force: 30 Apr. 2004
Ghana		In force: 17 Feb. 1975	226	In force: 11 Jun. 2004
Greece[17]		Accession: 17 Dec. 1981	193	In force: 30 Apr. 2004
Grenada[2]	X	In force: 23 Jul. 1996	525	
Guatemala[2]	Amended: 26 Apr. 2011	In force: 1 Feb. 1982	299	In force: 28 May 2008
Guinea	*Signed: 13 Dec. 2011*	*Signed: 13 Dec. 2011*		*Signed: 13 Dec. 2011*
Guinea-Bissau	*Signed: 21 Jun. 2013*	*Signed: 21 Jun. 2013*		*Signed: 21 Jun. 2013*
Guyana[2]	X	In force: 23 May 1997	543	
Haiti[2]	X	In force: 9 Mar. 2006	681	In force: 9 Mar. 2006
Holy See	Amended: 11 Sep. 2006	In force: 1 Aug. 1972	187	In force: 24 Sep. 1998
Honduras[2]	Amended: 20 Sep. 2007	In force: 18 Apr. 1975	235	In force: 17 Nov. 2017
Hungary[18]		Accession: 1 Jul. 2007	193	Accession: 1 Jul. 2007
Iceland	Amended: 15 Mar. 2010	In force: 16 Oct. 1974	215	In force: 12 Sep. 2003
India[19]		In force: 30 Sep. 1971 In force: 17 Nov. 1977 In force: 27 Sep. 1988 In force: 11 Oct. 1989 In force: 1 Mar. 1994 In force: 11 May 2009	211 260 360 374 433 754	In force: 25 Jul. 2014
Indonesia		In force: 14 Jul. 1980	283	In force: 29 Sep. 1999

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Iran, Islamic Republic of [20]		In force: 15 May 1974	214	Signed: 18 Dec. 2003
Iraq		In force: 29 Feb. 1972	172	In force: 10 Oct. 2012
Ireland		In force: 21 Feb. 1977	193	In force: 30 Apr. 2004
Israel		In force: 4 Apr. 1975	249/Add.1	
Italy		In force: 21 Feb. 1977	193	In force: 30 Apr. 2004
Jamaica[2]		In force: 6 Nov. 1978	265	In force: 19 Mar. 2003
Japan		In force: 2 Dec. 1977	255	In force: 16 Dec. 1999
Jordan		In force: 21 Feb. 1978	258	In force: 28 Jul. 1998
Kazakhstan		In force: 11 Aug. 1995	504	In force: 9 May 2007
Kenya	In force: 18 Sep. 2009	In force: 18 Sep. 2009	778	In force: 18 Sep. 2009
Kiribati	X	In force: 19 Dec. 1990	390	Signed: 9 Nov. 2004
Korea, Republic of		In force: 14 Nov. 1975	236	In force: 19 Feb. 2004
Kuwait	Amended: 26 Jul. 2013	In force: 7 Mar. 2002	607	In force: 2 Jun. 2003
Kyrgyzstan	X	In force: 3 Feb. 2004	629	In force: 10 Nov. 2011
Lao People's Democratic Republic	X	In force: 5 Apr. 2001	599	Signed: 5 Nov. 2014
Latvia[21]		Accession: 1 Oct. 2008	193	Accession: 1 Oct. 2008
Lebanon	Amended: 5 Sep. 2007	In force: 5 Mar. 1973	191	
Lesotho	Amended: 8 Sep. 2009	In force: 12 Jun. 1973	199	In force: 26 Apr. 2010
Liberia	In force: 10 Dec. 2018	In force: 10 Dec. 2018	927	In force: 10 Dec. 2018
Libya		In force: 8 Jul. 1980	282	In force: 11 Aug. 2006
Liechtenstein		In force: 4 Oct. 1979	275	In force: 25 Nov. 2015
Lithuania[22]		Accession: 1 Jan. 2008	193	Accession: 1 Jan. 2008
Luxembourg		In force: 21 Feb. 1977	193	In force: 30 Apr. 2004
Madagascar	Amended: 29 May 2008	In force: 14 Jun. 1973	200	In force: 18 Sep. 2003
Malawi	Amended: 29 Feb. 2008	In force: 3 Aug. 1992	409	In force: 26 Jul. 2007
Malaysia		In force: 29 Feb. 1972	182	Signed: 22 Nov. 2005
Maldives	X	In force: 2 Oct. 1977	253	
Mali	Amended: 18 Apr. 2006	In force: 12 Sep. 2002	615	In force: 12 Sep. 2002

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Malta[23]		Accession: 1 Jul. 2007	193	Accession: 1 Jul. 2007
Marshall Islands		In force: 3 May 2005	653	In force: 3 May 2005
Mauritania	Amended: 20 Mar. 2013	In force: 10 Dec. 2009	788	In force: 10 Dec. 2009
Mauritius	Amended: 26 Sep. 2008	In force: 31 Jan. 1973	190	In force: 17 Dec. 2007
Mexico[24]		In force: 14 Sep. 1973	197	In force: 4 Mar. 2011
Micronesia, Federated States of	*Signed: 1 Jun. 2015*	*Signed: 1 Jun. 2015*		
Monaco	Amended: 27 Nov. 2008	In force: 13 Jun. 1996	524	In force: 30 Sep. 1999
Mongolia	X	In force: 5 Sep. 1972	188	In force: 12 May 2003
Montenegro	In force: 4 Mar. 2011	In force: 4 Mar. 2011	814	In force: 4 Mar. 2011
Morocco		In force: 18 Feb. 1975	228	In force: 21 Apr. 2011
Mozambique	In force: 1 Mar. 2011	In force: 1 Mar. 2011	813	In force: 1 Mar. 2011
Myanmar	X	In force: 20 Apr. 1995	477	Signed: 17 Sep. 2013
Namibia	X	In force: 15 Apr. 1998	551	In force: 20 Feb. 2012
Nauru	X	In force: 13 Apr. 1984	317	
Nepal	X	In force: 22 Jun. 1972	186	
Netherlands	X	In force: 5 Jun. 1975[15] In force: 21 Feb. 1977	229 193	In force: 30 Apr. 2004
New Zealand[25]	Amended: 24 Feb. 2014	In force: 29 Feb. 1972	185	In force: 24 Sep. 1998
Nicaragua[2]	Amended: 12 Jun. 2009	In force: 29 Dec. 1976	246	In force: 18 Feb. 2005
Niger		In force: 16 Feb. 2005	664	In force: 2 May 2007
Nigeria		In force: 29 Feb. 1988	358	In force: 4 Apr. 2007
North Macedonia	Amended: 9 Jul. 2009	In force: 16 Apr. 2002	610	In force: 11 May 2007
Norway		In force: 1 Mar. 1972	177	In force: 16 May 2000
Oman	X	In force: 5 Sep. 2006	691	
Pakistan		In force: 5 Mar. 1962 In force: 17 Jun. 1968 In force: 17 Oct. 1969 In force: 18 Mar. 1976 In force: 2 Mar. 1977 In force: 10 Sep. 1991 In force: 24 Feb. 1993 In force: 22 Feb. 2007 In force: 15 Apr. 2011 In force: 3 May 2017	34 116 135 239 248 393 418 705 816 920	

