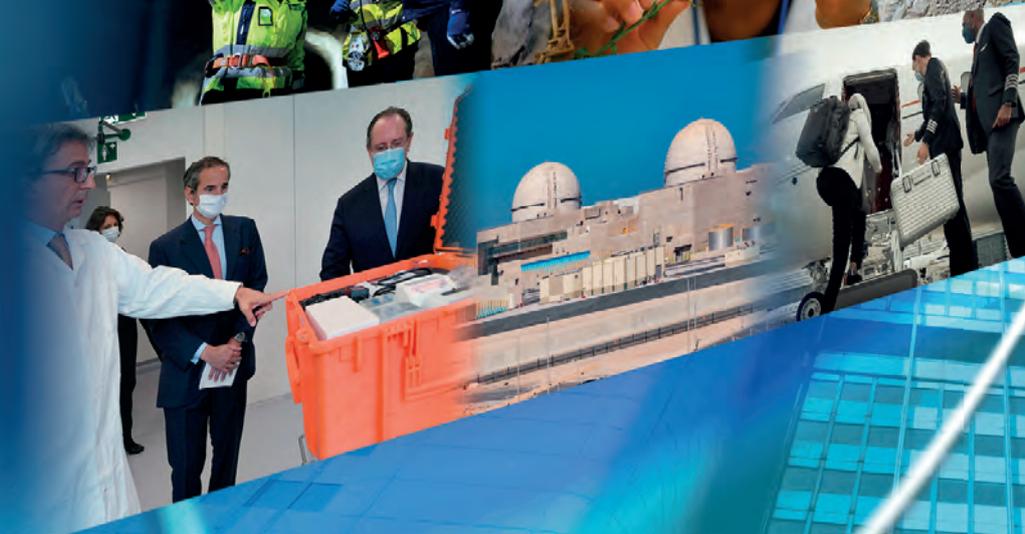


IAEA ANNUAL REPORT 2020

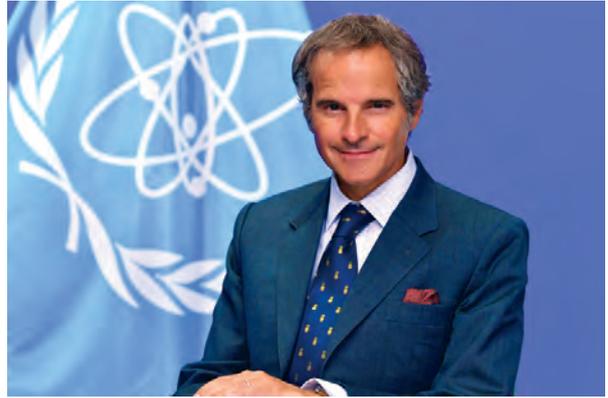


IAEA

International Atomic Energy Agency

Atoms for Peace and Development

Foreword by IAEA Director General Rafael Mariano Grossi



It has been an extraordinary year for the world and for the International Atomic Energy Agency. In 2020, COVID-19 made its devastating effect apparent. We started the year with one officially confirmed case and ended it with 82.7 million cases, of which nearly 2 million proved fatal, according to the World Health Organization.

This Report describes how the Agency adapted to the circumstances, steadfastly serving its Member States by fulfilling its indispensable mission. To have served side by side with such dedicated staff and supportive Member States at so critical a moment in time has been a privilege. We rose to the challenge as individuals, as teams, as an organization, and as a community. Working apart brought us together. As the pandemic grew, so did our level of resilience and commitment. When the need for Agency assistance became more urgent, we found new and innovative ways to offer it.

Even as commercial airlines curtailed their flights and quarantining became a necessary health and safety measure, inspection teams continued to travel throughout the world. Overcoming the challenges of the pandemic, the Agency was able to draw soundly based safeguards conclusions for all States in 2020.

In nuclear safety and security, we assessed whether we needed to enhance our standards and guidance to meet the circumstances of this and any future pandemics, and our Incident and Emergency Centre operated without interruption.

On the humanitarian front, we launched the largest technical cooperation project in the Agency's history, delivering RT-PCR equipment, and the knowledge of how to use it, to 127 countries and territories. As our assistance was reaching more than 28 million people, we looked to the future and developed a project to reduce the risk of the next zoonotic disease becoming a pandemic. Zoonotic Disease Integrated Action, or Zodiac, will better prepare countries to deal with future outbreaks. Meanwhile, we were able to continue to deliver our programmatic activities with minimal disruption, while giving full attention to the health and well-being of staff.

As the Agency's membership continued to grow and Member States continued to request more complex assistance from us, we responded. In June we marked the completion of all new facilities under the Renovation of the Nuclear Applications Laboratories initiative, ReNuAL, and in September we launched the final phase, ReNuAL 2.

In 2020, the consequences of global warming continued to make themselves felt; wildfires and floods illustrated the scale of the challenge. If the world is to meet its climate change objectives and its Sustainable Development Goals, it is clear that nuclear energy must be part of the solution. Two countries commissioned their first nuclear power plants in 2020, increasing the number of States producing nuclear power to 32. The Agency continued to help Member States assess their energy needs and to assist them throughout the entire fuel cycle. Meanwhile, we took a more proactive role in regional and global meetings where climate and energy policy were discussed.

A key part of all our work is to share knowledge and information. How it is delivered matters, which is why I am glad to see this Annual Report has put emphasis on being readable, accessible and visually appealing. It makes greater use of photos and infographics, and the succinct text is further enhanced by case studies that illustrate the Agency's impact on the lives and livelihoods of people living in our Member States.



Rafael Mariano Grossi
IAEA Director General

IAEA ANNUAL REPORT 2020

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 2020.

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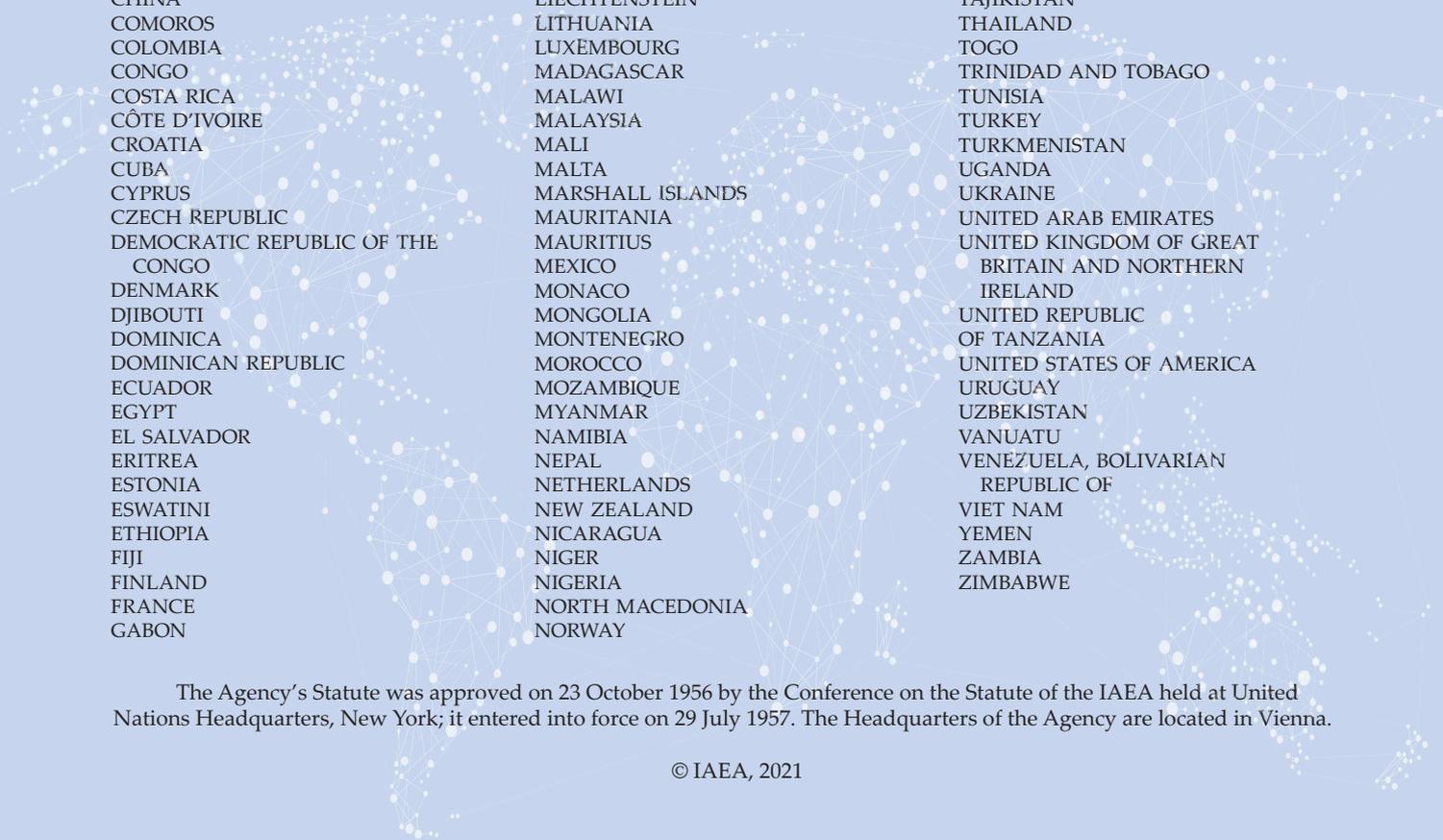
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Member States of the International Atomic Energy Agency

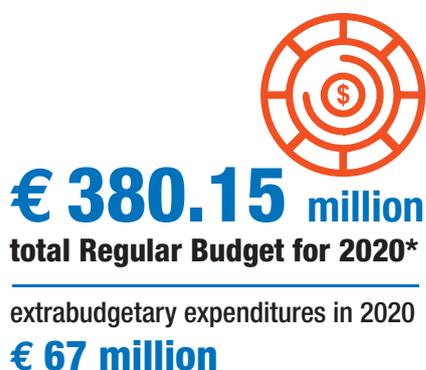
(as of 31 December 2020)



AFGHANISTAN	GEORGIA	OMAN
ALBANIA	GERMANY	PAKISTAN
ALGERIA	GHANA	PALAU
ANGOLA	GREECE	PANAMA
ANTIGUA AND BARBUDA	GRENADA	PAPUA NEW GUINEA
ARGENTINA	GUATEMALA	PARAGUAY
ARMENIA	GUYANA	PERU
AUSTRALIA	HAITI	PHILIPPINES
AUSTRIA	HOLY SEE	POLAND
AZERBAIJAN	HONDURAS	PORTUGAL
BAHAMAS	HUNGARY	QATAR
BAHRAIN	ICELAND	REPUBLIC OF MOLDOVA
BANGLADESH	INDIA	ROMANIA
BARBADOS	INDONESIA	RUSSIAN FEDERATION
BELARUS	IRAN, ISLAMIC REPUBLIC OF	RWANDA
BELGIUM	IRAQ	SAINT LUCIA
BELIZE	IRELAND	SAINT VINCENT AND THE GRENADINES
BENIN	ISRAEL	SAN MARINO
BOLIVIA, PLURINATIONAL STATE OF	ITALY	SAUDI ARABIA
BOSNIA AND HERZEGOVINA	JAMAICA	SENEGAL
BOTSWANA	JAPAN	SERBIA
BRAZIL	JORDAN	SEYCHELLES
BRUNEI DARUSSALAM	KAZAKHSTAN	SIERRA LEONE
BULGARIA	KENYA	SINGAPORE
BURKINA FASO	KOREA, REPUBLIC OF	SLOVAKIA
BURUNDI	KUWAIT	SLOVENIA
CAMBODIA	KYRGYZSTAN	SOUTH AFRICA
CAMEROON	LAO PEOPLE'S DEMOCRATIC REPUBLIC	SPAIN
CANADA	LATVIA	SRI LANKA
CENTRAL AFRICAN REPUBLIC	LEBANON	SUDAN
CHAD	LESOTHO	SWEDEN
CHILE	LIBERIA	SWITZERLAND
CHINA	LIBYA	SYRIAN ARAB REPUBLIC
COMOROS	LIECHTENSTEIN	TAJIKISTAN
COLOMBIA	LITHUANIA	THAILAND
CONGO	LUXEMBOURG	TOGO
COSTA RICA	MADAGASCAR	TRINIDAD AND TOBAGO
CÔTE D'IVOIRE	MALAWI	TUNISIA
CROATIA	MALAYSIA	TURKEY
CUBA	MALI	TURKMENISTAN
CYPRUS	MALTA	UGANDA
CZECH REPUBLIC	MARSHALL ISLANDS	UKRAINE
DEMOCRATIC REPUBLIC OF THE CONGO	MAURITANIA	UNITED ARAB EMIRATES
DENMARK	MAURITIUS	UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
DJIBOUTI	MEXICO	UNITED REPUBLIC OF TANZANIA
DOMINICA	MONACO	UNITED STATES OF AMERICA
DOMINICAN REPUBLIC	MONGOLIA	URUGUAY
ECUADOR	MONTENEGRO	UZBEKISTAN
EGYPT	MOROCCO	VANUATU
EL SALVADOR	MOZAMBIQUE	VENEZUELA, BOLIVARIAN REPUBLIC OF
ERITREA	MYANMAR	VIET NAM
ESTONIA	NAMIBIA	YEMEN
ESWATINI	NEPAL	ZAMBIA
ETHIOPIA	NETHERLANDS	ZIMBABWE
FIJI	NEW ZEALAND	
FINLAND	NICARAGUA	
FRANCE	NIGER	
GABON	NIGERIA	
	NORTH MACEDONIA	
	NORWAY	

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



* At the United Nations average rate of exchange of US \$0.878 to €1.00. The total Regular Budget was €386.66 million at the US \$1.00 to €1.00 rate.

1 139



**active technical
cooperation projects**

124



**active coordinated
research projects
to develop new technology**

184



**States with safeguards
agreements in force** of which

136

**States had additional
protocols in force**

46



**active
IAEA Collaborating Centres
designated Member State institutions
supporting Agency activities**

visitors a month to iaea.org

English site

800 000

up **14%** since 2019

other languages

130 000

up **103%** since 2019



over

1 million

**materials available
in the IAEA library**



**IAEA publications
issued in 2020**

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.

In the area of nuclear technologies, in the course of 2020 the Board considered the *Nuclear Technology Review 2020*.

In the area of safety and security, the Board discussed the *Nuclear Safety Review 2020* and the *Nuclear Security Report 2020*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2019*. It approved one safeguards agreement and one additional protocol. 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 also considered the issue of the NPT Safeguards Agreement with the Islamic Republic of Iran.

The Board discussed the *Technical Cooperation Report for 2019* and approved financing for the Agency's technical cooperation programme for 2021. The Board approved an off-cycle interregional technical cooperation project entitled 'Supporting National and Regional Capacity in Integrated Action for Control of Zoonotic Diseases'.

The Board considered reports on the Agency and the COVID-19 pandemic.

The Board approved the Agency's Draft Budget Update for 2021.



Composition of the Board of Governors (2020–2021)

Chair:

HE Ms. Heidi HULAN
Ambassador
Governor from Canada

Vice-Chairpersons:

HE Mr. Károly DÁN
Ambassador
Governor from Hungary

HE Mr. Rapulane MOLEKANE
Ambassador
Governor from the Republic of South Africa

Argentina
Australia
Austria
Brazil
Canada
China
Egypt
Estonia
France
Germany
Ghana
Greece

Hungary
India
Japan
Kuwait
Malaysia
Mexico
Mongolia
New Zealand
Nigeria
Norway
Panama
Paraguay

Peru
Poland
Russian Federation
Saudi Arabia
Senegal
South Africa
Sweden
Switzerland
United Arab Emirates
United Kingdom of Great Britain
and Northern Ireland
United States of America



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 2019 and budget for 2021; on the Agency and the COVID-19 pandemic; 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, nuclear power applications and nuclear knowledge management; 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; and on the application of Agency safeguards in the Middle East. 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; and on the report on the promotion of the efficiency and effectiveness of the Agency's decision making process.





Notes

- The *Annual Report 2020* aims to summarize only the significant activities of the Agency during the year in question. The main part of the report, starting on page 37, generally follows the programme structure as given in *The Agency's Programme and Budget 2020–2021* (GC(63)/2). 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 7 June 2021, the Board of Governors approved the *Annual Report for 2020* 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
CGULS	Coordinated Group for Uranium Legacy Sites
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
CRNS	cosmic ray neutron sensor
CRP	coordinated research project
CSA	comprehensive safeguards agreement
DSRS	disused sealed radioactive source
EPR	emergency preparedness and response
ESST	Energy Scenarios Simulation Tool
FAO	Food and Agriculture Organization of the United Nations
GNIP	Global Network of Isotopes in Precipitation
IACRNE	Inter-Agency Committee on Radiological and Nuclear Emergencies
ICERR	IAEA-designated International Centre based on Research Reactors
ICTP	Abdus Salam International Centre for Theoretical Physics
IEA	International Energy Agency
IGALL	International Generic Ageing Lessons Learned
INIR	Integrated Nuclear Infrastructure Review
INIS	International Nuclear Information System
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
JCPOA	Joint Comprehensive Plan of Action

KMAV	Knowledge Management Assist Visit
LEU	low enriched uranium
MAED	Model for Analysis of Energy Demand
MSCFP	IAEA Marie Skłodowska-Curie Fellowship Programme
NEA	Nuclear Energy Agency (Organisation for Economic Co-operation and Development)
NEM School	Nuclear Energy Management School (IAEA)
NEST	Nuclear Energy System Assessment Economics Support Tool
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
RT-PCR	reverse transcription–polymerase chain reaction
SDG	Sustainable Development Goal
SIT	sterile insect technique
SLA	State-level safeguards approach
SMR	small and medium sized or modular reactor
SPECT-CT	single photon emission computed tomography–computed tomography
SQP	small quantities protocol
UNICEF	United Nations Children’s Fund
VETLAB Network	Veterinary Diagnostic Laboratory Network
WHO	World Health Organization
ZODIAC	Zoonotic Disease Integrated Action

Overview

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.

The COVID-19 pandemic that shook the world in 2020 had a significant impact on the Agency. The Agency remained proactive, quickly adapting to the challenging new circumstances to continue carrying out its functions. Under the leadership of Director General Rafael Mariano Grossi, Agency staff demonstrated their professionalism, resilience and dedication, and achieved some remarkable outcomes, despite the constraints of lockdowns and disrupted international transport. The Agency continued to implement safeguards throughout the world to verify States' commitments to use nuclear material only for peaceful purposes. It successfully delivered on the largest technical cooperation project in Agency's history, in terms of both the number of beneficiary countries and the disbursement of resources, to help countries confront COVID-19. The Agency was also able to continue to deliver its programmatic activities with minimal disruption, while giving full attention to the health and well-being of staff.

The Agency and the COVID-19 Pandemic

The Agency scaled up the information technology (IT) infrastructure, adopted human resources guidelines on working arrangements and implemented relevant health and safety measures at Headquarters. Almost all staff and personnel were equipped to work from home. The Agency quickly and effectively adapted to remote working conditions and continued to deliver on its mandate. At the core of all the decisions was the health and well-being of Agency staff, primarily based on the evolving guidance from the Host Government. Business continuity arrangements were adjusted, and operations remained as close to normal as possible under the new constraints.

The Agency suspended all non-essential travel and physical meetings but continued with programmatic deliveries, using a virtual format where this was feasible and would not affect quality.

Necessary arrangements for remote simultaneous interpretation and adequate Internet connectivity were made to facilitate the meetings of the Agency's Policy-Making Organs. These meetings were organized in a combination of virtual, physical and hybrid settings, with scrupulous adherence to the governing rules and procedures and the relevant health related guidance. The meetings of the Programme and Budget Committee in May and the Board of Governors in June were successfully conducted in a virtual setting. The 64th regular session of the General Conference was held in a hybrid setting. The meeting of the Board of Governors in early September was conducted in a physical setting, and those of the Board and the Technical Assistance and Cooperation Committee in November were conducted entirely virtually.



The Agency's 1563rd Board of Governors meeting, held virtually with interpretation in the Board's six working languages at the Agency's Headquarters in Vienna.

Support to Member State efforts to address the pandemic

extrabudgetary
funding totalling
€ 26.3 M



127

countries and
territories
requested
and received
assistance



285

national
laboratories/
institutions
received
COVID-19
support
packages and
technical
guidance



1950

RT-PCR and
diagnostic
kits and
related items
ordered for
countries



500+

counterpart
laboratories
received
updated SOPs,
reagent
information and
validation data,
delivered via
VETLAB



In response to the growing number of requests for assistance in the rapid detection of COVID-19, the Agency procured and delivered to Member States diagnostic kits that use nuclear derived techniques (real-time reverse transcription–polymerase chain reaction, or real-time RT-PCR) through a dedicated technical cooperation project. Fifteen Member States and a private company supported the Agency's efforts with generous extrabudgetary funding of €26.3 million in total.

Under this technical cooperation project – the largest in the Agency's history – every effort was made to ensure timely procurement and delivery. The Agency coordinated with suppliers and freight forwarders on production and shipment, and worked closely with Member States to facilitate customs clearance and local deliveries. As a result, a total of 1950 orders for equipment for COVID-19 detection (238 sets of real-time RT-PCR equipment), biosafety cabinets, reagents and other supplies were delivered to 127 countries and territories.

To ensure that the equipment and materials procured to address Member State requests were in alignment with the overall United Nations response, the Agency coordinated with United Nations system organizations through the United Nations Crisis Management Team on COVID-19 and the supply chain task force as well as consortia led by the World Health Organization (WHO). The Agency concluded supply and logistics services agreements with WHO and the World Food Programme and participated in joint procurement of personal protective equipment led by the United Nations Children's Fund (UNICEF). The Agency also worked closely with the Food and Agriculture Organization of the United Nations (FAO) and WHO to provide a coordinated response to requests from its Member States.

Complementing these procurement activities, the Agency conducted a series of webinars and one-on-one advisory sessions to strengthen Member States' COVID-19 testing laboratories. The topics covered laboratory requirements for the effective use of real-time RT-PCR, including biosafety and biosecurity frameworks; best practices for sample collection and preparation; and interpretation of results and quality assurance and quality control. Additional guidance and webinars were provided to help health care providers in nuclear medicine and radiology facilities adjust their standard operating procedures to minimize the risk of COVID-19 infection among patients, staff and the public. This was particularly important for radiology practices used in COVID-19 diagnosis.

In addition, more than 500 animal production and health counterpart laboratories received updated standard operating procedures (SOPs), reagent information and validation data from the Agency through the Veterinary Diagnostic Laboratory (VETLAB) Network platform. Nine instructional videos were produced on the use of personal protective equipment; the collection, transport and storage of samples; and the use of real-time RT-PCR specifically for the detection of COVID-19.

During the year, 197 articles were published in the press on the role of the Agency and nuclear techniques, and an article on the Agency's web site explaining how real-time RT-PCR works became the most read iaea.org article of all time, reaching an audience of 570 000.

16

RT-PCR webinars were held



with over

2000

participants, and almost

2000

subsequent viewings of the recordings to date



11



webinars on SOPs were held for health care providers in nuclear medicine, radiology and radiation oncology facilities, with over

6000

participants, and more than

7900

subsequent viewings of the recordings



Loading of a shipment of COVID-19 detection equipment to a Member State.

Safeguards implementation during the pandemic

To maintain effective safeguards implementation, the Agency applied a series of mitigating measures, drawing on business continuity and disaster recovery plans already in place or in development. These measures enabled the Agency to conduct all of its most time-critical in-field verification activities and almost all of the safeguards activities normally carried out at the Agency's Headquarters and regional offices.

Agency inspectors and technical staff made extraordinary efforts to fulfil their official duties, for example isolating for up to 14 days in their destination State, driving long distances and crossing various national borders – instead of flying – to conduct verification activities, embarking on missions without having a confirmed date or means to return to Vienna and having the length of missions extended significantly.

The Agency adjusted the operational conduct of safeguards activities at Headquarters and in the field, including rescheduling a number of activities. The Agency's regional offices were instrumental in ensuring that the Agency's safeguards activities continued. States played a very important role in supporting the Agency's work, including by ensuring continued access to nuclear facilities for Agency inspectors as well as staff movement across borders and transfers through airports. In response to the unavailability of many commercial flights, the Agency, for the first time, chartered flights to ensure that inspections would not stop, as the Director General said, "for a single minute". Despite all the challenges presented by the pandemic, the Agency was able to draw soundly based safeguards conclusions for all States for 2020.



An Agency inspector boarding a chartered aircraft.

Operation, safety and security of nuclear and radiation facilities and activities during the pandemic

The Agency's information systems remained fully operational. A COVID-19 Nuclear Power Plant Operating Experience Network was developed and piloted to assess measures undertaken by all 32 countries with operating nuclear power plants and to discuss the impact on training activities and human resources policies in nuclear power plants.

The Agency conducted a survey in April on the impact of COVID-19 on the safety and regulatory oversight of radiation sources; the conclusions, based on responses from 93 regulatory bodies, were shared with Member States. An Agency survey of major reactor based medical radioisotope producers indicated that most research reactors that produce radioisotopes continued to operate — as the production facilities had been defined as essential by the relevant governments — but that hospitals could face shortages due to bottlenecks in transport and distribution. The Agency set up a network for research reactor operators to share information on the status of research reactors and the remedial measures being implemented.

The Agency's Incident and Emergency Centre continued to ensure that the communication channels for notification of and information exchange on nuclear and radiological emergencies remained fully operational on a 24/7 basis, including during the lockdowns.

The development of safety standards and security guidance continued, and a gap analysis was performed to assess the need to enhance standards or guidance to meet additional requirements of pandemic situations. On the basis of this analysis, the Agency proposed enhancements to address pandemic situations in a few draft Safety Guides, to be presented to the appropriate committees for final approval. Although many Agency peer review and advisory services were deferred, some were conducted as scheduled.



The Integrated Safety Assessment of Research Reactors team concluded an eight day mission to assess the safety of the 10 MW LVR-15 research reactor in the Czech Republic. (Photograph courtesy of V. Vrbík, Research Centre Řež.)

NUCLEAR TECHNOLOGY

Nuclear Power, Fuel Cycle and Nuclear Technology

Status and trends

At the end of 2020, the world's total nuclear power capacity was 392.6 gigawatts (electrical) (GW(e)), generated by 442 operational nuclear power reactors in 32 countries. During the year, some 5.5 GW(e) of new nuclear capacity was connected to the grid, from five new pressurized water reactors, while 5.2 GW(e) of nuclear capacity was retired, with the permanent shutdown of six nuclear power reactors. Supplying 2553.2 terawatt-hours of greenhouse gas emission-free electricity, nuclear power accounted for about 10% of total global electricity generation and nearly a third of the world's low carbon electricity production. At the end of the year, 52 reactors were under construction around the world, including four where construction started in 2020.

The Agency's 2020 nuclear power projections remained largely in line with those of the previous year. In the high case, global nuclear electricity generating capacity was projected to increase by 82% to 715 GW(e) by 2050, corresponding to 11% of global electricity generation, versus around 10% in 2019. The low case projected a decrease of 7% to 363 GW(e), representing a 6% share of global electricity generation.

In October, the Agency organized the International Conference on the Management of Naturally Occurring Radioactive Material (NORM) in Industry, held virtually. Participants highlighted the need for clear national policies, based on well defined inventories and sound cost estimation methodologies, to enable the establishment and implementation of NORM waste management strategies.

Climate change and sustainable development

At several events throughout the year, including the Clean Energy Transitions Summit organized by the International Energy Agency (IEA), the Director General emphasized the importance of nuclear power in providing stability to electrical grids, particularly those with high shares of variable renewable sources. The Director General noted that nuclear power plants can operate flexibly in line with electricity demand and limit the impact of seasonal fluctuations in renewable output. Nuclear power can also bolster energy security owing to the diversified supply of nuclear fuels and the capability to store nuclear fuel on site for several years of operation. The Director General also talked about the contribution of nuclear power to the future production of low carbon hydrogen, for use in energy storage, transportation, industry and other applications.

Energy assessment services

The Agency continued to assist Member States in building and strengthening their capacities for energy system analysis and energy planning, through distance support and e-learning. The Agency launched the updated Energy Scenarios Simulation Tool (ESST), which covers all energy products and can be used for rapid analysis of a country's overall energy system or its specific parts, such as power generation.

The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) updated its Nuclear Energy System Assessment Economics Support Tool (NEST), which now includes new types of nuclear power plant, updated and refined algorithms, several new economics functions, an improved interface and a complete user manual.

Support to operating nuclear power plants

The Agency launched the Nuclear Supply Chain Toolkit to support Member States in coordinating among owner/operators of nuclear facilities and their suppliers, regulators and technical support organizations. The webinar entitled 'Covid-19 and Its Impact on the Nuclear Power Supply Chain' highlighted the innovative solutions nuclear power plant operators introduced during the pandemic to overcome physical distancing and mobility restrictions, including remote quality and safety related assessments of systems, structures and components.

The Agency's new webinar series entitled 'Training and Qualification for Nuclear Facility Personnel' was launched to support Member States in meeting the challenge of ensuring the safety, reliability and performance of nuclear facilities, operating or newly built, by attaining and maintaining the competence and qualification of personnel.

Launching nuclear power programmes

In a milestone year for nuclear power, when two countries — Belarus and the United Arab Emirates — commissioned their first nuclear power plants, the Agency continued its assistance to newcomer countries. It conducted an Integrated Nuclear Infrastructure Review (INIR) Phase 3 mission to Belarus and delivered the final INIR report to the Government, with recommendations and suggestions aimed at assisting the country in making further progress ahead of commissioning the country's first reactor. The Agency also delivered the final report of the INIR Phase 2 mission to Egypt, conducted in late 2019, with recommendations and suggestions to help Egypt move its programme forward.

The Agency conducted virtual courses on topics ranging from establishing a national position on nuclear power, to financing and risk allocation, to contract specifications and reactor technology assessment. In addition, the Agency organized three webinars on the roles and responsibilities of the government and key organizations in developing a new nuclear power programme.

Capacity building, knowledge management and nuclear information

The Agency conducted five virtual Knowledge Management Assist Visit (KMAV) missions, to Chile, Hungary, Romania, Uzbekistan and Viet Nam, reviewing their knowledge management programmes and providing recommendations for enhancements.

The Agency launched a series of webinars on nuclear knowledge management to support professionals worldwide in maintaining and preserving the technical expertise and skills required for nuclear power programmes and other nuclear technologies.

Over the year, 123 374 new records were added to the International Nuclear Information System (INIS), a 49% increase compared with 2019. This includes 18 537 full text documents. The INIS repository was accessed by over 1.7 million users, who viewed 4 million pages and performed 2.5 million unique searches. This was the highest number of visits in the 50 year history of INIS and represented a 13% increase from the previous year.

Stakeholder involvement

The Agency conducted four webinars from the series entitled 'Stakeholder Involvement Related to Nuclear Power'. These webinars help strengthen the capacity of Member States to develop, implement, manage and adapt effective stakeholder involvement programmes for nuclear power.

Assurance of supply

The IAEA Low Enriched Uranium Bank in Kazakhstan, which became operational in 2019, continued safe operations at the Ulba Metallurgical Plant. A transport contract was signed with the China Nuclear Energy Industry Corporation (CNEIC), providing a second possible route (in addition to the route through the Russian Federation) for the transport of low enriched uranium (LEU) and/or equipment necessary for the operations of 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

As part of its 'E-learning on Spent Fuel and Radioactive Waste Management, Decommissioning and Environmental Remediation' collection, the Agency released a course on spent fuel storage. The course describes different choices for deploying storage facilities under the different spent fuel management strategies.

The Agency and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development jointly published Uranium 2020: Resources, Production and Demand, also known as the 'Red Book', which presents the most recent review of uranium market fundamentals and offers a statistical profile of the global uranium industry.

Reactor technology development and innovation

An Agency webinar series entitled 'Nuclear Technology Breakthroughs for the 21st Century' was launched to share information on how current and future sustainable nuclear energy systems can help countries to meet both growing energy demand and climate change goals. The webinars take into consideration advances in other energy technologies as well as developments in society at large.

The Agency published the 2020 edition of Advances in Small Modular Reactor Technology Developments, a supplement to its Advanced Reactors Information System (ARIS) database. It provides the latest data and information on small modular reactors around the world, including detailed descriptions of 72 reactors under development or construction in 18 countries. The booklet for the first time contains annexes on waste management and disposal as well as a section on microreactors.

Research reactors

The Agency designated the Institute for Nuclear Research Pitesti (RATEN ICN) in Romania and re-designated the French Alternative Energies and Atomic Energy Commission (CEA) as IAEA-designated International Centres based on Research Reactors (ICERRs). The ICERR programme enables researchers from various countries to have hands-on training and the opportunity to conduct experiments and work at state of the art facilities in other countries. There are now six ICERRs in six Member States.

Radioactive waste management

Despite restrictions in place owing to the global pandemic, the Agency assisted in successfully bringing high activity disused sealed radioactive sources, previously used in cancer treatment, to safer and more secure storage facilities in several countries, including Colombia.

Together with the Abdus Salam International Centre for Theoretical Physics (ICTP), the Agency organized the first Joint ICTP-IAEA International School on Radioactive Waste Cementation, held virtually. The event featured vibrant debates on a variety of topics,

including cement chemistry, as well as the latest theoretical and experimental advances and technological approaches to waste cementation.