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Palau	Amended: 15 Mar. 2006	In force: 13 May 2005	650	In force: 13 May 2005
Panama[8]	Amended: 4 Mar. 2011	In force: 23 Mar. 1984	316	In force: 11 Dec. 2001
Papua New Guinea	Amended: 6 Feb. 2019	In force: 13 Oct. 1983	312	
Paraguay[2]	Amended: 17 Jul. 2018	In force: 20 Mar. 1979	279	In force: 15 Sep. 2004
Peru[2]		In force: 1 Aug. 1979	273	In force: 23 Jul. 2001
Philippines		In force: 16 Oct. 1974	216	In force: 26 Feb. 2010
Poland[26]		Accession: 1 Mar. 2007	193	Accession: 1 Mar. 2007
Portugal[27]		Accession: 1 Jul. 1986	193	In force: 30 Apr. 2004
Qatar	In force: 21 Jan. 2009	In force: 21 Jan. 2009	747	
Republic of Moldova	Amended: 1 Sep. 2011	In force: 17 May 2006	690	In force: 1 Jun. 2012
Romania[28]		Accession: 1 May 2010	193	Accession: 1 May 2010
Russian Federation		In force: 10 Jun. 1985	327*	In force: 16 Oct. 2007
Rwanda	In force: 17 May 2010	In force: 17 May 2010	801	In force: 17 May 2010
Saint Kitts and Nevis[5]	Amended: 19 Aug. 2016	In force: 7 May 1996	514	In force: 19 May 2014
Saint Lucia[5]	X	In force: 2 Feb. 1990	379	
Saint Vincent and the Grenadines[5]	X	In force: 8 Jan. 1992	400	
Samoa	X	In force: 22 Jan. 1979	268	
San Marino	Amended: 13 May 2011	In force: 21 Sep. 1998	575	
Sao Tome and Principe	*Approved: 21 Nov. 2019*	*Approved: 21 Nov. 2019*		*Approved: 21 Nov. 2019*
Saudi Arabia	X	In force: 13 Jan. 2009	746	
Senegal	Amended: 6 Jan. 2010	In force: 14 Jan. 1980	276	In force: 24 Jul. 2017
Serbia[29]		In force: 28 Dec. 1973	204	In force: 17 Sep. 2018
Seychelles	Amended: 31 Oct. 2006	In force: 19 Jul. 2004	635	In force: 13 Oct. 2004
Sierra Leone	X	In force: 4 Dec. 2009	787	
Singapore	Amended: 31 Mar. 2008	In force: 18 Oct. 1977	259	In force: 31 Mar. 2008
Slovakia[30]		Accession: 1 Dec. 2005	193	Accession: 1 Dec. 2005
Slovenia[31]		Accession: 1 Sep. 2006	193	Accession: 1 Sep. 2006
Solomon Islands	X	In force: 17 Jun. 1993	420	

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Somalia				
South Africa		In force: 16 Sep. 1991	394	In force: 13 Sep. 2002
Spain		Accession: 5 Apr. 1989	193	In force: 30 Apr. 2004
Sri Lanka		In force: 6 Aug. 1984	320	Approved: 12 Sep. 2018
State of Palestine [32]	*Signed: 14 Jun. 2019*	*Signed: 14 Jun. 2019*		
Sudan	X	In force: 7 Jan. 1977	245	
Suriname[2]	X	In force: 2 Feb. 1979	269	
Sweden[33]		Accession: 1 Jun. 1995	193	In force: 30 Apr. 2004
Switzerland		In force: 6 Sep. 1978	264	In force: 1 Feb. 2005
Syrian Arab Republic		In force: 18 May 1992	407	
Tajikistan		In force: 14 Dec. 2004	639	In force: 14 Dec. 2004
Thailand		In force: 16 May 1974	241	In force: 17 Nov. 2017
Timor-Leste	*Signed: 6 Oct. 2009*	*Signed: 6 Oct. 2009*		*Signed: 6 Oct. 2009*
Togo	Amended: 8 Oct. 2015	In force: 18 Jul. 2012	840	In force: 18 Jul. 2012
Tonga	Amended: 3 Apr. 2018	In force: 18 Nov. 1993	426	
Trinidad and Tobago[2]	X	In force: 4 Nov. 1992	414	
Tunisia		In force: 13 Mar. 1990	381	Signed: 24 May 2005
Turkey		In force: 1 Sep. 1981	295	In force: 17 Jul. 2001
Turkmenistan		In force: 3 Jan. 2006	673	In force: 3 Jan. 2006
Tuvalu	X	In force: 15 Mar. 1991	391	
Uganda	Amended: 24 Jun. 2009	In force: 14 Feb. 2006	674	In force: 14 Feb. 2006
Ukraine		In force: 22 Jan. 1998	550	In force: 24 Jan. 2006
United Arab Emirates		In force: 9 Oct. 2003	622	In force: 20 Dec. 2010
United Kingdom	Signed: 6 Jan. 1993	In force: 14 Dec. 1972[34] In force: 14 Aug. 1978 Signed: 6 Jan. 1993[15] Signed: 7 Jun. 2018*	175 263*	In force: 30 Apr. 2004 Signed: 7 Jun. 2018
United Republic of Tanzania	Amended: 10 Jun. 2009	In force: 7 Feb. 2005	643	In force: 7 Feb. 2005
United States of America	Amended: 3 Jul. 2018	In force: 9 Dec. 1980 In force: 6 Apr. 1989[15]	288* 366	In force: 6 Jan. 2009
Uruguay[2]		In force: 17 Sep. 1976	157	In force: 30 Apr. 2004