Decommissioning and environmental remediation

The Agency's crowdsourcing challenge on decommissioning and environmental remediation, aimed at promoting innovative technologies and highlighting the attractive career opportunities available to young people in this field, received 26 submissions from 12 countries. The proposals showed significant potential for practical use in decommissioning and remediation operations. The five entries judged the best ranged from characterization toolkits and instruments for in-field measurements and collecting 3D radiation data to robots and artificial intelligence.

Nuclear fusion

The Agency launched a new Fusion Device Information System (FusDIS), the first interactive database offering information on more than 100 public and private experimental fusion research devices currently in operation, under construction, closed or being planned.

The Agency continued supporting international and regional schools on nuclear fusion, such as the international summer school on 'Plasma Physics and Controlled Fusion', organized by Peter the Great St. Petersburg Polytechnic University in the Russian Federation, and the Graduate University for Advanced Studies (SOKENDAI) in Japan, and the sixth ASEAN School on Plasma and Nuclear Fusion and the SOKENDAI Winter School, held in Thailand. The participants learned about the fundamentals of plasma physics and were trained to set up experiments, interpret results and present findings to peers.

Nuclear data

The Agency launched a coordinated research project (CRP) entitled 'Updating Fission Yield Data for Applications' to improve existing fission yield evaluations for uranium-235, plutonium-239 and californium-252. This CRP will enable the compilation of all new experimental data, including uncertainty quantification, so that the fission yield data can be reliably applied in reactor and other nuclear analysis, leading to more accurate predictions of nuclear inventories and fuel depletion profiles.

Accelerator technology and its applications

Member States' access to expert services in accelerator and beam line design and technique development will increase as a result of the designation of Elettra Sincrotrone Trieste in Italy as an IAEA Collaborating Centre for light source and beam line technology. Through this designation, the Agency will also provide assistance to Member States planning to build or improve their own synchrotron facilities by training scientists and technologists in key areas.

Nuclear instrumentation

The Agency facilitated remote access to resources on nuclear instrumentation and information exchange through further development and consolidation of the Nuclear Science and Instrumentation Portal, including the creation of virtual 'sibling' laboratory rooms that allow virtual tours of the experimental facilities. This enables researchers from around the world to access relevant e-learning materials, technical documents and reports relating to nuclear instrumentation and applications based on the use of X rays, neutrons and ion beams. It also offers downloads of various software tools for experimental data acquisition, analysis and interpretation.



NUCLEAR POWER AND THE CLEAN TRANSITION

IAEA Scientific Forum: Nuclear Power and the Clean Energy Transition

The IAEA Scientific Forum, held on the margins of the 64th regular session of the General Conference, focused on technological innovations that are making nuclear power a more affordable and attractive energy option as well as on challenges hindering its greater deployment, such as concerns about costs and financing. Among the forum's conclusions was that nuclear power must have a seat at the table in global discussions on energy policies to curb emissions and meet climate goals, as technical and scientific advances further improve the economics of and public support for this low carbon source of energy.

R ENERGY SITATION



Director General Grossi delivers his remarks at the opening session of the 2020 Scientific Forum on Nuclear Power and the Clean Energy transition.

NUCLEAR SCIENCES AND APPLICATIONS

The International Conference on Molecular Imaging and Clinical PET–CT in the Era of Theranostics (IPET 2020)

In November, the International Conference on Molecular Imaging and PET–CT in the Era of Theranostics (IPET-2020) provided a platform for live presentations on important clinical aspects and the appropriate use of medical imaging in the management of patients with cancer. Special sessions were dedicated to COVID-19, education, ethics and leadership, and a keynote lecture focused on the global burden of cancer. The conference, which had the cooperation of ten professional organizations and was held virtually, was attended by over 3000 participants from 126 Member States, with many more accessing the recorded lectures on-line. Participants were awarded 15 continuing medical education credits; such credits are a requirement for maintaining medical licences in many Member States.

Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) network: Twenty five year anniversary

The annual coordination meeting of the Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) network, held as a virtual event in 2020, marked the network's 25th anniversary. Future activities stemming from the meeting will focus on strengthened collaboration for emergency preparedness and response, increased interest in specialized proficiency tests and reference materials, and targeted training. Established in 1995, the ALMERA network brings together 190 expert laboratories across 89 Member States, providing Member States with reliable environmental radioactivity data for routine monitoring and in the case of nuclear or radiological emergencies.

Food and Agriculture

New technique to distinguish between artificial and naturally occurring soil erosion

In 2020, the Agency developed a technique to distinguish and apportion naturally occurring and anthropogenic soil erosion in upland agroecosystems using caesium-137 resampling. The technique involves repeated soil sampling at set time intervals to determine the rate of erosion using caesium-137 fallout radionuclides. The approach, which has been demonstrated in field studies carried out in China, Italy, Morocco and Spain, allows evaluation of the effectiveness of soil conservation measures. This information is important for identifying appropriate soil conservation and management practices to minimize soil erosion and its negative impact.

Enhancing agricultural water management

In 2020, the Agency developed the cosmic ray neutron sensor (CRNS) technology to bridge the soil moisture measurement gap between large scale satellite imaging and point scale ground sensors for managing agricultural water productivity. By combining CRNS technology with satellite imagery, high resolution soil moisture maps for agricultural water management can be produced. The technology, which was developed at the IAEA Seibersdorf laboratories, was tested in both temperate and semi-arid environments and can be used to support agricultural decision making, not only for agricultural water management purposes but also for hydrology and drought and flood prediction. It may even be useful in efforts to prevent the spread of the desert locust in the future.

Impacts of phosphorus fertilizers on agriculture and the environment

Phosphorus fertilizers are known to increase crop productivity; however, when applied in excess, they pollute the soil and groundwater. To assess phosphorus pollution in freshwater ecosystems and the environment, the Agency — through technical support from a CRP and applied research and development — modified a technique developed at the IAEA Seibersdorf laboratories in 2018 involving the stable isotopes of oxygen in phosphate ($\delta^{18}\text{Op}$) to address specific practical issues when applied in different environments.

Development of a DNA chip for camel improvement

As an adaptation to climate change, pastoralists in Africa who have historically depended on cattle are shifting to camel husbandry, because camels can better tolerate severe drought and the prolonged dry periods brought on by climate change. At the same time, there is a growing market for camel milk and other products that provide a source of income to nomadic herders in Asia and Africa. Today, thanks to advances in nuclear and related genomic technologies, it is possible to estimate the breeding potential of an animal on the day of its birth simply by looking at its deoxyribonucleic acid (DNA). Genome maps produced using a nuclear technique known as radiation hybrid mapping can pinpoint the location of specific features in an animal's chromosomes, so-called DNA markers. During 2020, the Agency, in collaboration with partners, developed a multi-species camelid DNA chip for selection and breeding of more productive camels. This novel multi-species chip can be used for genetic evaluation and improvement of several members of the Camelidae family including the dromedary, Bactrian camel, alpaca and llama.

Human Health

New on-line data entry platform and calculator for body composition

One of the main stable isotope techniques used in nutrition assessments is the deuterium dilution technique for body composition assessment. The final outputs of the assessment rely on information from several sources. The difficulty of keeping track of many variables from different sources at different time points and of preparing the data for statistical analysis is often underestimated and may be a bottleneck in projects. In 2020, the Agency developed an on-line data entry platform and body composition calculator to improve the quality of data, support data management, and facilitate good record keeping and standardized calculations. The platform, which was built using the Agency's International Research Integration System (IRIS), also makes it possible to add and provide safe storage for project specific data, making it a one stop location for data management and entry.

Biological dosimetry

The Agency installed a number of pieces of biodosimetry research equipment this year, including the Metafer imaging platform, an important tool for biodosimetry that enables the reconstruction of a particular radiation dose received by patients after planned or accidental exposure. Other similar biodosimetry methods and infrastructure available at the IAEA Seibersdorf laboratories can be used to support applications in molecular research, medical cytogenetics, forensics, and viral diagnostics and quantification, including for severe acute respiratory syndrome coronavirus 2, the virus that causes COVID-19.

Enhancing capacity building in small field dosimetry for advanced radiotherapy technologies

The Agency has provided training in dosimetry to medical physicists from around the world since 2017, when it published the first international code of practice dedicated to dosimetry for small static fields. Agency training courses on dosimetry used in advanced radiotherapy technologies and techniques have been held for several years in all regions. The course materials have been assembled and expanded into a self-paced e-learning course entitled 'IAEA TRS483 Code of Practice on Dosimetry of Small Static Fields Used in External Beam Radiotherapy'. Released on the Agency's Cyber Learning Platform for Network Education and Training (CLP4Net) in 2020, the course enables clinical radiotherapy medical physicists to undergo continuous professional development on demand and to contribute to ensuring that patients receive accurate doses from complex radiotherapy techniques.

SPECT/CT Atlas of Quality Control and Image Artefacts

The technology involved in performing scans in the nuclear medicine department hospital is a complex fusion of nuclear medicine and radiological imaging techniques that have evolved over 50 years into sophisticated hybrid systems known as SPECT-CT, or single photon emission computed tomography-computed tomography. The new Agency publication SPECT/CT Atlas of Quality Control and Image Artefacts (IAEA Human Health Series No. 36) presents an overview of potential pitfalls as well as the quality control procedures and standards required in SPECT-CT.

Water Resources

Assessment of mining impacts on water resources utilization and pollution

Mining activities can pollute underground aquifers and surface water bodies. To help safeguard water resources, a new CRP will focus on the development and application of stable isotope and radioisotope techniques for efficient water resources management in diverse mining operations. Two thematically related technical cooperation projects completed in 2020 in Argentina and Chile used isotope hydrology methods to guide water quality remediation efforts to help eliminate pollution of water resources from active and abandoned mines.

Application of machine learning tools for global isotope hydrology networks

Machine learning tools were applied to the Global Network of Isotopes in Precipitation (GNIP) – the Agency's isotope hydrology database established 60 years ago – to detect climate driven processes and hydrological changes. New high resolution isotope prediction maps were generated that will enable scientists to predict the stable isotope (oxygen-18 and hydrogen-2) and radioisotope (hydrogen-3) content of rainfall around the world. This information will help policy makers protect vulnerable aquifers and can be used to validate global climate change prediction models. Application of the machine learning tools revealed that large scale cyclical hydroclimatic processes such as the North Atlantic and Pacific Decadal Oscillations are moderators of global climate change impacts.

Environment

Evidence of positive effects from strict global contaminant releases restriction

The Agency released an assessment report on century-scale global pollution trends derived from data on select coastal environments. The report, entitled 'Global Pollution Trends: Coastal Ecosystem Assessment for the Past Century', highlights legacy and emerging coastal contaminants and concludes that the amount of strictly regulated contaminants — such as polychlorinated biphenyls (PCBs), a subclass of persistent organic pollutants — has been decreasing globally over the past 50 years. This trend demonstrates that strict policies can have a positive environmental impact.

A ten year time series of marine microplastic abundance in the coastal waters off Ecuador

In 2020, scientists from the Agency and Ecuador completed a first ever, decade long study of the abundance of marine microplastic particles at select sites in the coastal waters off Ecuador. Results confirm that the abundance of marine microplastic particles in these waters has risen consistently over the past few years. Unless action is taken to change this trajectory, by 2050 the quantity of marine microplastic particles is projected to increase more than tenfold from 2008 values.

Emergency response to Mauritius oil spill to assess effects on coral reef ecosystems

In July 2020, a cargo ship ran aground on a coral reef in Mauritius and began leaking oil into nearby coastal waters, potentially endangering corals, fish and other marine life. The Agency, upon the request of the Government, provided an emergency response to help address potential environmental consequences of the oil spill. After technical consultations, it advised Mauritius to develop and implement a comprehensive long term monitoring programme for the impacted coastal waters, sediment, biota and air. With the procurement of dedicated laboratory equipment and training of local staff, the Agency helped the national laboratories to increase their capacity to monitor the effects of the oil spill in the marine environment and associated volatile organic compounds in the air and to assess their potential toxicological impacts.

Radioisotope Production and Radiation Technologies

Recycling of polymer waste for structural and non-structural materials by using ionizing radiation

The CRP entitled 'Recycling of Polymer Waste for Structural and Non-Structural Materials by using Ionizing Radiation', launched in 2020, will build on outcomes of a consultancy meeting held during the year involving recognized international experts in the field of plastic waste recycling using radiation technologies. The CRP targets reduction of plastic waste volumes using radiation technologies and is part of the Agency's ongoing, integrated response aimed at assisting Member States in using nuclear techniques to address plastic pollution challenges.

Production of cyclotron based gallium-68 radioisotope and related radiopharmaceuticals

Gallium-68 has become one of the most important medical radioisotopes for disease diagnosis, and a new CRP entitled 'Production of Cyclotron-Based Gallium-68 Radioisotope and Related Radiopharmaceuticals' was launched to focus on a new route of gallium-68 production that will allow more Member States to produce it locally. The CRP aims to formulate guidelines and promote networks to enable cyclotron based production of gallium-68 and the preparation of gallium-68 radiopharmaceuticals for preclinical and human use.

Zoonotic Disease Integrated Action (ZODIAC)

The Zoonotic Disease Integrated Action (ZODIAC) project was launched in 2020, drawing on the Agency's experience supporting Member States in using nuclear and nuclear derived techniques to enhance global response preparedness to combat zoonotic diseases such as COVID-19, Ebola, avian influenza and Zika. The project, through its interconnected pillars, will increase Member States' capacity for early detection and monitoring of pathogens in the animal-human interface. It will support countries in creating appropriate ZODIAC relevant infrastructure by providing equipment, training and necessary research and development tools. The project will maintain a network of participating laboratories for storing and exchanging relevant scientific and technical information. ZODIAC also envisages providing increased access to reliable data for Member States to improve understanding of the impact of zoonotic diseases on human health and to support science based decision making using radiation imaging technologies or radiomics. At the General Conference, Member States adopted a resolution on ZODIAC, and in November the Board of Governors approved an off-cycle interregional technical cooperation project aimed at building the infrastructure and human capacity needed to implement ZODIAC activities. The Agency will continue to seek opportunities for establishing partnerships with national and international organizations as well as non-traditional partners to create synergies with other initiatives.

Inauguration of The Yukiya Amano Laboratories Building and Launch of ReNuAL 2

Director General Grossi and Austrian Federal Minister for European and International Affairs Alexander Schallenberg officially opened The Yukiya Amano Laboratories building on 5 June 2020, marking the completion of all new facilities launched to date under the Renovation of the Nuclear Applications Laboratories (ReNuAL) initiative. The new facility now serves as the home to the Animal Production and Health Laboratory, the Food and Environmental Protection Laboratory and the Soil and Water Management and Crop Nutrition Laboratory. Providing more laboratory space and significant improvements to scientific and research capabilities, the new building has strengthened the capacity of the three laboratories to support Member States in responding to existing and emerging challenges, including COVID-19. The opening of The Yukiya Amano Laboratories building followed the launch in 2019 of two other major facilities constructed under this initiative — a new Insect Pest Control Laboratory building and a new linear accelerator facility for the Dosimetry Laboratory.

The Director General launched the final phase of laboratory modernization in September. ReNuAL 2 will include construction of a new building for three laboratories, refurbishment of the Dosimetry Laboratory and replacement of ageing greenhouses. The modern facilities will strengthen the laboratories' support for Member States on climate-smart agriculture, environmental resource management and food security.



Austrian Foreign Minister Schallenberg and Director General Grossi formally open The Yukiya Amano Laboratories building.

NUCLEAR SAFETY AND SECURITY

Nuclear Safety

Safety standards and their application

The Agency issued one General Safety Guide and nine Specific Safety Guides after endorsement by the Commission on Safety Standards. It conducted 15 safety related peer review and advisory service missions to support 15 Member States in their application of Agency safety standards. Although Member State requests for these services remained high, the majority of reviews requiring site visits were postponed until 2021, owing to the COVID-19 pandemic travel restrictions.

International Conference on Radiation Safety: Improving Radiation Protection in Practice

In November, the Agency organized the International Conference on Radiation Safety: Improving Radiation Protection in Practice, held as a virtual event in cooperation with seven international organizations. The conference underscored the need to apply the principles of justification and optimization to the use of radiation, underlining that ethical principles such as prudence, reasonableness and tolerability must also be taken into account in decision making.

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

The Agency held a technical meeting of the International Generic Ageing Lessons Learned (IGALL) Steering Committee as well as nine workshops and eight IGALL meetings to support operators, regulators and other organizations in ageing management and long term operation of nuclear power plants.

The Agency published *Experiences in Implementing Safety Improvements at Existing Nuclear Power Plants* (IAEA-TECDOC-1894), which includes a variety of technical approaches that can be applied by Member States, and *Effective Management of Regulatory Experience for Safety* (IAEA-TECDOC-1899), providing a source of knowledge and learning for improving overall regulatory effectiveness for ensuring safety.