State [a]	Small quantities protocols [b]	Safeguards agreements [c]	INFCIRC	Additional protocols
Uzbekistan		In force: 8 Oct. 1994	508	In force: 21 Dec. 1998
Vanuatu	In force: 21 May 2013	In force: 21 May 2013	852	In force: 21 May 2013
Venezuela, Bolivarian Republic of [2]		In force: 11 Mar. 1982	300	
Viet Nam		In force: 23 Feb. 1990	376	In force: 17 Sep. 2012
Yemen	X	In force: 14 Aug. 2002	614	
Zambia	X	In force: 22 Sep. 1994	456	Signed: 13 May 2009
Zimbabwe	Amended: 31 Aug. 2011	In force: 26 Jun. 1995	483	

Key

Bold States not party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) whose safeguards agreements are of INFCIRC/66-type.

Italics States Parties to the NPT that have not yet brought into force comprehensive safeguards agreements (CSAs) pursuant to Article III of the NPT.

* Voluntary offer safeguards agreement with NPT nuclear-weapon States.

X 'X' in the 'small quantities protocols' column indicates that the State has an operative small quantities protocol (SQP). 'Amended' indicates that the operative SQP is based on the revised SQP standardized text.

NB: This table does not aim at listing all safeguards agreements that the Agency has concluded. Not included are agreements under which the application of safeguards has been suspended upon the entry into force of a CSA. Unless otherwise indicated, the safeguards agreements referred to are CSAs concluded pursuant to the NPT.

[a] An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

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

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

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

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

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

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

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

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

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

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

[9] The application of safeguards for Croatia under the NPT bilateral safeguards agreement (INFCIRC/463), in force since 19 January 1995, was suspended on 1 April 2017, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193), to which Croatia had acceded, entered into force for Croatia.

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

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

[12] The application of safeguards for Denmark under the NPT bilateral safeguards agreement (INFCIRC/176), in force since 1 March 1972, was suspended on 21 February 1977, on which date the agreement of 5 April 1973 between the non-nuclear-weapon States of Euratom, Euratom and the Agency (INFCIRC/193) entered into force for Denmark. Since 21 February 1977, INFCIRC/193 also applies to the Faroe Islands. Upon Greenland's secession from Euratom as of 31 January 1985, INFCIRC/176 re-entered into force for Greenland. The Additional Protocol for Greenland entered into force on 22 March 2013 (INFCIRC/176/Add.1).

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

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

[15] The safeguards agreement is in connection with Additional Protocol I to the Treaty of Tlatelolco.

[16] The NPT safeguards agreement of 7 March 1972 concluded with the German Democratic Republic (INFCIRC/181) is no longer in force with effect from 3 October 1990, on which date the German Democratic Republic acceded to the Federal Republic of Germany.

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

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

[19] The application of safeguards for India under the safeguards agreement between the Agency, Canada and India (INFCIRC/211), in force since 30 September 1971, was suspended as of 20 March 2015. The application of safeguards for India under the following safeguards agreements between the Agency and India was suspended as of 30 June 2016: INFCIRC/260, in force since 17 November 1977; INFCIRC/360, in force since 27 September 1988; INFCIRC/374, in force since 11 October 1989; and INFCIRC/433, in force since 1 March 1994. Items subject to safeguards under the aforementioned safeguards agreements are subject to safeguards under the safeguards agreement between India and the Agency (INFCIRC/754), which entered into force on 11 May 2009.

[20] Pending entry into force, the Additional Protocol is being applied provisionally for the Islamic Republic of Iran as of 16 January 2016.

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

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

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

[24] The safeguards agreement was concluded pursuant to both the Treaty of Tlatelolco and the NPT. The application of safeguards under an earlier safeguards agreement pursuant to the Treaty of Tlatelolco, which entered into force on 6 September 1968 (INFCIRC/118), was suspended as of 14 September 1973.

[25] Whereas the NPT safeguards agreement and SQP with New Zealand (INFCIRC/185) also apply to Cook Islands and Niue, the additional protocol thereto (INFCIRC/185/Add.1) does not apply to those territories. Amendments to the SQP entered into force only for New Zealand on 24 February 2014 (INFCIRC/185/Mod.1).

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

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

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

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

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

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

[32] 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.

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

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

Table A7. Participation in multilateral treaties for which the Director General is the depositary (status as of 31 December 2019)

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Afghanistan						X					
*	Albania	X	X	X	X	X	X	X				
*	Algeria		X	X			X	X				
	Andorra						X					
*	Angola		X									
*	Antigua and Barbuda						X	X				
*	Argentina	X	X	X	X	X	X	X	X	X	X	
*	Armenia		X	X	X	X	X	X	X			
*	Australia	X	X	X	X	X	X	X				
*	Austria		X	X	X	X	X	X				
*	Azerbaijan						X	X				
*	Bahamas						X					
*	Bahrain		X		X		X	X				
*	Bangladesh		X	X	X		X	X				
*	Barbados											
*	Belarus	X	X	X	X	X	X		X	X		
*	Belgium	X	X	X	X	X	X	X				
*	Belize											
*	Benin	X	X	X	X	X	X	X	X	X	X	X
	Bhutan											
*	Bolivia, Plurinational State of	X	X	X	X	X	X	X	X			
*	Bosnia and Herzegovina	X	X	X	X	X	X	X	X	X		
*	Botswana		X	X		X	X	X				
*	Brazil	X	X	X	X	X	X		X			
*	Brunei Darussalam	X										
*	Bulgaria	X	X	X	X	X	X	X	X			X

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Burkina Faso		X	X			X	X				
*	Burundi											
	Cabo Verde						X					
*	Cambodia		X		X		X					
*	Cameroon	X	X	X			X	X	X			X
*	Canada	X	X	X	X	X	X	X			X	
*	Central African Republic						X					
*	Chad						X	X				
*	Chile	X	X	X	X	X	X	X	X			X
*	China	X	X	X	X	X	X	X				
*	Colombia	X	X	X			X	X				
	Comoros						X	X				
*	Congo	X										
*	Costa Rica		X	X			X	X				
*	Côte d'Ivoire	X					X	X				
*	Croatia	X	X	X	X	X	X	X	X			X
*	Cuba	X	X	X	X	X	X	X	X			
*	Cyprus	X	X	X	X	X	X	X				
*	Czech Republic	X	X	X	X	X	X	X	X			X
	Dem. People's Rep. of Korea											
*	Dem. Rep. of the Congo	X					X					
*	Denmark	X	X	X	X	X	X	X				X
*	Djibouti						X	X				
*	Dominica						X					
*	Dominican Republic		X				X	X				
*	Ecuador	X	X	X			X	X				
*	Egypt	X	X	X					X			X
*	El Salvador		X	X			X	X				

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
	Equatorial Guinea						X					
*	Eritrea											
*	Estonia	X	X	X	X	X	X	X	X			X
*	Eswatini						X	X				
*	Ethiopia											
*	Fiji						X	X				
*	Finland	X	X	X	X	X	X	X				X
*	France		X	X	X	X	X	X				X
*	Gabon		X	X		X	X	X				
	Gambia											
*	Georgia	X	X	X		X	X	X				
*	Germany	X	X	X	X	X	X	X				X
*	Ghana	X	X	X	X	X	X	X			X	
*	Greece	X	X	X	X	X	X	X				X
*	Grenada						X					
*	Guatemala		X	X			X					
	Guinea						X					
	Guinea-Bissau						X					
*	Guyana						X					
*	Haiti											
*	Holy See	X										
*	Honduras						X					
*	Hungary	X	X	X	X	X	X	X	X			X
*	Iceland	X	X	X	X	X	X	X				
*	India	X	X	X	X		X	X			X	
*	Indonesia	X	X	X	X	X	X	X				
*	Iran, Islamic Republic of	X	X	X								
*	Iraq	X	X	X			X					

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Ireland	X	X	X	X	X	X	X				
*	Israel		X	X			X	X				
*	Italy	X	X	X	X	X	X	X				X
*	Jamaica	X					X	X				
*	Japan	X	X	X	X	X	X	X			X	
*	Jordan	X	X	X	X	X	X	X	X	X		
*	Kazakhstan	X	X	X	X	X	X	X	X	X		
*	Kenya						X	X				
	Kiribati											
*	Korea, Republic of	X	X	X	X	X	X	X				
*	Kuwait	X	X	X	X		X	X				
*	Kyrgyzstan					X	X	X				
*	Lao People's Dem. Rep.		X	X			X					
*	Latvia	X	X	X	X	X	X	X	X	X		X
*	Lebanon		X	X	X		X		X			
*	Lesotho	X	X	X		X	X	X				
*	Liberia											
*	Libya		X	X	X		X	X				
*	Liechtenstein		X	X			X	X				
*	Lithuania	X	X	X	X	X	X	X	X			X
*	Luxembourg	X	X	X	X	X	X	X				
*	Madagascar		X	X	X	X	X	X				
*	Malawi						X					
*	Malaysia		X	X								
	Maldives											
*	Mali		X	X	X		X	X				
*	Malta				X	X	X	X				
*	Marshall Islands						X	X				

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Mauritania		X	X		X	X	X				
*	Mauritius	X	X	X		X			X			
*	Mexico	X	X	X	X	X	X	X	X			
	Micronesia, Federated States of											
*	Monaco		X	X			X	X				
*	Mongolia	X	X	X			X					
*	Montenegro	X	X	X	X	X	X	X	X	X	X	X
*	Morocco	X	X	X	X	X	X	X		X	X	
*	Mozambique	X	X	X			X					
*	Myanmar		X		X		X	X				
*	Namibia						X	X				
	Nauru						X	X				
*	Nepal											
*	Netherlands	X	X	X	X	X	X	X				X
*	New Zealand	X	X	X			X	X				
*	Nicaragua	X	X	X			X	X				
*	Niger	X		X	X	X	X	X	X	X		
*	Nigeria	X	X	X	X	X	X	X	X			
	Niue						X					
*	North Macedonia		X	X	X	X	X	X	X			
*	Norway	X	X	X	X	X	X	X				X
*	Oman	X	X	X	X	X	X					
*	Pakistan	X	X	X	X		X	X				
*	Palau	X					X					
	Palestine						X[b]	X[b]				
*	Panama		X	X			X	X				
*	Papua New Guinea											
*	Paraguay	X	X	X	X	X	X	X				

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Peru		X	X	X	X	X	X	X			
*	Philippines	X	X	X			X		X			
*	Poland	X	X	X	X	X	X	X	X	X		X
*	Portugal	X	X	X	X	X	X	X				
*	Qatar		X	X			X	X				
*	Republic of Moldova	X	X	X	X	X	X	X	X			
*	Romania	X	X	X	X	X	X	X	X	X	X	X
*	Russian Federation	X	X	X	X	X	X	X	X			
*	Rwanda						X		X			
	Saint Kitts and Nevis						X	X				
*	Saint Lucia						X	X				
*	Saint Vincent and the Grenadines		X	X					X			X
	Samoa											
*	San Marino						X	X				
	Sao Tome and Principe											
*	Saudi Arabia		X	X	X	X	X	X	X	X		
*	Senegal	X	X	X	X	X	X	X	X			
*	Serbia	X	X	X	X	X	X	X	X			
*	Seychelles						X	X				
*	Sierra Leone											
*	Singapore	X	X	X	X		X	X				
*	Slovakia	X	X	X	X	X	X	X	X			X
*	Slovenia	X	X	X	X	X	X	X				X
	Solomon Islands											
	Somalia											
*	South Africa	X	X	X	X	X	X					
	South Sudan											
*	Spain	X	X	X	X	X	X	X				