Safe deployment of advanced reactors

The Agency initiated the development of a Safety Report to provide a roadmap for the application of its safety standards as part of a technology neutral safety and regulatory framework to small modular reactors and published *Applicability of Design Safety Requirements to Small Modular Reactor Technologies Intended for Near Term Deployment* (IAEA-TECDOC-1936). The safety characteristics of small modular reactors, which are advanced reactors with passive safety features, differ from those of the current fleet of nuclear power plants; therefore, the application of safety standards may provide a challenge to some regulators. The report will assist them in the review and licensing process.

Assisting countries embarking on a new nuclear power programme

The Agency assisted Member States embarking on nuclear power programmes in developing a regulatory framework for siting and site evaluation by continuing to apply the Integrated Work Plan process to 17 Member States.

The Regulatory Cooperation Forum (RCF) launched the 2020–2024 RCF Strategic Plan to address common challenges in developing a regulatory framework for countries introducing or expanding their nuclear power programmes. The topics to be addressed

under the plan include independence of regulatory bodies, human resources, and drafting of regulations and guides.

Incident and emergency preparedness and response

The Agency, in the framework of the Emergency Preparedness and Response Standards Committee, identified priorities for developing additional guidance to support Member States in further aligning their national emergency preparedness and response (EPR) arrangements with IAEA Safety Standards Series No. GSR Part 7, *Preparedness and Response for a Nuclear or Radiological Emergency*. This prioritization will inform a work plan to develop additional guidance to enhance Member States' understanding of the implementation of GSR Part 7 requirements, thus strengthening their national EPR arrangements.

The Agency held the Tenth Meeting of the Representatives of Competent Authorities Identified under the Early Notification Convention and the Assistance Convention as a virtual event. The meeting adopted nine conclusions with 22 associated actions for the Secretariat and Member States to establish, maintain and strengthen national operational arrangements to implement the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; utilize and refine tools to securely exchange information, request and deliver assistance, ensure effective public communication, share environmental radiation data in a nuclear or radiological emergency, and perform assessments and prognoses; and conduct and promote international and national exercises to test emergency preparedness and response.

Radioactive waste management, environmental assessments and decommissioning of nuclear facilities

On the basis of the lessons identified from the first Integrated Regulatory Review Service (IRRS) and Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) combined mission, the Agency finalized guidelines to support efficient implementation of future IRRS–ARTEMIS combined missions. These combined missions continue to be requested by Member States.

The Agency held the Second Technical Meeting of the International Project on Decommissioning of Small Facilities (MIRDEC) and the Third Technical Meeting of the International Project on Completion of Decommissioning (COMDEC). The MIRDEC meeting resulted in further collection, review and exchange of experiences, knowledge and lessons on the decommissioning of small medical, industrial and research facilities. The COMDEC meeting furthered knowledge sharing and lessons regarding completion of decommissioning, which is concerned with actions taken to prepare sites for re-use and for termination of regulatory authorization.

The Agency published *Safety Culture Practices for the Regulatory Body* (IAEA-TECDOC-1895) and made available a harmonized safety culture model, jointly developed with the World Association of Nuclear Operators (WANO) and the Institute of Nuclear Power Operations (INPO) in the United States of America. The model is a comprehensive tool intended for all organizations that deal directly or indirectly with ionizing radiation, enabling them to set goals, implement changes and measure progress.

Radiation protection

The Agency held 18 webinars on radiation safety addressing patient protection, occupational radiation protection, radon, non-medical human imaging, food and drinking water, and consumer products, in collaboration with professional societies and international organizations. It also conducted a series of webinars bringing together leading experts to

share knowledge and expertise on strengthening radiation protection efforts and ensuring continuity of all services important for radiation protection.

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

The Agency conducted 205 capacity building activities, including over 100 EPR related webinars. These aimed at building capacity in Member States in nuclear, radiation, transport and waste safety, and in emergency preparedness and response.

At an Agency International School of Nuclear and Radiological Leadership for Safety held in Tokyo, participants gained an understanding of the role of leadership in strengthening nuclear safety in practice. The Agency extended the Practical Arrangements between the IAEA and the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO) on Cooperation in the Areas of Nuclear and Radiation Safety, Emergency Preparedness and Response and Nuclear Security in July.

The Agency created a dedicated area on the CLP4NET e-learning platform to host materials from the virtual School for Drafting Regulations, including training materials and technical documentation, and launched Version 2 of Modules 1–4 of the e-learning course on the safe transport of radioactive material to reflect requirements established in IAEA Safety Standards Series No. SSR-6 (Rev. 1), *Regulations for the Safe Transport of Radioactive Material*. These developments will make the learning materials of the School accessible to a wider audience in the important area of drafting safety regulations in line with Agency safety standards.

Safety conventions

Owing to measures imposed in response to COVID-19, the Organizational Meeting for the Seventh Review Meeting of the Contracting Parties to the Joint Convention was initially postponed and then held virtually later in the year. The Fourth Extraordinary Meeting and Seventh Review Meeting of the Contracting Parties to the Joint Convention were also postponed. The Eighth Review Meeting of the Contracting Parties to the Convention on Nuclear Safety was postponed.

The Agency's Radiation Safety and Nuclear Security Regulator

The authorizations of the Agency's internal service providers for individual monitoring and calibration services and the operation authorization of the Dosimetry Laboratory were renewed. Authorizations were also issued for the operation of the Insect Pest Control Laboratory in the new building in Seibersdorf and for the processing of plutonium-containing material for transfer from the Nuclear Material Laboratory to the Oak Ridge National Laboratory in the United States of America. In addition, the safety case for The Yukiya Amano Laboratories in Seibersdorf was reviewed and assessed, and a regulatory guide on cross-Divisional activities was prepared.

Civil liability for nuclear damage

The International Expert Group on Nuclear Liability (INLEX), which provides 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 20th regular meeting in June 2020 virtually. Participants heard about new developments and activities by the Secretariat in the field of civil liability for nuclear damage and discussed future outreach activities.

With the assistance of INLEX members, the Secretariat undertook several outreach activities to provide an overview of the international nuclear liability regime and its

implementation in national laws, such as a workshop for newcomer countries and a virtual seminar for Pakistan. In addition, the Director General sent letters in June to selected Member States, in particular those which already operate nuclear power plants, or are considering or working towards introducing nuclear power, encouraging them to adhere to relevant nuclear liability treaties.

In October, following a request made by Canada on behalf of the Contracting Parties to the Convention on Supplementary Compensation for Nuclear Damage (CSC), the Secretariat agreed to convene future meetings of the Contracting Parties and Signatories to the CSC on a regular basis.

Nuclear Security

International Conference on Nuclear Security: Sustaining and Strengthening Efforts

In February, the Agency organized the International Conference on Nuclear Security: Sustaining and Strengthening Efforts (ICONS 2020) in Vienna (Fig. 1). The conference brought together more than 1900 participants, including a record number of 53 ministers, to formulate and exchange views on experiences and achievements for nuclear security, including cybersecurity. Member States adopted a Ministerial Declaration reaffirming their support for nuclear security, and 109 national statements were delivered.



FIG. 1. The Director General delivers his remarks at the closing session of the International Conference on Nuclear Security ICONS 2020: Sustaining and Strengthening Efforts, held in February.

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

In line with Article 16.1 of the Convention on the Physical Protection of Nuclear Material (CPPNM), as amended in 2005, the Secretariat continued to facilitate preparations for the Conference of the Parties to the Amendment to the CPPNM. A meeting of the Preparatory Committee for the Conference took place virtually in December. The Agency continued encouraging universal adherence to and effective implementation of the CPPNM and its Amendment and provided assistance upon request. A further three States became party to the CPPNM and its Amendment in 2020.

Assistance to Member States

During 2020, the Agency supported the consolidation of nine high activity disused sealed radioactive sources. The Agency completed physical protection upgrades in two Member States at two research reactors, a nuclear power plant and 13 hospitals. It also provided assistance in drafting nuclear security regulations to 18 Member States. The Agency provided one Member State with handheld detection equipment and another with a mobile radiation portal monitor. Additionally, the Agency established a pool of radiation detection equipment available for loan with the Malaysian Atomic Energy Licensing Board and supplied detection equipment to Lebanon following the Beirut port explosion in August. The Agency conducted 42 training events, most of them virtually; continued to deliver its e-learning activities; and held a new computer security incident response course.

NUCLEAR VERIFICATION^{1,2}

Implementing safeguards and other verification activities in 2020 was much more of a challenge as a result of the global COVID-19 pandemic. Nevertheless, with considerable extra effort and adaptation to the new circumstances, the Agency conducted almost the same level of verification activities as in the previous year. The Agency carried out over 2 850 verification activities (2 953 in 2019) and spent more than 12 700 days in the field conducting those activities (13 140 in 2019). This ensured that the Agency was able to draw soundly based conclusions for all States in which safeguards were implemented by the Agency for 2020.

Implementation of safeguards in 2020

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.

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.

In 2020, 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 force⁵ the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 72 States⁶ (for 66 of which⁷ integrated safeguards were implemented during the whole of 2020); for the remaining 59 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 the selected facilities to which safeguards had been applied remained in peaceful activities or had been withdrawn from safeguards as provided for in the agreements. The Agency also implemented safeguards for three States not party 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 2020, 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 2020 is shown in Table A6 in the Annex to this report. During 2020, a CSA with an SQP and an AP was approved by the Board of Governors for Eritrea. A voluntary offer agreement and an AP entered into force for the United Kingdom. An SQP was amended for Haiti. In 2020, the Director General sent letters to 31 States with SQPs based on the original standard text calling upon them to amend or rescind their SQPs. At the end of 2020, 94 States had operative SQPs in force, of which 63 SQPs were based on the revised standard text. Eight 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 2020, 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 four reports providing updates on developments in between the issuance of the 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)*.

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.

Islamic Republic of Iran

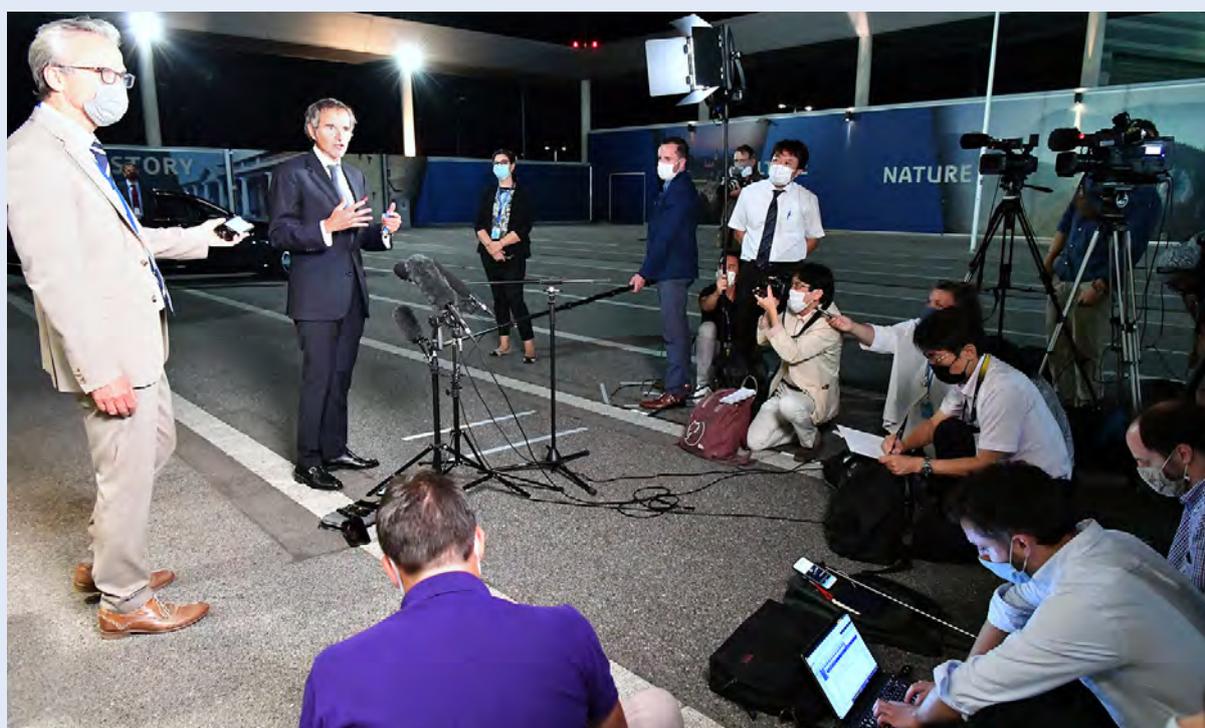
During 2020, the Agency interacted with Iran to clarify information relating to the correctness and completeness of Iran's declarations under its Safeguards Agreement and AP. The Agency submitted three reports to the Board of Governors entitled *NPT Safeguards Agreement with the Islamic Republic of Iran*.

Director General Grossi in Tehran

Following Iran's denial of access, under the AP, for the Agency to two undeclared locations in Iran, in June 2020 the Board of Governors adopted a resolution in which it called on Iran to fully cooperate with the Agency and satisfy the Agency's requests without any further delay, including by providing prompt access to the locations specified by the Agency. In August 2020, Director General Grossi had discussions in Tehran with President Rouhani, Foreign Minister Zarif and Head of the Atomic Energy Organization of Iran (AEOI) and Vice-President Salehi. The objectives of the Director General's visit were to establish a direct channel of communication with high level Iranian officials and to make concrete progress in addressing the Agency's outstanding questions related to safeguards, in particular to resolve the issue of access.

On 26 August 2020, Director General Grossi and Head of the AEOI and Vice-President Salehi issued a joint statement in which Iran and the Agency agreed to further reinforce their cooperation and enhance mutual trust to facilitate the full implementation of Iran's Safeguards Agreement and AP and reached an agreement on the resolution of the safeguards implementation issues specified by the Agency.

Following the issuance of the joint statement, the Agency conducted both complementary accesses, under the AP, at the two locations specified by the Agency, where Agency inspectors took environmental samples as planned. At the end of the year, these samples were being analysed by laboratories that are part of the Agency's Network of Analytical Laboratories, including the Agency's own analytical laboratories in Seibersdorf, Austria.



The Director General speaks to the press following his return from Tehran.

Syrian Arab Republic (Syria)

In September 2020, the Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic*. The Director General urged Syria to cooperate fully with the Agency in connection with all unresolved issues and expressed his willingness to engage with Syria to take concrete steps towards a mutually acceptable solution to this matter. Syria has yet to respond to these calls.

Democratic People's Republic of Korea (DPRK)

In September 2020, the 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 2020, 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. 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 2020, the Agency developed State-level safeguards approaches (SLAs) for two States with a CSA and an AP in force. This brings the total number of States with a CSA for which an SLA has been developed to 133. These 133 States hold 97% of all nuclear material (by significant quantity) under Agency safeguards in States with a CSA and include 70 States with a CSA and an AP in force and a broader conclusion; 36 States with a CSA and an AP in force and without a broader conclusion; and 27 States with a CSA but no AP in force. The Agency developed an SLA for a State with a voluntary offer agreement and an AP in force. There are now two States with a voluntary offer agreement and an AP in force for which an SLA has been developed.

Cooperation with State and regional authorities

Due to the COVID-19 pandemic, in 2020 the Agency had to postpone many of its international, regional and national training courses aimed at assisting States in building capacity for implementing their safeguards obligations. To address the training needs of States, the Agency developed new safeguards e-learning courses, including a course entitled 'Basics of Safeguards', as well as several modules on nuclear material accounting. To further help States strengthen the effectiveness of their State or regional authority responsible for safeguards implementation (SRA) and of their respective State system of accounting for and control of nuclear material (SSAC), the Agency launched the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) to provide assistance and services tailored to the needs of the State concerned.

Safeguards equipment and tools

Despite the pandemic in 2020, the Agency ensured that instrumentation and monitoring equipment used by inspectors during inspections or installed in nuclear facilities around the world and services related to the provision thereof, continued to function as required.

At the end of the year, 1611 unattended safeguards data streams⁸ were collected remotely from 142 facilities in 31 States⁹ around the world. The Agency also had 1530 cameras operating or ready to use at 260 facilities in 37 States¹⁰. The transition to the next generation surveillance system, to replace earlier generation cameras that have reached the end of their life cycle, neared completion.

Safeguards analytical services

In 2020, the Agency collected 489 nuclear material samples, 460 environmental samples and 9 heavy water samples that were analysed by the Agency's laboratories in Seibersdorf and by the Network of Analytical Laboratories.

Developing the safeguards workforce

In 2020, the Agency conducted 39 distinct safeguards training courses, helping to provide safeguards inspectors, analysts and supporting staff with the necessary core and functional competencies. Owing to the COVID-19 pandemic, redevelopment and redesign of training courses enabled the delivery of some hybrid and on-line courses to safeguards staff.

Preparing for the future

As part of its strategic foresight and planning activities for nuclear safeguards aimed at taking advantage of technological advances, the Agency held a workshop in January to identify new opportunities, explore challenges, and deepen its understanding of emerging technologies. The workshop generated ideas related to the use of artificial intelligence, novel approaches to verifying spent nuclear fuel and visualization techniques for analysis.