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Sri Lanka		X	X	X							
*	Sudan						X					
	Suriname											
*	Sweden	X	X	X	X	X	X	X				X
*	Switzerland	X	X	X	X	X	X	X				
*	Syrian Arab Republic	X	X	X	X							
*	Tajikistan	X	X	X		X	X	X				
*	Thailand	X	X	X	X	X	X	X				
	Timor Leste											
*	Togo						X					
	Tonga						X					
*	Trinidad and Tobago						X		X			
*	Tunisia	X	X	X	X		X	X				
*	Turkey	X	X	X	X		X	X				X
*	Turkmenistan						X	X				
	Tuvalu											
*	Uganda						X					
*	Ukraine	X	X	X	X	X	X	X	X			X
*	United Arab Emirates		X	X	X	X	X	X		X	X	X
*	United Kingdom	X	X	X	X	X	X	X				
*	United Republic of Tanzania		X	X			X					
*	United States of America		X	X	X	X	X	X			X	
*	Uruguay		X	X	X	X	X	X	X			X
*	Uzbekistan					X	X	X				
*	Vanuatu											
*	Venezuela, Bolivarian Republic of		X									
*	Viet Nam	X	X	X	X	X	X	X				
*	Yemen						X					

	State/Organization[a]	P&I	ENC	AC	CNS	JC	CPPNM	A/CPPNM	VC	A-VC	CSC	JP
*	Zambia						X					
*	Zimbabwe											
	Euratom		X	X	X	X	X	X				
	FAO		X	X								
	WHO		X	X								
	WMO		X	X								

P&I	Agreement on the Privileges and Immunities of the IAEA
ENC	Convention on Early Notification of a Nuclear Accident
AC	Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
CNS	Convention on Nuclear Safety
JC	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
CPPNM	Convention on the Physical Protection of Nuclear Material
A/CPPNM	Amendment to the Convention on the Physical Protection of Nuclear Material
VC	Vienna Convention on Civil Liability for Nuclear Damage
A-VC	Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage
CSC	Convention on Supplementary Compensation for Nuclear Damage
JP	Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention
*	Agency Member State
X	Party

[a] An entry in this column does not imply the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

[b] Acceded as State of Palestine.

Table A8. Member States that have concluded a Revised Supplementary Agreement (status as of 31 December 2019)[a]

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Azerbaijan
Bahrain
Bangladesh
Belarus
Belize
Benin
Bolivia, Plurinational State of
Bosnia and Herzegovina
Botswana
Brazil
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Central African Republic
Chad
Chile
China
Colombia
Congo
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Cyprus
Czech Republic
Democratic Republic of the Congo
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt
El Salvador
Eritrea
Estonia
Eswatini
Ethiopia
Fiji
Gabon
Georgia
Ghana
Greece
Guatemala
Guyana
Haiti
Honduras
Hungary
Iceland
Indonesia
Iran, Islamic Republic of
Iraq
Ireland
Israel
Jamaica
Jordan
Kazakhstan
Kenya
Korea, Republic of
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libya
Lithuania
Madagascar
Malawi
Malaysia
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Mongolia
Montenegro
Morocco
Mozambique
Myanmar
Namibia
Nepal
Nicaragua
Niger
Nigeria
North Macedonia
Oman
Pakistan
Palau
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
Saudi Arabia
Senegal
Serbia
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
South Africa
Spain
Sri Lanka
Sudan
Syrian Arab Republic
Tajikistan
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Republic of Tanzania
Uruguay
Uzbekistan
Vanuatu
Venezuela, Bolivarian Republic of
Viet Nam
Zambia
Zimbabwe

[a] In 2019, 5 RSAs were concluded. By the end of the year, there were 141 States party to an RSA.

Table A9. Acceptance of Amendment to Article VI of the Agency's Statute (status as of 31 December 2019)

Afghanistan
Albania
Algeria
Argentina
Austria
Belarus
Bosnia and Herzegovina
Brazil
Bulgaria
Canada
Colombia
Croatia
Cyprus
Czech Republic
Denmark
El Salvador
Estonia
Ethiopia
Finland
France
Germany
Greece
Holy See
Hungary
Iceland
Ireland
Israel
Italy
Japan
Kazakhstan
Korea, Republic of
Latvia
Libya
Liechtenstein
Lithuania
Luxembourg
Malta
Mexico
Monaco
Morocco
Myanmar
Netherlands
Norway
Pakistan
Panama
Peru
Poland
Portugal
Republic of Moldova
Romania
San Marino
Slovakia
Slovenia
South Africa
Spain
Sweden
Switzerland
Tunisia
Turkey
Ukraine
United Kingdom
Uruguay

Table A10. Acceptance of Amendment to Article XIV.A of the Agency's Statute (status as of 31 December 2019)

Albania
Algeria
Argentina
Australia
Austria
Belarus
Bosnia and Herzegovina
Brazil
Bulgaria
Canada
Colombia
Croatia
Cyprus
Czech Republic
Denmark
Ecuador
Estonia
Finland
France
Germany
Greece
Holy See
Hungary
Iceland
Iran, Islamic Republic of
Ireland
Italy
Japan
Kazakhstan
Kenya
Korea, Republic of
Latvia
Liechtenstein
Lithuania
Luxembourg
Malta
Mexico
Monaco
Myanmar
Netherlands
Norway
Pakistan
Peru
Poland
Portugal
Republic of Moldova
Romania
San Marino
Seychelles
Slovakia
Slovenia
South Africa
Spain
Sweden
Switzerland
Syrian Arab Republic
Tunisia
Turkey
Ukraine
United Kingdom

Table A11. Multilateral treaties negotiated and adopted under the auspices of the Agency and/or for which the Director General is the depositary (status and relevant developments)

Agreement on the Privileges and Immunities of the IAEA (reproduced in INFCIRC/9/Rev.2). In 2019, there were 4 new Parties to the Agreement. By the end of the year, there were 90 Parties.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2019, there were 2 new Parties to the Convention. By the end of the year, there were 124 Parties.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (reproduced in INFCIRC/336). Entered into force on 26 February 1987. In 2019, there were 2 new Parties to the Convention. By the end of the year, there were 119 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2019, there were 3 new Parties to the Convention. By the end of the year, there were 88 Parties.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (reproduced in INFCIRC/546). Entered into force on 18 June 2001. In 2019, there were 2 new Parties to the Convention. By the end of the year, there were 82 Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2019, there were 2 new Parties to the Convention and 1 new Contracting State. By the end of the year, there were 159 Parties and 1 Contracting State.

Amendment to the Convention on the Physical Protection of Nuclear Material. Entered into force on 8 May 2016. In 2019, there were 4 new Parties to the Amendment and 1 new Contracting State. By the end of the year, there were 122 Parties and 1 Contracting State.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2019, there were 2 new Parties to the Convention. By the end of the year, there were 42 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2019, the status of the Protocol remained unchanged with 2 Parties.

Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/566). Entered into force on 4 October 2003. In 2019, there was 1 new Party to the Protocol. By the end of the year, there were 14 Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Entered into force on 15 April 2015. In 2019, there was 1 new Party to the Convention. By the end of the year, there were 11 Parties.

Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (reproduced in INFCIRC/402). Entered into force on 27 April 1992. In 2019, there were 2 new Parties to the Protocol. By the end of the year, there were 30 Parties.

Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology, 2017 (2017 RCA) (reproduced in INFCIRC/919). Entered into force on 11 June 2017. In 2019, the status of the Agreement remained unchanged with 17 Parties.

African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (Fifth Extension) (reproduced in INFCIRC/377/Add.20). Entered into force on 4 April 2015. In 2019, the status of the Agreement remained unchanged with 41 Parties.

Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) (First Extension) (reproduced in INFCIRC/582/Add.4). Entered into force on 5 September 2015. In 2019, the status of the Agreement remained unchanged with 21 Parties.

Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) (Second Extension) (reproduced in INFCIRC/613/Add.3). Entered into force on 29 July 2014. In 2019, the status of the Agreement remained unchanged with 9 Parties.

Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/702). Entered into force on 24 October 2007. In 2019, the status of the Agreement remained unchanged with 7 Parties.

Agreement on the Privileges and Immunities of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (reproduced in INFCIRC/703). Entered into force on 24 October 2007. In 2019, the status of the Agreement remained unchanged with 6 Parties.

Table A12. Nuclear power reactors in operation and under construction in the world (as of 31 December 2019)[a]

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2019		Total operating experience through 2019	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW·h	% of total	Years	Months
Argentina	3	1 641	1	25	7.9	5.9	88	2
Armenia	1	375			2.0	27.8	45	8
Bangladesh			2	2 160				
Belarus			2	2 220				
Belgium	7	5 930			41.4	47.6	303	7
Brazil	2	1 884	1	1 340	15.2	2.7	57	3
Bulgaria	2	2 006			15.9	37.5	167	3
Canada	19	13 554			94.9	14.9	769	6
China	48	45 518	11	10 564	330.1	4.9	370	1
Czech Republic	6	3 932			28.6	35.2	170	10
Finland	4	2 794	1	1 600	22.9	34.7	163	4
France	58	63 130	1	1 630	382.4	70.6	2 280	4
Germany	6	8 113					846	7
Hungary	4	1 902			15.4	49.2	138	2
India	22	6 255	7	4 824	40.7	3.2	526	11
Iran, Islamic Republic of	1	915	1	974	5.9	1.8	8	4
Japan	33	31 679	2	2 653	65.7	7.5	1 899	6
Kazahstan							25	10
Korea, Republic of	24	23 172	4	5 360	138.8	26.2	572	2
Mexico	2	1 552			10.9	4.5	55	11
Netherlands	1	482			3.7	3.1	75	0
Pakistan	5	1 318	2	2 028	9	6.6	82	5
Romania	2	1 300			10.4	18.5	35	11
Russian Federation	38	28 437	4	4 525	195.5	19.7	1 334	5
Slovakia	4	1 814	2	880	14.3	53.9	172	7

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2019		Total operating experience through 2019	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW·h	% of total	Years	Months
Slovenia	1	688			5.5	37.0	38	3
South Africa	2	1 860			13.6	6.7	70	3
Spain	7	7 121			55.9	21.4	343	1
Sweden	7	7 740			64.4	34.0	467	0
Switzerland	4	2 960			25.4	23.9	224	11
Turkey			1	1 114				
Ukraine	15	13 107	2	2 070	78.1	53.9	518	6
United Arab Emirates			4	5 380				
United Kingdom	15	8 923	2	3 260	51.0	15.6	1 619	7
United States of America	96	98 152	2	2 234	809.4	19.7	4 505	8
Total [b,c,d]	**443**	**392 098**	**54**	**57 441**	**2 586.2**		**18 329**	**10**

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

[b] Total nuclear electricity supplied in 2019 does not include data from seven German reactor units, as information for these units was not submitted by the time of publication.

[c] The total figures include the following data from Taiwan, China: 4 units, 3844 MW(e) in operation; 2 units, 2600 MW(e) under construction.

[d] The total operating experience also includes shutdown plants in Italy (80 years, 8 months), Kazakhstan (25 years, 10 months) and Lithuania (43 years, 6 months), and shutdown and operational plants in Taiwan, China (224 years, 1 month).

Table A13. Member State participation in selected Agency activities

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Afghanistan								
Albania	3			4				
Algeria	6							
Angola				4				
Antigua and Barbuda								
Argentina	42	1	2			1	1	
Armenia	2			2				
Australia	41	1	3					
Austria	10		4		1			
Azerbaijan	1							
Bahamas	1			2				
Bahrain								
Bangladesh	16							
Barbados				1				
Belarus	4		1					
Belgium	15		2					
Belize								
Benin	1							
Bolivia, Plurinational State of	1							
Bosnia and Herzegovina	1		3	6				
Botswana	1							
Brazil	52	3	4			2		
Brunei Darussalam				3				
Bulgaria	5		2					
Burkina Faso	7	1			2			

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Burundi								
Cambodia	1							
Cameroon	5			1	1			
Canada	36		3					
Central African Republic								
Chad	1							
Chile	11		1	7		1		
China	94	2	3	18				
Colombia	5			1				
Congo					1			
Costa Rica	9	1	1	6				
Côte d'Ivoire	1							
Croatia	13		2	11				
Cuba	16		3	5				
Cyprus			1	3				
Czech Republic	6		1					
Dem. Rep. of the Congo								
Denmark	4		1					
Djibouti								
Dominica								
Dominican Republic				21				
Ecuador	6		1	11				
Egypt	18	1	1					
El Salvador				2				
Eritrea								
Estonia	4		1	3				1

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Eswatini								
Ethiopia	7		1	1				
Fiji					3			
Finland	8		1					
France	48	2	5					
Gabon								
Georgia	1			16				
Germany	39		3		3			
Ghana	15			1	1			
Greece	17		6					
Grenada								
Guatemala	7							
Guyana				1				
Haiti								
Holy See								
Honduras				1				
Hungary	18	2	3	27	1			
Iceland			1					
India	73	1	3	33				
Indonesia	24	2	1	11				
Iran, Islamic Republic of	16		3	27				
Iraq			1	5				
Ireland	2		1					
Israel	13		2	13				
Italy	40	2	8					
Jamaica	7		1	5				