MANAGEMENT OF TECHNICAL COOPERATION FOR DEVELOPMENT

The technical cooperation programme in 2020

The technical cooperation programme is the major vehicle through which the Agency transfers nuclear technology to Member States and builds their capacities in the peaceful use of nuclear science and technology. In 2020, the Agency provided support and assistance to Member States through almost 2000 national, regional and interregional technical cooperation projects. Nuclear knowledge development and management accounted for the highest proportion of actuals (disbursements) delivered through the programme, at 33.1%. This was followed by health and nutrition at 23.5%, and by food and agriculture at 18.8%. By the end of the year, financial implementation of the Technical Cooperation Fund stood at 80.4%, thanks to the joint efforts of Member States and the Secretariat, and despite the challenges posed by the COVID-19 pandemic in delivering certain capacity building activities.

Twelve Country Programme Frameworks (CPFs) — for Chad, Chile, Croatia, Georgia, Indonesia, the Lao People's Democratic Republic, Mauritania, Mauritius, Panama, the Republic of Moldova, Sudan and Togo — were signed in 2020. By the end of the year, the total number of valid CPFs was 113.

⁸ A data stream is a flow of information coming from a data collection module.

⁹ And Taiwan, China.

¹⁰ And Taiwan, China.

Continuation of technical cooperation programme delivery in challenging circumstances

At the outset of the COVID-19 pandemic, the Secretariat moved immediately to ensure business continuity and the safety of fellows and scientific visitors. In close consultation with Member States, 102 fellows and scientific visitors were repatriated, while around 120 chose to shelter in place.

Given the challenges and restrictions related to the pandemic, the Agency worked closely with counterparts to reprioritize activities and reschedule planned events. Fellowship placements for long term training continued throughout the year, in close consultation with Member States on feasibility and acceptance. Where appropriate, face to face events were replaced with remote training, meetings and expert services, and the quality of these events was assessed jointly by Member States and the Secretariat. Procurements planned for the 2020–2021 technical cooperation cycle were carefully reviewed, and some procurements planned for implementation in 2021 were initiated in 2020. In the Programme of Action for Cancer Therapy (PACT), a new hybrid modality was introduced to carry out imPACT (integrated missions of PACT) Review missions partially virtually

Overview of regional activities

Africa

The technical cooperation programme provided assistance to 45 Member States in Africa in 2020, of which 26 are classified as least developed countries. Approximately 70% of this assistance was delivered in food and agriculture, health and nutrition, radiation and nuclear safety, and human resource development. Throughout 2020, the Agency continued to work closely with the African Union Commission, and held several webinars with the African Commission on Nuclear Energy on topics related to the development of nuclear power in Africa and women in nuclear science in Africa.

Under a regional project for PhD sandwich programmes, 13 candidates from 13 Member States (including ten least developed countries) pursued Agency fellowship training to carry out their PhD research work at foreign universities. To enhance expertise in isotope hydrology, a regional water resources management project for the Sahel region also awarded 15 PhD sandwich fellowships. Most students were able to complete their first period at foreign universities despite the COVID-19 restrictions.

Most African Member States received assistance to strengthen their capabilities for safe and secure testing for COVID-19, supporting national efforts to control the pandemic. States Parties to the African Regional Co operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) conducted a mid-term review of the AFRA Regional Strategic Cooperative Framework for 2019–2023 in 2020, taking into consideration emerging priority areas.

Asia and the Pacific

In 2020, the technical cooperation programme in Asia and the Pacific provided technical assistance to 37 Member States and territories, including eight least developed countries and five small island developing States. Assistance focused on food and agriculture, human health and nutrition, radiation and nuclear safety infrastructure, and water and the environment.

In collaboration with the WHO Regional Office for the Western Pacific, a series of webinars was organized for COVID-19 testing laboratories. Arrangements were initiated to replicate the series through the WHO Regional Offices for South-East Asia and the Eastern Mediterranean in Arabic.

Two new publications highlighting technical cooperation achievements in the region were launched. *Journeys to Success: A collection of success stories from IAEA technical cooperation in Asia and the Pacific* showcases projects that have brought about positive change; while *Social and Economic Impact Assessment of Mutation Breeding in Crops of the RCA Programme in Asia and the Pacific*, a first-of-its-kind socioeconomic impact assessment conducted by the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) for Asia and the Pacific with support from the Agency, examines quantifiable achievements made through the crop mutation breeding programme under the RCA (Fig. 2). Five new resource centres of the Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) for secondary standards dosimetry have been identified, expanding the existing resource centres for human health.



FIG. 2. The Regional Co-operative Agreement (RCA) for Asia and the Pacific has conducted a socioeconomic assessment of achievements made under the RCA crop mutation breeding programme.

Europe

The technical cooperation programme provided assistance to 33 Member States in Europe and Central Asia, focusing predominantly on nuclear and radiation safety and human health. Efforts continued to strengthen radiation medicine within the region, particularly in Central Asia, where significant investments are planned in cancer management.

Support for Member States embarking or considering embarking on a nuclear power programme was strengthened, including in effective and safe long term operation, radioactive waste management and environmental remediation. The Agency enhanced capabilities for

the application of isotope tracer technology in groundwater and coastal management, and for the identification of sources of air pollution and aerosols. Environmental monitoring and impact assessment capabilities for public and environmental protection were supported by the generation of fit-for-purpose, comparable and optimized radiological monitoring data according to international standards.

Latin America and the Caribbean

In 2020, the Agency provided technical assistance to 31 Member States in the Latin America and the Caribbean region, focusing on human health, 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) continues to be the main mechanism to promote South–South cooperation in the region. ARCAL’s new Regional Strategic Profile, ‘Agenda ARCAL 2030’, was launched during the ARCAL meeting on the margins of the 64th regular session of the Agency’s General Conference. The document will guide the development and implementation of regional projects for the coming decade.

At the end of the year, Hurricanes Eta and Iota hit Central America, with devastating consequences for human lives and basic infrastructure. Through the technical cooperation programme, the Agency procured mobile X ray systems for Guatemala, Honduras and Nicaragua to restore medical diagnostic facilities and enable the provision of urgently needed services for affected populations in remote areas. Support for the implementation of non destructive testing to assess damage to civil infrastructure was included as part of the assistance package.

Programme of Action for Cancer Therapy (PACT)

Through PACT, the Agency focused on reviewing national capacities for cancer control, supporting national cancer control planning and mobilizing additional resources and partnerships.

ImPACT Review missions, conducted jointly by the Agency, WHO and the International Agency for Research on Cancer, assess a country’s cancer control capacities and needs, and identify priority interventions to effectively respond to its cancer burden. In 2020, ImPACT Reviews were conducted for the Central African Republic, Mali and Senegal, using a hybrid physical–virtual format. Reviews were also initiated in the Democratic Republic of the Congo, Iraq and Nepal. Virtual consultations were held with more than 10 Member States to take stock of their progress in the implementation of cancer control efforts and imPACT Review recommendations.

The Agency established collaboration with the Joint United Nations Programme on HIV/AIDS (UNAIDS) to scale up cervical cancer services; further expanded its partnership with the Islamic Development Bank (IsDB) to address women’s cancers; and signed a partnership with the Global Access to Cancer Care Foundation in November to train cancer care professionals in low and middle income countries. Collaboration with WHO and the International Agency for Research on Cancer was further strengthened, and the critical role of the Agency in global cancer control was highlighted at key global events, including the World Health Assembly and WHO Regional Committee meetings, as well as at the second PACT partner meeting.

Technical cooperation and the global development context

The work of the Agency’s technical cooperation programme was dominated by the response to the COVID-19 pandemic, programmatically and in terms of advocacy and outreach with external partners. Building on past achievements, the Agency continued to

position nuclear science and technology as an important driver in the implementation of the 2030 Agenda for Sustainable Development.

At the beginning of the year, a special session on nuclear technology applications for the Sustainable Development Goals (SDGs) was included in the programme of a workshop of the United Nations Inter-agency Task Team on Science, Technology and Innovation for the SDGs. This event provided an overview of how nuclear science and technology can support national efforts to achieve the SDGs and offered concrete examples of solutions where nuclear techniques can improve human and animal health, accelerate prosperity and protect the planet.

Following on from this, in June the Agency presented at a special preparatory session of the High-level Political Forum on Sustainable Development on science, technology and innovation in the response to the pandemic. The Agency signalled its commitment to SDG 17, on partnerships for the goals, and the Technology Facilitation Mechanism – one of the main commitments under the goal – by becoming a key partner in the new 2030 Connect platform, launched in July to share information about technology for achieving the SDGs with a broad community of decision makers, academia and representatives of the private sector and civil society. The Agency's emergency response technology was showcased among the solutions to address the COVID-19 pandemic.

Addressing the plastic pollution problem has been the focus of several technical cooperation projects. Countries in Latin America and the Caribbean have been at the forefront of enhancing their capabilities in marine environmental monitoring, with a focus on nano- and microplastics. In the Asia and the Pacific region, a financial feasibility model was developed through a regional project which can be applied for establishing a irradiator based pilot plant for plastic recycling.

Legislative assistance

Country specific bilateral legislative assistance was provided to 12 Member States through written comments and advice on drafting national nuclear legislation, and one regional workshop on harmonizing national nuclear law with international and European law was held. Four virtual activities on nuclear law were held as an on-line alternative to some training activities. In addition, a new series of interactive webinars on nuclear law was launched. Given the success of this series and in response to expressed interest from industry, law firms, non-governmental organizations, civil society and academia, a supplementary webinar – Nuclear Law in Practice: The IAEA Perspective – was held for the general public. The 2020 session of the annual interregional Nuclear Law Institute (NLI) training event was postponed until 2021.

Technical cooperation programme management

Quality assurance activities, reporting and monitoring

In 2020, the Agency made significant progress in developing processes and tools to increase programme quality in line with the principles of results based management, including an update of the TC Programme Quality Criteria, and the development of impact assessment approaches, on-line tutorials and training materials on risk management. Given global travel restrictions, training material on results based management and project design for the 2022–2023 technical cooperation cycle was made available in electronic format on the Programme Cycle Management Framework IT platform.

Increased efforts were made to develop appropriate methods and metrics to demonstrate the impact of the Agency programme and to improve evidence based reporting on the results delivered. In addition, the electronic technical cooperation reports platform was further developed to increase the current overall Project Progress Assessment Report

(PPAR) submission rate of 71%. The submission and finalization of electronic versions of PPARs (e-PPARs) and Project Achievement Reports as a basis for systematic collection of experiences and success stories was strongly encouraged.

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 €128.6 million in 2020, with approximately €84.5 million for the Technical Cooperation Fund (including assessed programme costs arrears, National Participation Costs and miscellaneous income), €44.1 million in extrabudgetary resources and about €0.1 million representing in-kind contributions. The rate of attainment for the Technical Cooperation Fund stood at 91.1% on payments and 92.6% on pledges at the end of 2020. Payment of National Participation Costs totalled € 3.7 million.

Actuals

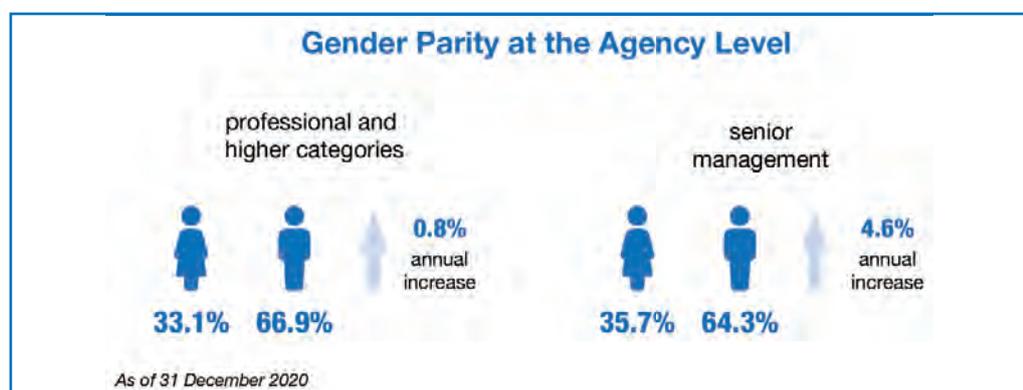
In 2020, approximately €92.1 million was disbursed to 146 countries or territories, of which 35 were least developed countries.

MANAGEMENT ISSUES

Gender parity

Further to the goal set by the Director General, the Agency is striving to achieve gender parity in all levels of the Professional and higher categories by 2025. In May, the Agency adopted within human resources policies new special measures that, among other things, focus on outreach activities to attract more women to apply for vacancies, and establish accountability and monitoring mechanisms for the implementation of these measures, including training for managers.

As a result, and in the context of the Agency policy of preserving the highest standards of efficiency, technical competence and integrity, 57.6% of all job offers in the Professional and higher categories were extended to and accepted by women. At the end of 2020, the proportion of women in the Professional and higher categories was 33.1% and that of women in senior management positions (D level or higher) was 35.7%. These figures represent an increase of 0.8% and 4.6%, respectively, compared with the adjusted figures¹¹ from December 2019.



¹¹ The figures for 2019 have been retroactively updated to align with the criteria established in the Special Measures for the Achievement of Gender Parity issued in 2020. They now include temporary assistance, extrabudgetary and non-competitive positions.

Towards More Women in the Nuclear Field: The IAEA Marie Skłodowska-Curie Fellowship Programme

In March, the Director General launched the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP), which aims to inspire and encourage women to pursue a career in nuclear science and technology, nuclear safety and security, or non-proliferation, by providing scholarships for master's programmes and an opportunity to pursue internships relating to their field of study, facilitated by the Agency.

The MSCFP has received broad support from Member States and non-governmental organizations, with a number of them making financial and in-kind contributions.

The first 100 recipients of scholarships under the MSCFP were selected in November. They come from 71 countries and study a wide range of nuclear related subjects.



Lesego Mvembeli
from South Africa, studying applied
radiation science and technology at
North West University in South Africa

"I am a girl from a village in Mafikeng, and I have always dreamed of becoming a scientist. I decided to study applied radiation science out of interest; I wanted to find out more about it. When I learned more about nuclear energy, I thought it was the most fascinating subject and I decided to pursue a master's degree in it. The IAEA MSCFP helps me do that, both to finance my studies and complete my research.

"In the future, I see myself as an influential scientist who will work all over the world and especially in countries that are yet to have technological developments, helping them have better and easier lives."

"As a physics graduate, I have a special interest in medical physics. This field is not only about nuclear radiation, but also about human well-being. I have seen very closely the hard stages that a person with cancer must go through and I want, with all my heart, to help improve the quality of life for those people and contribute to an early diagnosis to increase their chance of overcoming the disease.

"In 10 years, I see myself as a mature professional, helping my country in strengthening medical physics at the research level in hospitals, universities or research centres."



Duque Geraldine Ule
from Colombia, studying medical
physics at Universidade
de Sao Paulo in Brazil



Nanako Kawano from Japan,
studying nuclear engineering/nuclear
communication/fusion at Tokyo
Institute of Technology in Japan

"The Fukushima Daiichi accident in 2011 inspired me to choose nuclear engineering as my master's degree. I am extremely interested in technical but also social challenges faced by nuclear science and technology. My dream is to make our lives more comfortable with nuclear energy. I specialize in liquid divertors, since they are directly related to the safety and efficiency of operating the reactors continuously.

"I used to have a great fear of nuclear technology because of the Fukushima Daiichi accident. In the future I hope to work on improving nuclear power plants and to share the correct knowledge on nuclear science."

“The MSCFP scholarship will mitigate my stress in financially supporting my studies and will allow me to fully focus on my academic work and research. During my undergraduate physics studies, I came across the field of nuclear physics and I realized its importance in understanding the physical world. I was especially interested in the close links of experimental nuclear physics with applied nuclear science.

“In 10 years, I imagine myself as part of a diverse scientific community, conducting research in nuclear science and technology for a better world. I also hope to inspire young scientists and especially young women to work in nuclear research and contribute to the peaceful uses of nuclear science.”



Stamatina Alexandropoulou
from Greece, studying nuclear physics
at the University of York, UK



Lindsay Leslie Bryda from the United
States of America, studying nuclear
security at the Middlebury Institute of
International Studies, USA

“The IAEA MSCFP will remove much of the financial burden from my master’s programme in non-proliferation and terrorism. As the world will increasingly feel the effects of climate change, more countries will likely embrace nuclear power. However, we need to ensure that robust measures are undertaken to keep this material out of terrorists’ hands.

“I hope to play a role in building the international nuclear security regime and develop more stringent systems to track nuclear material in all phases.”

Managing for results

In 2020, special attention was given to collecting and analysing data that would be useful for applying a results based approach to performance assessment during the COVID-19 pandemic. Necessary tools and capacity building activities on accountability for results were also developed to support operationalization of the Accountability Framework.

Partnerships and resource mobilization

The Agency mobilized more resources and expanded partnerships beyond its traditional donors to meet increasing demand from Member States. The Agency seized opportunities for new partnerships and built on existing ones with a view to increasing funding for technical cooperation activities and for new flagship initiatives solely funded by extrabudgetary contributions, such as the ZODIAC initiative, the MSCFP and ReNuAL 2.

Coordination and cooperation with other international organizations, governments and non-traditional partners were expanded. The Agency forged partnerships and topical collaborations with the IEA, UNAIDS, the United Nations Environment Programme, the United Nations Industrial Development Organization and WHO, among others, in areas ranging from clean energy transition to COVID-19 assistance. The Agency also established partnerships with numerous national and international professional associations and organizations, particularly in the area of training and capacity building.

The Agency also made use of the United Nations Global Marketplace for involving the private sector in providing key equipment to its laboratories. These laboratories are of interest to private companies and organizations because they are extensively used to support Member States in building capacity for peaceful applications of nuclear science and technology to meet their sustainable development goals.

An event was held to mark the 10th anniversary of the Peaceful Uses Initiative (PUI). By the end of 2020, PUI had helped to provide more than €174 million in funding and supported over 300 projects benefitting more than 150 Member States. At the event, PUI donors and recipients acknowledged the significant role of the PUI, including the announcement made by the United States of America to continue supporting the PUI for the next five years. The Director General invited all Member States in a position to do so to continue to support the initiative.

Information security and technology

In addition to addressing the operational needs of the Agency in the context of the COVID-19 pandemic, special focus continued to be given to the ongoing cyberthreats as a part of the Agency's regular IT operations. In this context, the Agency implemented a new security incident and event management system to prevent, detect and respond to threats. The Agency continued to focus on educating staff on their role in protecting the Agency's most sensitive information through phishing and other information security awareness efforts. It also made concerted efforts to upgrade systems and decommission legacy systems to reduce vulnerabilities.

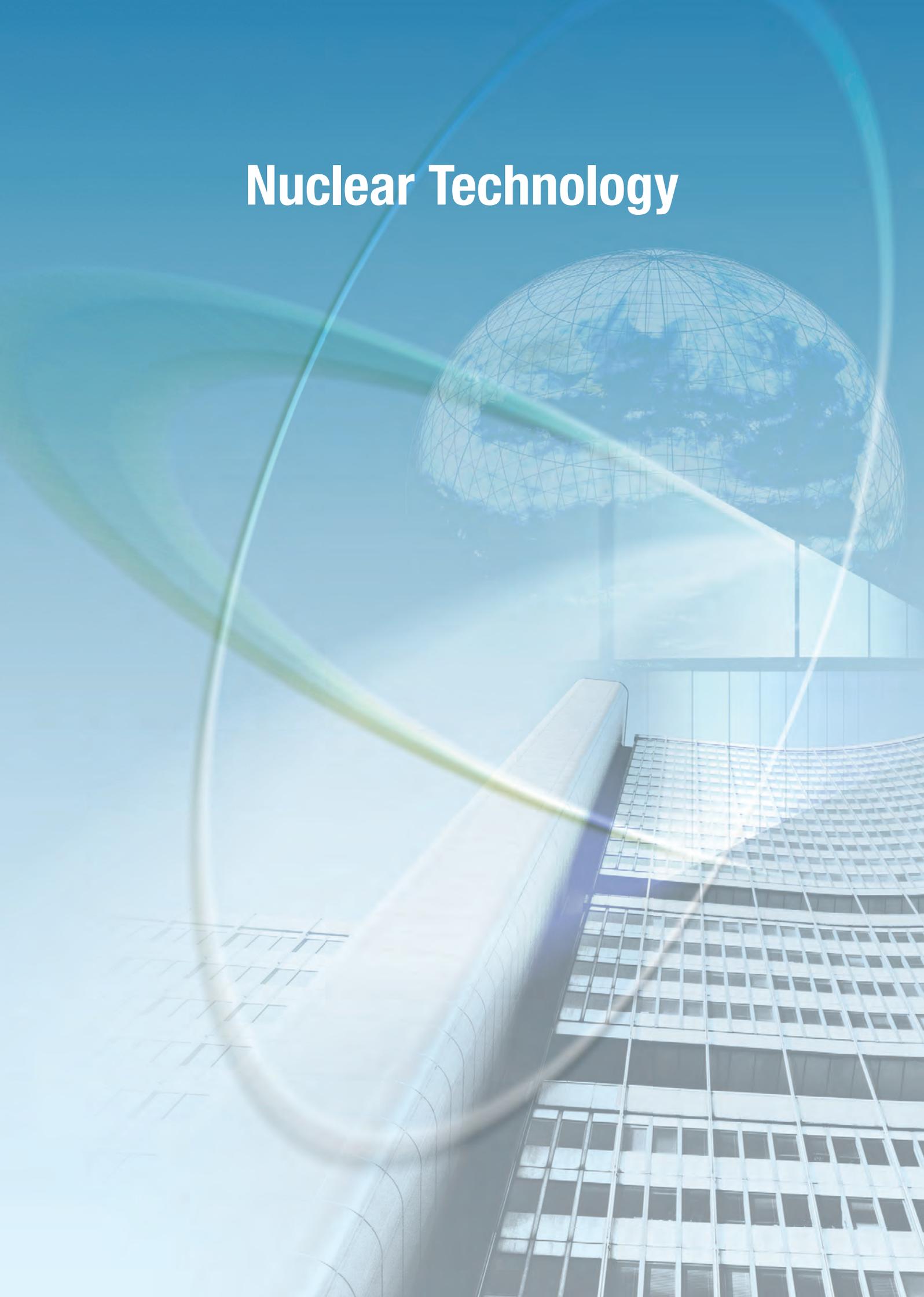
The Agency moved IT servers and equipment supporting the work done at Seibersdorf from a room that was not fit-for-purpose into a new first class data centre in the Insect Pest Control Laboratory in Seibersdorf. This move supports a higher level of reliability as well as more data capacity needed by the scientists.

Multilingualism

In 2020, the Agency began offering regionally targeted (or 'localized') news on its web site to better serve its audience in Arabic, Chinese, French, Russian and Spanish, which by the end of the year accounted for 14% of overall web traffic. This, along with search engine optimization measures, has led to a 50% growth in readership.

The Agency launched an account on the Chinese social media network Weibo, while maintaining regular publishing of content on its Facebook accounts in Arabic, French, Russian and Spanish. The number of followers on social media in languages other than English grew by 33% during the year.

Nuclear Technology



Nuclear Power, Fuel Cycle and Nuclear Science

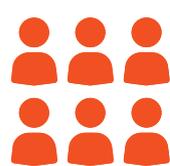


over **1100** **on-line training and education courses** hosted on **CLP4NET**

34 **coordinated research projects**



8 **nuclear back end webinars** with **1100 participants**



over **8000** participants

in about **50 webinars**



over **1.7 million** **INIS users**



2.5 million unique searches

4 million pageviews

50 years **INIS**



40



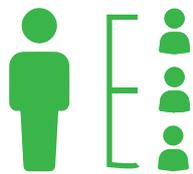
publications in 2020

Internet Reactor Laboratory

3 host institutions



6 guest institutions



19
professional networks



19
databases



6 IAEA-designated International Centres
based on Research Reactors

in **6** countries



over
260
meetings



8
active IAEA Collaborating Centres
within the Department of Energy

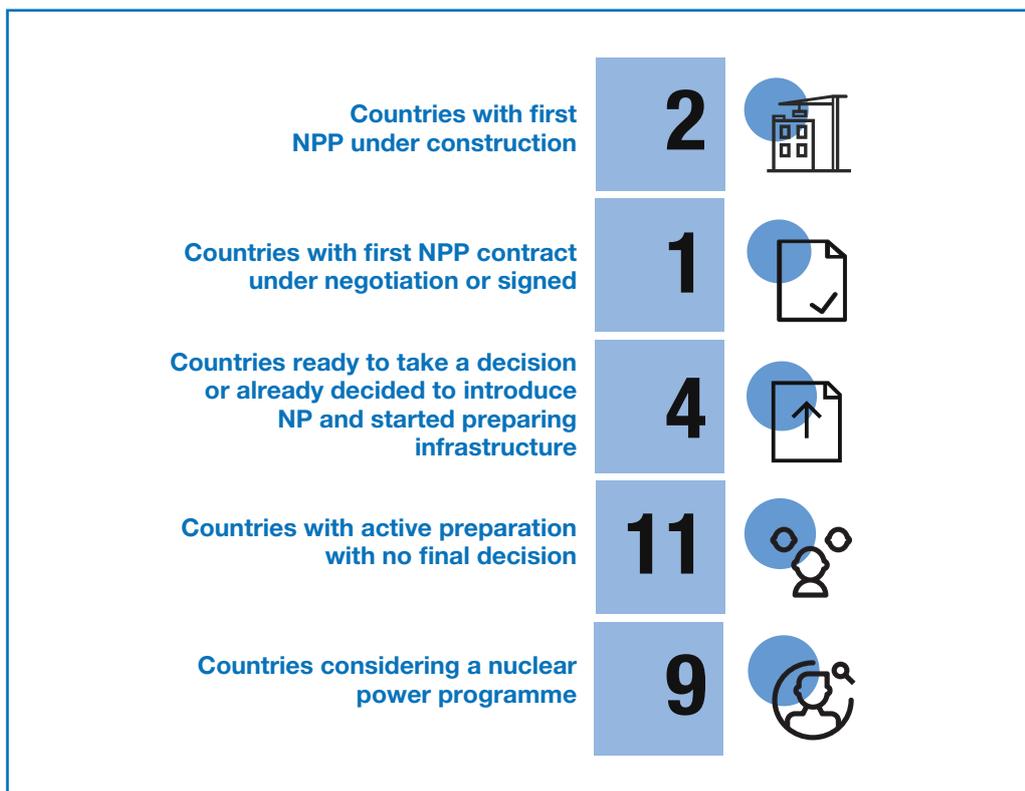
Nuclear Power

Objective

To support Member States with existing nuclear power plants to enhance operating performance and safe, secure, efficient and reliable long term operation, including development of human resource capability, leadership and management systems. To support 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 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. In 2020, 27 Member States were actively considering, planning or embarking on a nuclear power programme.



The Agency continued to support all embarking countries in developing the required nuclear power infrastructure. Three in-person Integrated Work Plan–Country Nuclear Infrastructure Profile meetings were conducted for Belarus, Jordan and Saudi Arabia at the beginning of 2020. Five Integrated Work Plan mid-term review meetings were held virtually with Egypt, Jordan, Kenya, Poland and Saudi Arabia. Meetings with other Member States were scheduled for early 2021.

The Agency conducted four interregional training courses within the Integrated Nuclear Infrastructure Training programme on the following topics: economic and financing aspects to be considered when developing a national position on nuclear power; nuclear power plant financing and risk allocation; nuclear power plant contract specifications and reactor technology assessment, to support Member States in preparing to invite bids or negotiate a contract for a nuclear power plant with a technology-neutral approach; and nuclear power infrastructure development, providing an overview of the Agency’s Milestones approach (Fig. 1).

The Agency updated *Initiating Nuclear Power Programmes: Responsibilities and Capabilities of Owners and Operators* (IAEA Nuclear Energy Series No. NG-T-3.1 (Rev. 1)), which provides information on the establishment and development of the owner/operator organization and its responsibilities and interfaces with other organizations involved throughout the programme phases.

The Technical Meeting on the Application of the IAEA Integrated Nuclear Infrastructure Review Evaluation Methodology for Small Modular Reactors served as a forum for the exchange of information on the deployment business models offered by technology suppliers and on expectations of Member States interested in small modular reactors in terms of nuclear power infrastructure support.



FIG. 1. A technical visit to the Zwentendorf nuclear power plant within the framework of the IAEA Training Course on Nuclear Power Infrastructure Development (file photograph).

Operating Nuclear Power Plants and Expanding Nuclear Power Programmes

The Agency launched the ‘Nuclear Supply Chain’ webinar series. The new series presents a global overview of the nuclear supply chain, highlighting future challenges and avenues and taking stock of the Agency’s work in this area. Over 230 participants from 30 Member States took part in two webinars on this topic.

The new publication *Challenges and Approaches for Selecting, Assessing and Qualifying Commercial Industrial Digital Instrumentation and Control Equipment for Use in Nuclear Power Plant Applications* (IAEA Nuclear Energy Series No. NR-T-3.31) focuses on the activities required to demonstrate the suitability of commercial off the shelf digital instrumentation and control equipment in nuclear safety applications.

The Agency signed Practical Arrangements with the National Nuclear Laboratory of the United Kingdom, strengthening cooperation in support of a sustainable future for nuclear power, including activities on existing and emerging nuclear reactor technologies, decommissioning and radioactive waste management.

The new publication *Reload Design and Core Management in Operating Nuclear Power Plants, Experiences and Lessons Learned* (IAEA-TECDOC-1898) outlines the main issues to be considered when developing and improving strategies for reload design and core management in nuclear power plants.

The publication *Quality Assurance and Quality Control in Nuclear Facilities and Activities* (IAEA-TECDOC-1910) presents the relevant concepts and good practices for their implementation within the processes of the management systems of nuclear facilities (Fig. 2). *Management of Nuclear Power Plant Projects* (IAEA Nuclear Energy Series No. NG-T-1.6) provides information on the implementation of a project management framework and the systems necessary to manage the activities within nuclear projects.



FIG. 2. Inside the power plant’s control room at Dukovany nuclear power plant (file photograph).

The publication *Implementation and Effectiveness of Actions Taken at Nuclear Power Plants following the Fukushima Daiichi Accident* (IAEA-TECDOC-1930) discusses good practices and effective solutions to issues related to the implementation of post-Fukushima actions in operating nuclear power plants.

The 2020 edition of *Country Nuclear Power Profiles* summarizes organizational and industrial aspects of nuclear power programmes across Member States and provides information about their respective legislative and regulatory frameworks and bilateral, multilateral and international agreements.

Human Resource Development and Management and Stakeholder Involvement Support

The Agency published *Assuring the Competence of Nuclear Power Plant Contractor Personnel* (IAEA-TECDOC-1232/Rev.1), which offers a framework for assuring the competence of contractors who provide essential services to nuclear power plants.

Participants in a training course on the assessment of behavioural competencies for safe, secure and effective performance in nuclear organizations learned about the relevant guidelines, methodologies and practices for enhancing employee related decision making processes and practices. The Agency also published *Assessing Behavioural Competencies of Employees in Nuclear Facilities* (IAEA-TECDOC-1917), outlining a variety of tools and approaches that can aid in behavioural assessment processes.

Four webinars in the series entitled ‘Stakeholder Involvement Related to Nuclear Power’ were attended by 550 participants from 63 Member States, with 672 additional viewings of the recordings.

Nuclear Reactor Technology Development

Advanced water cooled reactors

The webinar entitled ‘Nuclear–Renewable Integrated Energy Systems: Prospects and Issues’ introduced the concept of combining clean energy sources to provide reliable, sustainable electrical energy, with 400 participants from 54 countries. In another webinar, attended by 556 participants from 63 Member States, the Agency presented its suite of nuclear power plant simulators that enable efficient hands-on learning of the physics and engineering designs of various reactor types.

Small and medium sized or modular reactors, including high temperature reactors

The webinar entitled ‘Small Modular Reactors in Integrated Energy Systems’ provided insights on small and medium sized or modular reactor (SMR) technology for deploying SMRs in different near-future scenarios, such as for replacing fossil fuel plants and for smaller grids or remote communities. The webinar entitled ‘Molten Salt Reactors: A Game Changer in the Nuclear Industry’ offered an overview of the status of molten salt reactor technology and the feasibility of deploying molten salt reactors in the near future. The new edition of *Advances in Small Modular Reactor Technology Developments*, which was presented during a webinar of the same title, reported on progress made by SMR technology frontrunners and on the advances in global SMR designs and technologies.

The publication *Considerations for Environmental Impact Assessment for Small Modular Reactors* (IAEA-TECDOC-1915) provides current information on considerations about environmental impact assessments related to SMRs and is intended for both technology holders and licensing authorities.

At the third research coordination meeting of the coordinated research project entitled ‘Development of Approaches, Methodologies and Criteria for Determining the Technical

Basis for Emergency Planning Zone for Small Modular Reactor Deployment’, participants concluded that methodologies and criteria for defining emergency planning zone boundaries vary among Member States, as they depend on different allowable dose or risk values at the boundary or different values used to measure effectiveness.

The Agency, through its technical cooperation programme, launched a two year regional project to assist countries in the Europe and Central Asia region in energy planning and determining the role of SMRs in helping them meet their climate targets.

The new coordinated research project entitled ‘Economic Appraisal of Small Modular Reactor Projects: Methodologies and Applications’ focuses on techno-economic assessment approaches for SMRs, including microreactors.

The Agency circulated a draft advance publishing copy of *Technology Roadmap for Small Modular Reactor Deployment*, scheduled for publication in 2021. The Agency’s new three year project for the development of generic user requirements and criteria on small modular reactor technology was started.