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Japan	37	2	5					
Jordan	6		1	3				
Kazakhstan	1		1	26				1
Kenya	15		1	3	1			
Korea, Republic of	32	2	2					
Kuwait	6	1	1	11				1
Kyrgyzstan	1							
Lao People's Dem. Rep.	1			4				
Latvia			1	12				
Lebanon	6		1	15				
Lesotho								
Liberia								
Libya				12				
Liechtenstein								
Lithuania	6		3	6		1		
Luxembourg	1		1					
Madagascar	3		1					
Malawi					1			
Malaysia	27	1	1	14				
Mali	1				2			
Malta								
Marshall Islands								
Mauritania				2				
Mauritius	4			2				
Mexico	31	2	3	19				
Monaco								
Mongolia	2		1	5	1			

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Montenegro	1		1	3				
Morocco	23	1	1	27				1
Mozambique								
Myanmar	4		1	3				
Namibia	2				3			
Nepal	1							
Netherlands	13	1	4		2			
New Zealand	7		1					
Nicaragua	1			2				
Niger								
Nigeria	5			2	1			
North Macedonia	5		1	5				
Norway	3	1	2					
Oman				3	1			
Pakistan	36	1	1					
Palau								
Panama	1		1	5				
Papua New Guinea	1							
Paraguay								
Peru	10		1	7				
Philippines	11	1	1	38				
Poland	24	1	6					
Portugal	9		1					
Qatar			1	3				
Republic of Moldova								
Romania	17		3	15				
Russian Federation	47	1	4	60				

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Rwanda								
Saint Lucia								
Saint Vincent and the Grenadines								
San Marino								
Saudi Arabia	7	1	1	10				
Senegal	7				1			
Serbia	9		5	20				
Seychelles								
Sierra Leone								
Singapore	10		2					
Slovakia	4		3					
Slovenia	7		1	5				
South Africa	31		3	2				
Spain	33	2	2		1			
Sri Lanka	13		1	7				
Sudan	6			2	1			
Sweden	8		2					
Switzerland	8	2	3					
Syrian Arab Republic	10		1					
Tajikistan			1	1				
Thailand	26	1	2	32				1
Togo					1			
Trinidad and Tobago	1							
Tunisia	18		1	1				
Turkey	19		2	16				
Turkmenistan								

Member State	No. of research contracts and agreements	No. of Collaborating Centres	Services provided to Member States					
			ALMERA [a]	Dosimetry audits for radiotherapy	Plant irradiation services	QUANUM [b]	QUAADRIL [c]	QUATRO [d]
Uganda	6			2	1			
Ukraine	20		1	9	1			
United Arab Emirates	2	1	3	3	1			
United Kingdom	47		4					
United Republic of Tanzania	4			2	1			
United States of America	108	1	7		1			
Uruguay	7		1					
Uzbekistan			1					
Vanuatu								
Venezuela, Bolivarian Republic of			2	11				
Viet Nam	23	1	3					
Yemen								
Zambia	8		1					
Zimbabwe	3				1	1		

[a] ALMERA: Analytical Laboratories for the Measurement of Environmental Radioactivity.

[b] QUANUM: Quality Assurance in Nuclear Medicine.

[c] QUAADRIL: Quality Assurance Audit for Diagnostic Radiology Improvement and Learning.

[d] QUATRO: Quality Assurance Team for Radiation Oncology.

Table A14. Advisory Missions on Regulatory Infrastructure for Radiation Safety (AMRAS) in 2019

Type	Country
AMRAS	Barbados
AMRAS	Plurinational State of Bolivia
AMRAS	Central African Republic
AMRAS	Dominican Republic
AMRAS	Grenada
AMRAS	Lesotho
AMRAS	Mauritania
AMRAS	Netherlands
AMRAS	Saint Vincent and the Grenadines
AMRAS	Sierra Leone
AMRAS	Zambia
AMRAS follow-up	Sri Lanka

Table A15. Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) missions in 2019

Type	Country
ARTEMIS	Estonia
ARTEMIS	Germany
ARTEMIS	Latvia

Table A16. Education and Training Appraisal (EduTA) missions in 2019

Type	Country
EduTA	Indonesia
EduTA	Kenya
EduTA	Zambia

Table A17. Emergency Preparedness Review (EPREV) missions in 2019

Type	Country
EPREV	Canada
EPREV follow-up	United Arab Emirates

Table A18. IAEA-designated International Centres Based on Research Reactor (ICERR)

Type	Organization/research centre	Country	Year of designation
ICERR	Korea Atomic Energy Research Institute	Republic of Korea	2019
ICERR	Belgian Nuclear Research Centre	Belgium	2017
ICERR	Idaho National Laboratory and Oak Ridge National Laboratory	United States of America	2017
ICERR	Research Institute of Atomic Reactors	Russian Federation	2016
ICERR	CEA Cadarache and CEA Saclay Centre	France	2015

Table A19. Integrated missions of the Agency's Programme of Action for Cancer Therapy (imPACT) in 2019

Type	Country
imPACT	Armenia
imPACT	Burkina Faso
imPACT	Ecuador
imPACT	Seychelles
imPACT	Sri Lanka

Table A20. Integrated Nuclear Infrastructure Review (INIR) missions in 2019

Type	Country
INIR Phase 2	Egypt
INIR Phase 1 follow-up	Ghana

Table A21. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2019

Type	Country
INSARR	Nigeria
INSARR follow-up	Netherlands

Table A22. International Physical Protection Advisory Service (IPPAS) missions in 2019

Type	Country
IPPAS	Belgium
IPPAS	Lebanon
IPPAS	Madagascar
IPPAS	Paraguay
IPPAS	Uruguay

Table A23. Integrated Regulatory Review Service (IRRS) missions in 2019

Type	Country
IRRS	Canada
IRRS	Germany
IRRS	Latvia
IRRS	Norway
IRRS	United Kingdom of Great Britain and Northern Ireland
IRRS follow-up	Armenia
IRRS follow-up	Croatia
IRRS follow-up	Estonia
IRRS follow-up	Indonesia

Table A24. Integrated Research Reactor Utilization Review (IRRUR) missions in 2019

Type	Country
Pilot IRRUR mission	Italy

Table A25. Independent Safety Culture Assessment (ISCA) missions in 2019

Type	Country
ISCA	Thailand
ISCA follow-up	Netherlands

Table A26. Knowledge Management Assist Visit (KMAV) missions in 2019

Type	Organization/nuclear power plant	Country
KMAV	Armenian Nuclear Power Plant	Armenia
KMAV	Eletrobras Eletronuclear	Brazil
KMAV	Korea Hydro & Nuclear Power Company	Republic of Korea
KMAV	Pakistan Atomic Energy Commission	Pakistan

Table A27. Operation and Maintenance Assessment for Research Reactors (OMARR) missions in 2019

Type	Country
OMARR	Indonesia
Pre-OMARR	Indonesia
Pre-OMARR	Thailand
Post-OMARR	Uzbekistan

Table A28. Occupational Radiation Protection Appraisal Service (ORPAS) missions in 2019

Type	Country
ORPAS	Nicaragua
ORPAS	Sri Lanka
ORPAS follow-up	Ghana

Table A29. Operational Safety Review Team (OSART) missions in 2019

Type	Country
OSART	Belarus
OSART	China
OSART	France
OSART	France
OSART	Slovakia
OSART follow-up	China
OSART follow-up	Finland
OSART follow-up	France
OSART follow-up	France
OSART follow-up	Romania
OSART follow-up	Russian Federation
OSART follow-up	Spain
OSART follow-up	United Kingdom of Great Britain and Northern Ireland
OSART follow-up	United States of America

Table A30. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2019

Type	Country
PROSPER	Russian Federation

Table A31. Safety Aspects of Long Term Operation (SALTO) missions in 2019

Type	Country
SALTO	Mexico
SALTO	South Africa
SALTO	Spain
SALTO	Sweden
SALTO follow-up	Belgium
SALTO follow-up	China

Table A32. Site and External Events Design (SEED) missions in 2019

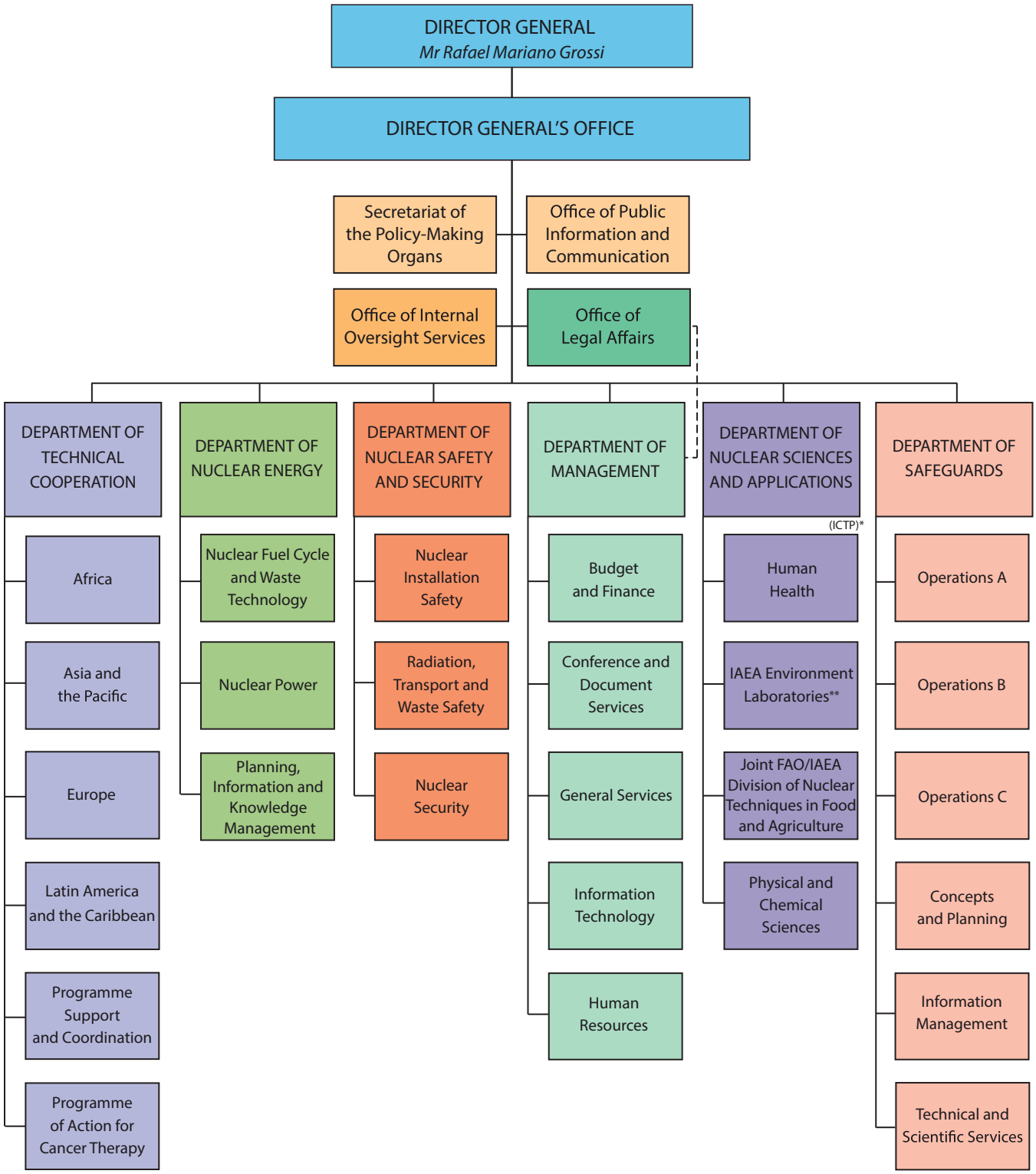
Type	Country
SEED	Egypt

Table A33. Technical Safety Reviews (TSRs) in 2019

Type	Country
Safety Requirements Review	Egypt

ORGANIZATIONAL CHART

(as of 31 December 2019)



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

** With the participation of UNEP and IOC.

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

Article II of the IAEA Statute

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