The transfer to the Agency of the knowledge base and code package system for high temperature reactors of Germany’s Jülich Research Centre was completed as part of the initiative to preserve knowledge in the field of high temperature gas cooled reactors.

Fast reactors

The publication *Passive Shutdown Systems for Fast Neutron Reactors* (IAEA Nuclear Energy Series No. NR-T-1.16) details the findings of a study of and provides comprehensive information about passive shutdown systems for fast neutron reactors.

The fourth and final research coordination meeting of a coordinated research project entitled ‘Radioactive Release from the Prototype Fast Breeder Reactor under Severe Accident Conditions’ reviewed the work and scientific contributions of the participants, identified remaining gaps and wrapped up the project.

Non-electric Applications of Nuclear Power

The webinar entitled ‘Cogeneration: Nuclear Energy Beyond Electricity Production’ presented the status of ongoing activities and cogeneration projects worldwide.

At the Technical Meeting on Assessing Technologies that Enable Nuclear Power to Produce Hydrogen, participants gained a better understanding of several issues, including challenges related to the commercialization of technologies involved in nuclear hydrogen production; the need to identify societal and regulatory barriers for nuclear hydrogen production; and the importance of international cooperation for the demonstration of nuclear hydrogen production.

Enhancing Global Nuclear Energy Sustainability through Innovation

The Agency hosted the 14th Generation IV International Forum (GIF)–INPRO/IAEA Interface Meeting as a virtual event. The meeting defined the scope and details of cooperation, meetings and joint activities between the Agency and GIF, including for next generation nuclear power technologies, early deployment of innovative nuclear reactor systems and revision of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) Methodology for Sustainability Assessment of Nuclear Energy Systems with regard to proliferation resistance.

The Agency released a new e-learning course to help countries gain a broad understanding of a new INPRO service, Analysis Support for Enhanced Nuclear Energy Sustainability (ASENES). The new service makes it possible for countries to evaluate and compare different nuclear energy systems and nuclear energy scenarios and develop roadmaps to strategically plan how to move towards enhanced nuclear energy sustainability.

CASE STUDY

Nuclear Power Expansion Achieves Historic Milestones with Agency Support

The role of nuclear power in mitigating climate change while reliably providing electricity continues to grow with Agency help. After years of working closely with the Agency on developing the necessary infrastructure and enabling environment for a new nuclear power programme, Belarus and the United Arab Emirates (UAE) began producing electricity in 2020, becoming the first countries to introduce nuclear power in almost a decade. And the community of what are now 32 countries with operating nuclear power plants looks set to expand further, with the Agency supporting around 30 other newcomers interested in nuclear power, including Bangladesh and Turkey, which are building their first nuclear power plants.

Implementing a nuclear power programme is a complex endeavour. It requires the development of a legislative and regulatory framework and a radioactive waste management plan, as well as stakeholder involvement. The Agency supports Member States that choose to introduce nuclear power through a range of initiatives, including the Integrated Nuclear Infrastructure Review (INIR) and a host of other peer review services, as well as technical training activities, customized workshops and advisory services.

The Barakah nuclear power plant, consisting of four APR-1400 units, is the first nuclear power plant built in the UAE, a country with a population of nearly 10 million. The first unit came on-line on 19 August, and the plant will provide up to 25% of the country's electricity

The Barakah nuclear power plant in the United Arab Emirates, connected to the electricity grid in 2020, is the country's first nuclear power station. The Agency supported the development of the facility with training and review missions.



once all four units are connected to the grid. “What makes our programme successful is our Government’s robust commitment, a viable business model, high public acceptance and strong international cooperation and support, including with and from the IAEA,” said Ambassador Hamad Alkaabi, the UAE’s Permanent Representative to the IAEA. “The UAE’s commitment to the highest standards of operational transparency, safety, security and non-proliferation, as well as our cooperation with the IAEA have enabled our country to serve as a model for many countries embarking on nuclear power.”

Belarus, which connected the first of two VVER-1200 units to its electricity grid on 3 November, has benefitted from Agency advice, and invited and received numerous expert review missions during the planning and construction of its plant. “The recommendations and suggestions we received have been an important guidance for our continuous efforts aimed at ensuring the highest level of safety and reliability of the Belarusian nuclear power plant,” said Mikhail Mikhadyuk, Deputy Minister of Energy. Once fully operational, the Astravets nuclear power plant will provide around one third of the country’s electricity needs.

Construction of the first nuclear power plants in Bangladesh and Turkey is well under way, with commissioning of their first units planned for 2023. Both countries have received support from Agency activities and remain in close contact with Agency experts as they look to join the growing list of countries using low carbon nuclear power to meet their needs on energy security, climate change and sustainable development.



Nuclear Fuel Cycle and Waste Management

Objective

To support Member States in raising awareness and promoting sustainable (safe, secure, effective, innovative) fuel cycle and life cycle management for nuclear energy programmes and nuclear applications users, and contingency planning for a post-incident situation. To support Member States in strengthening their capabilities and human resources, or having access to the best available knowledge, technologies and services.

Uranium Resources and Processing

The new publication *Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits* (IAEA-TECDOC-1929) provides a summary of the research and selected papers from a completed coordinated research project (CRP) on this topic. The project led to a better understanding of the genesis of uranium and thorium mineralization and improved evaluation of uranium and thorium resources.

The Agency published *World Uranium Geology, Exploration, Resources and Production*, a comprehensive 'one stop' summary and reference volume for world uranium geology and resources, allowing insight into potential future uranium discoveries and supply. Another new publication, *Descriptive Uranium Deposit and Mineral System Models*, provides a set of systematic descriptive models for each uranium deposit type, subtype and class, enabling Member States to assess the potential of remaining or speculative uranium resources for long term supply in a consistent and reproducible manner.

The Agency published the proceedings of the International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2018), held in 2018.

Nuclear Power Reactor Fuel

The new publication *Analysis of Options and Experimental Examination of Fuels for Water Cooled Reactors with Increased Accident Tolerance (ACTOF)* (IAEA-TECDOC-1921) captures the results of a CRP of the same title, which developed and improved modelling of advanced fuel concepts and supported the collection of the experimental data needed for the introduction of such fuels into commercial reactors.

The publication *Modelling of Fuel Behaviour in Design Basis Accidents and Design Extension Conditions* (IAEA-TECDOC-1913) reports on Member States' capabilities in modelling, predicting and improving their understanding of the behaviour of nuclear fuel under accident conditions and presents the main results and outcomes of a CRP on this topic.

The Agency also published *Light Water Reactor Fuel Enrichment beyond the Five Per Cent Limit: Perspectives and Challenges* (IAEA-TECDOC-1918), which captures the conclusions of two technical meetings on the benefits of using high assay low enriched uranium fuel, with due consideration of safety issues that arise from its use.

The Agency designated the National Nuclear Laboratory of the United Kingdom as a Collaborating Centre to support Member States in implementing programmatic activities in the field of advanced fuel and advanced fuel cycles.

Management of Spent Fuel from Nuclear Power Reactors

The Agency published the proceedings of the 2019 International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Learning from the Past, Enabling the Future. A new CRP entitled 'Spent Fuel Characterization' is aimed at sharing information among Member States on issues related to the characterization of spent nuclear fuel in the various steps of its management.

Radioactive Waste Management

The Agency issued three new publications on radioactive waste management in 2020. *Costing Methods and Funding Schemes for Radioactive Waste Disposal Programmes* (IAEA Nuclear Energy Series No. NW-T-1.25) provides guidance on developing cost estimates for a disposal programme and establishing funding mechanisms. It is applicable to all waste categories and both near surface and geological disposal, and contains relevant examples and case studies from national programmes (Fig. 1). *Design Principles and Approaches for Radioactive Waste Repositories* (IAEA Nuclear Energy Series No. NW-T-1.27) describes the



FIG. 1. Director General Grossi visits the ONKALO deep disposal site in Olkiluoto, Finland, in November.

approaches and principles to be considered by responsible organizations involved in the planning and design of radioactive waste disposal facilities. *Underground Disposal Concepts for Small Inventories of Intermediate and High Level Radioactive Waste* (IAEA-TECDOC-1934) presents underground disposal concepts other than a mined deep geological repository that may provide a safe and economical solution for the relatively small inventories of radioactive waste arising in Member States without a major nuclear power programme.

Management of disused sealed radioactive sources

The Agency's International Catalogue of Sealed Radioactive Sources and Devices (ICSRS) was updated with a modernized user interface and search functionality. The ICSRS contains information on more than 5000 different types of radioactive sources, 4000 radioactive devices and over 1000 manufacturers or suppliers worldwide.

A new CRP entitled 'Developing a Framework for the Effective Implementation of a Borehole Disposal System' was launched to provide Member States with a package of essential materials for the development of borehole disposal and to make this disposal solution more readily implementable.

Decommissioning and Environmental Remediation

Decommissioning

At the Technical Meeting on Advancing Collaboration on Competence Building and Knowledge Management for Decommissioning, participants discussed good practices and lessons learned in capturing and sharing knowledge and experience relevant to the decommissioning of nuclear facilities, including relevant activities being undertaken at the national and international levels (Fig. 2).

The Agency issued the *IAEA Follow-up Review of Progress Made on Management of ALPS Treated Water and the Report of the Subcommittee on Handling of ALPS treated water at TEPCO's Fukushima Daiichi Nuclear Power Station*. The review concluded that the two options for controlled disposal outlined by a Japanese advisory subcommittee in February — vapour release and discharges to the sea — were both technically feasible.

The new publication *Decommissioning of Particle Accelerators* (IAEA Nuclear Energy Series No. NW-T-2.9) presents relevant experience and lessons learned. It is intended to contribute to decommissioning planning during the design stage of new facilities, minimizing the generation of radioactive waste without compromising structural characteristics and the effectiveness of the construction.

The Agency launched a new collaborative project on the decommissioning of sodium cooled fast reactors to collect information on recent status, good practices, issues and challenges associated with decommissioning such reactors.

Environmental remediation

More than 680 participants from 105 Member States gathered at the International Conference on the Management of Naturally Occurring Radioactive Material (NORM) in Industry, held as a virtual event. The conference endorsed the need for clear policies at the national level, based on well defined inventories and sound cost estimation methodologies, to enable the establishment of NORM waste management strategies.

Participants in the Technical Meeting on the Use of Controls for Radioactively Contaminated Land exchanged good practices and experiences in approaches to and performance of controls for radioactively contaminated land.



FIG. 2. Workers dismantling the turbine hall at Ignalina nuclear power plant measure scrap metal for traces of radiation (file photograph).

Capacity Building and Nuclear Knowledge for Sustainable Energy Development

Objective

To support Member States in strengthening their capacities to formulate robust energy strategies, plans and programmes, and to improve the understanding of nuclear technology's contribution to achieving the SDGs, with an emphasis on mitigating climate change. To support Member States in strengthening their capacities to establish, manage and use their nuclear knowledge base by disseminating knowledge management methodologies, guidance and tools; providing relevant training and service; and fostering international networking. To acquire, preserve and provide Member States with access to 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 issued the 40th edition of *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050* (Reference Data Series No. 1), which provides detailed global trends in nuclear power by region.

The Energy Scenarios Simulation Tool (ESST), the Model for Analysis of Energy Demand (MAED) and the Wien Automatic System Planning Package (WASP) tools were upgraded and improved. The updated tools were made available to Member States for assessing energy system development and for planning and expanding power generating systems over a long period, and to provide a systematic framework for analysis of trends in energy needs.

The Agency hosted 18 training events on energy planning, where energy and climate specialists in Africa, Asia, Europe and Latin America and the Caribbean received support in the evaluation of their energy needs using the MAED and ESST tools. Energy planning is essential in informing decision making for sustainable energy development and the clean energy transition.

Energy–Economy–Environment (3E) Analysis

The new report *Climate Change and Nuclear Power 2020* provides an overview of the current and future contributions of nuclear energy to climate change mitigation, in particular with respect to the objective of limiting global warming to 1.5°C above pre-industrial levels, in line with the 2015 Paris Agreement.

Another new Agency publication, *Integrated Assessment of Climate, Land, Energy and Water*, presents the findings of the coordinated research project on this topic, which addressed the development and application of an analytical framework for energy planning that enables the integrated assessment of climate, land (including food), energy and water.

The Agency published the proceedings of the International Conference on Climate Change and the Role of Nuclear Power, held in 2019.

A new coordinated research project entitled ‘Economic Appraisal of Small Modular Reactor Projects: Methodologies and Applications’ will focus on technoeconomic assessment approaches for small modular reactors, including microreactors, and address methodologies for planning and cost analysis, project structuring, financial valuation, business case demonstration and economic appraisal.

By signing a Memorandum of Understanding, the Agency and the International Energy Agency agreed to strengthen cooperation on activities involving nuclear power and the clean energy transition needed to achieve global climate goals by mid-century.

At the UN-Energy Principals meeting, Director General Grossi highlighted the role of nuclear energy in the clean energy transition and fight against climate change as well as the Agency’s potential contributions to the High-level Dialogue on Energy 2021, an initiative launched by the United Nations Secretary-General.

The Director General chaired a meeting of the Vienna Energy Club, which brings together 11 Vienna based international organizations in an informal platform for discussions on energy. The Director General also participated in a side event of the 11th Clean Energy Ministerial, entitled ‘Flexibility in Clean Energy Systems: The Enabling Roles of Nuclear Energy’. At these meetings, the Director General emphasized the need for all available sources of clean energy, including nuclear, in the decarbonization of the energy sector.

Nuclear Knowledge Management

A four year coordinated research project entitled ‘Sustainable Education in Nuclear Science and Technology’ was concluded. The project supported national authorities in the adoption of innovative information technology (IT) practices, developed new IT tools and enabled further collaboration on nuclear science and technology education in participating countries.

Three universities received International Nuclear Management Academy (INMA) endorsement certificates: North-West University and University of the Witwatersrand in South Africa, and the Budapest University of Technology and Economics in Hungary. The certificates indicate that the master’s programmes at these universities provide training in the set of competencies identified by the Agency as necessary for master’s graduates to become competent managers in the nuclear sector.

The Agency provided a forum at the Annual Meeting of the INMA for 25 universities from 15 Member States to exchange information on their existing or planned nuclear technology management master’s programmes.

The new publication *International Nuclear Management Academy Master’s Programmes in Nuclear Technology Management* (IAEA Nuclear Energy Series No. NG-T-6.12) provides information for master’s programmes that focus on the management and leadership required by the nuclear sector and describes the requirements for an INMA nuclear technology management programme (Fig. 1).

The publication *Application of Plant Information Models to Manage Design Knowledge through the Nuclear Power Plant Life Cycle* (IAEA-TECDOC-1919) provides an overview of plant information models, emphasizing the importance of their application in the management of design knowledge throughout the nuclear power plant life cycle.

A Technical Meeting to Develop Guidance on a Methodology for Defining Key Performance Indicators for Knowledge Management in Nuclear Organizations was conducted virtually. Participants exchanged lessons learned from establishing and using key performance indicators and provided comments on the related draft IAEA Technical Document.

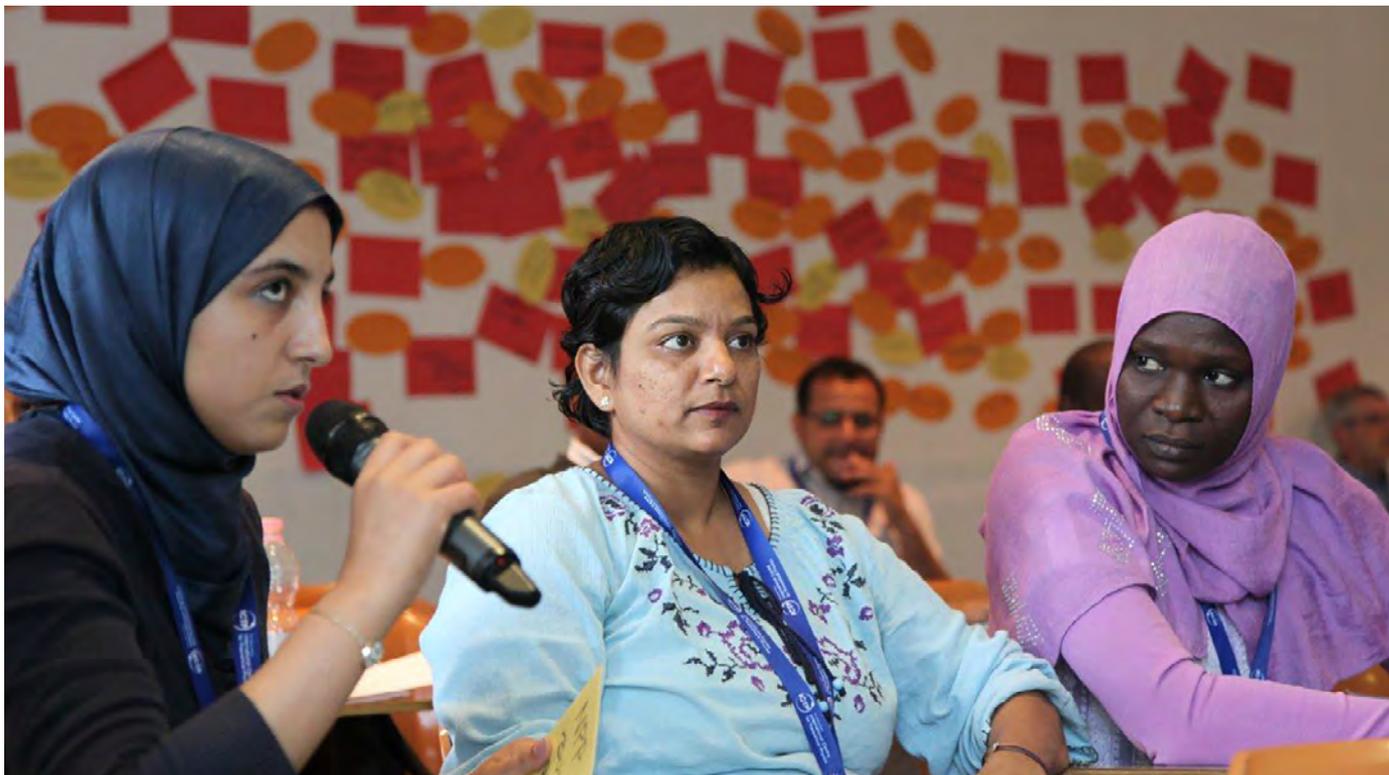


FIG. 1. Participants in a Nuclear Knowledge Management School in Trieste, Italy (file photograph).

At a Training Workshop on the Methodology for the IAEA Knowledge Management Maturity Assessment Tool, participants learned how to use the tool to help identify strengths and areas for development in an organization's overall knowledge management framework.

Collection and Dissemination of Nuclear Information

The International Nuclear Information System (INIS) began a series of webinars entitled 'Strengthening National Nuclear Information Centres'. Three such webinars were held in cooperation with INIS Liaison Officers in 11 African States, attracting a total of 91 participants.

Nuclear Science

Objective

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

Nuclear Data

The Agency's Isotope Browser app reached 120 000 single-user downloads in over 140 countries (Fig. 1). The Agency prepared the source code for an open source release, enabling users to contribute to its development.

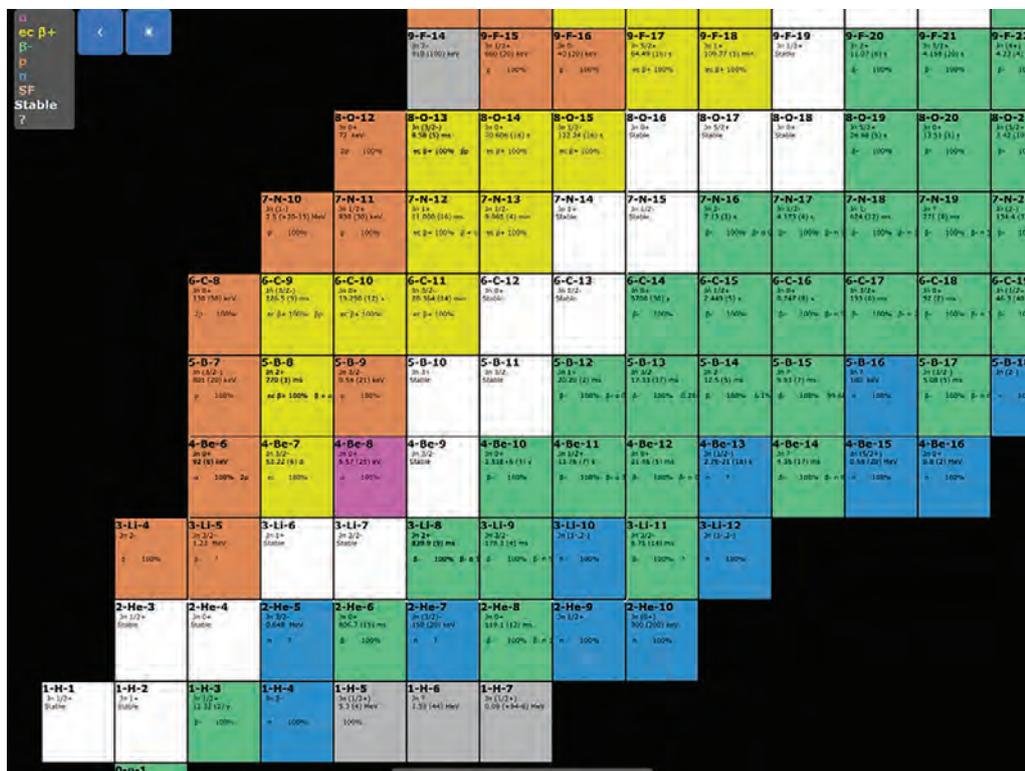


FIG. 1. Isotope Browser is an Agency app that can be installed on smartphones. It gives the most important properties for more than 4000 nuclides. A LiveChart of Nuclides, with zooming and tapping enabled, and a periodic table of elements are included to allow easy selection and navigation.

The Agency published a special issue of *Atomic and Plasma–Material Interaction Data for Fusion* with ten articles reviewing the outcome of a coordinated research project (CRP) entitled ‘Plasma–Wall Interaction with Irradiated Tungsten and Tungsten Alloys in Fusion Devices’.

A new CRP entitled ‘Hydrogen Permeation in Fusion-Relevant Materials’ was launched to provide experimental and theoretical data on hydrogen permeation in fusion reactor wall materials and components. The data obtained through this CRP will be used in benchmarking of modelling codes for hydrogen permeation in fusion relevant conditions.

Research Reactors

Utilization and applications of research reactors

The Agency launched a new neutron imaging e-learning course that addresses the broad applicability of neutron imaging, from the fundamental principles that govern its use to new and emerging experimental techniques.

In cooperation with the Australian Nuclear Science and Technology Organisation (ANSTO), the Agency held the first iteration of the Regional Training Course on Supporting Women for Nuclear Science Education and Communication: A Continuing Education Program for Female University Science Teachers and Science Communication Professionals. The course focused on the role of nuclear science in the global endeavour to achieve the Sustainable Development Goals.

New research reactor projects, infrastructure development and capacity building

The Agency signed a host agreement with the Czech Technical University in Prague and guest agreements with the Belarusian State University and the National Centre for Nuclear Science and Technology of Tunisia on the Internet Reactor Laboratory (IRL) project in Europe. The IRL project provides nuclear engineering students and young specialists with an opportunity to participate in live reactor experiments on-line.

The Agency supported the workshop in Belgium and France on capacity building in research reactors for Member States in Africa and the Asia and the Pacific region, organized jointly by the IAEA-designated International Centres based on Research Reactors (ICERRs) at the Belgian Nuclear Research Centre (SCK·CEN) and the French Alternative Energies and Atomic Energy Commission (CEA). Thirteen participants from ten Member States visited research reactors and ancillary laboratories in Belgium and France, discussed research reactor projects in their countries and identified collaboration opportunities and training needs that could be addressed using the ICERR facilities of the CEA and SCK·CEN.

Research reactor fuel cycle

At the Technical Meeting on Global Capabilities for the Production and Manufacture of Non-High Enriched Uranium Molybdenum-99 Targets, participants shared insights into the progress towards production of molybdenum-99 without high enriched uranium.

The Technical Meeting on Current Practices and Developments in Research Reactor Spent Fuel Dry Storage provided a forum for owners, operators, designers and regulators of research reactors and spent fuel management organizations to discuss and exchange information, experiences and practical knowledge related to dry storage of spent research reactor fuel.

The Agency published *Material Properties of Unirradiated Uranium–Molybdenum (U–Mo) Fuel for Research Reactors* (IAEA-TECDOC-1923), describing the material properties of all unirradiated uranium–molybdenum fuel constituents that are essential for evaluating the fuel’s performance and safety for research reactors.

Research reactor operation and maintenance

Two publications were issued on the operation and maintenance of research reactors. *Condition Monitoring and Incipient Failure Detection of Rotating Equipment in Research Reactors* (IAEA-TECDOC-1920) includes fundamentals on condition monitoring of rotating equipment, standards and guidelines, implementation strategies, current status and recent developments, as well as the experience gained from projects carried out in Member States. *Guidelines for the Operation and Maintenance Assessment for Research Reactors (OMARR)* (IAEA Services Series No. 44) provides information on the preparation, implementation and reporting of OMARR missions, including follow-up missions.

Accelerator Applications

The conclusions of the Technical Meeting on Advances in Boron Neutron Capture Therapy will contribute to the update of the publication *Current Status of Neutron Capture Therapy* (IAEA-TECDOC-1223), issued in 2001.

The new publication *Modern Neutron Detection* (IAEA-TECDOC-1935) covers the current state of the art of neutron detection and provides a medium term outlook on neutron detection technology development, including new materials, detector electronics and spectral unfolding techniques.

The Agency launched a new e-learning course entitled 'Introduction to Electrostatic Accelerators: From Basic Principles to Operation and Maintenance'. The course provides theoretical and practical information on the effective and safe operation and maintenance of accelerators, ion sources, other facility systems and components, and associated instrumentation, as well as on operational procedures.

Through partnership agreements with Elettra Sincrotrone Trieste in Italy and the Ruđer Bošković Institute in Croatia (Fig. 2), 74 days of beam time were allocated to ten research



FIG. 2. The 'He Ion Source and DiFU Dual-Beam Facility', installed with Agency support in Croatia's Ruđer Bošković Institute, ensures access to experiments in the field of materials research for fusion, among other research areas.

groups from six Member States using the joint IAEA–Elettra Sincrotrone Trieste X ray fluorescence experimental end station, while 26 days of beam time were allocated to nine research groups from five Member States using the Agency co-funded ion beam facility infrastructure. The areas of research ranged from fusion materials research, detector testing and life sciences to environmental studies, electrochemistry and cultural heritage.

Nuclear Instrumentation

The Agency project entitled ‘Rapid Environmental Mapping with UAV, Phase II: Operational Support’ supporting Fukushima Prefecture, Japan, was completed with the development of equipment and a methodology specifically for the use of instrumented unmanned aerial vehicles (UAVs). Under the project, the Agency developed and provided a complete UAV based instrumentation system and assisted in trial radiological mapping as well as in training relevant Prefecture staff in using the equipment (Fig. 3).

The Agency launched a proficiency test for nuclear and related analytical techniques laboratories involved in the analysis of various samples and materials. The invitation was accepted by 101 laboratories in 55 Member States, which were provided with the Agency samples for analysis.



FIG. 3. A new technology using drones, developed by the Agency for use by the authorities of Fukushima Prefecture, Japan, allows for radiological measurements. (Photograph courtesy of Fukushima Prefecture.)

Nuclear Fusion

The Agency published *Challenges for Coolants in Fast Neutron Spectrum Systems* (IAEA-TECDOC-1912), which evaluates the different coolant options considered for nuclear applications with a fast neutron spectrum, such as fusion, fission and accelerator based systems; presents the latest information in the field; and identifies further research needs.

The Agency's new CRP entitled 'Pathways to Energy from Inertial Fusion: Materials Research and Technology Development' is the fourth in a series of CRPs on this topic. The project will continue to facilitate international cooperation and information exchange on inertial fusion research and development, and will promote the use of inertial fusion technologies in fundamental science and industrial applications. The results of a previous CRP in the series are captured in a new publication entitled *Pathways to Energy from Inertial Fusion: Structural Materials for Inertial Fusion Facilities* (IAEA-TECDOC-1911).

The Agency launched its first CRP in the area of accelerator based techniques for materials research relevant to fusion technology, entitled 'Development and Application of Ion Beam Techniques for Materials Irradiation and Characterization relevant to Fusion Technology'. The project will assist the international ion beam analysis community in coordinating research efforts aimed at understanding aspects of ion induced radiation damage in materials relevant to fusion technology as well as their analysis and interpretation.

The First Joint IAEA-ITER Technical Meeting on Safety and Radiation Protection for Fusion Reactors focused on safety and radiation protection issues relevant to experimental fusion facilities, with a focus on ITER.

CASE STUDY

Providing Access to Nuclear Research to All Countries: The ICERR Programme

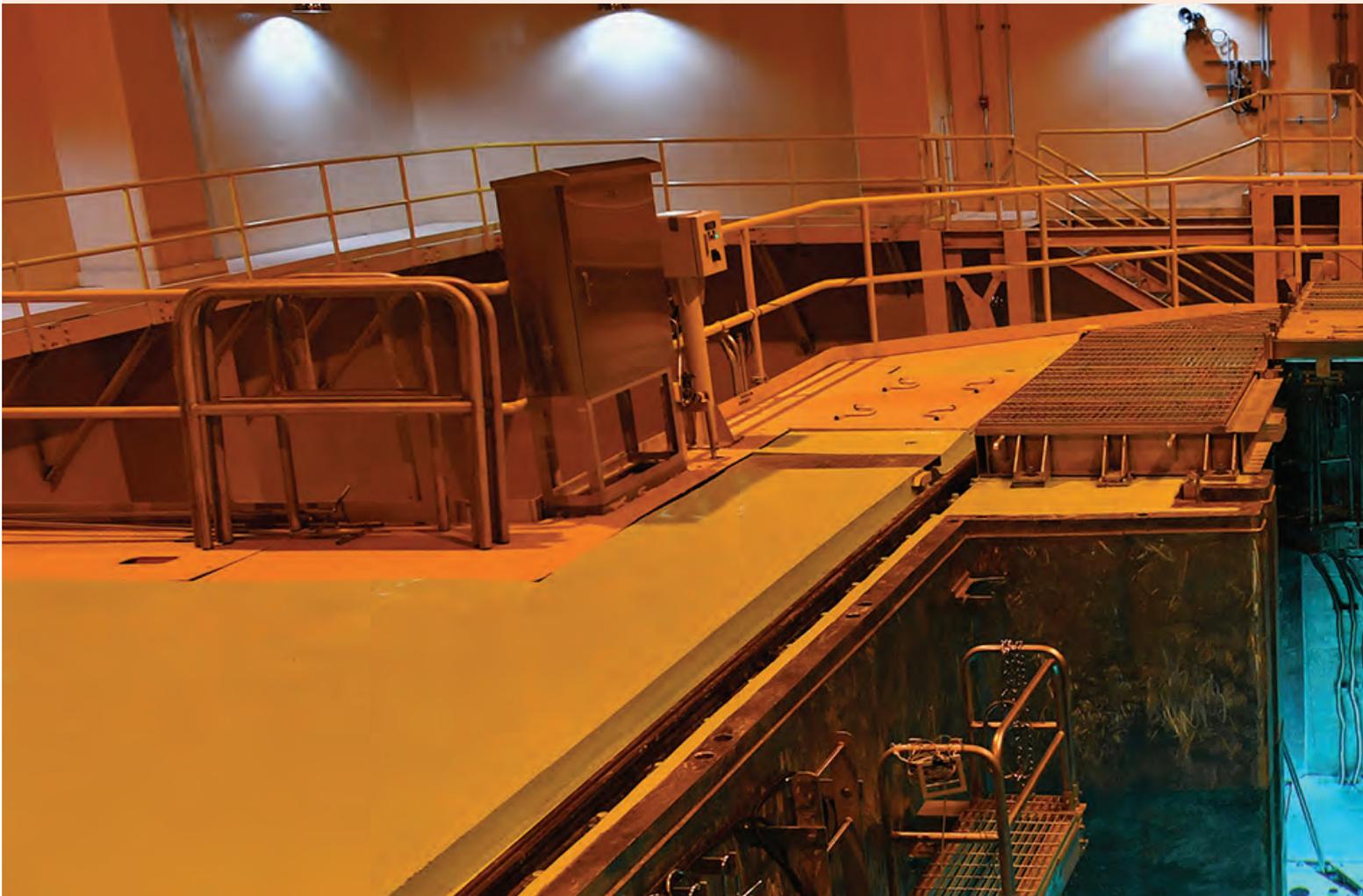
Research reactors have been centres of innovation for nuclear science and technology since the inception of nuclear energy. They are used in materials research and modification, and radioisotope production. The IAEA-designated International Centre based on Research Reactors (ICERR) initiative enables researchers from various countries to have hands on training and the opportunity to conduct experiments and work at state of the art facilities in other countries.

In the five years since the French Alternative Energies and Atomic Energy Commission (CEA) became the first ICERR in 2015, it has hosted around 60 events under the ICERR scheme, including scientific visits, workshops, hands-on training and joint research and development activities. In its work with ICERR affiliated scientific research institutes in Algeria, Indonesia, Jordan, Morocco, Slovenia, Tunisia and the United Arab Emirates, the CEA's experience demonstrates how the ICERR programme acts as a force multiplier in fostering advanced training as well as joint research and development around the world.

Under the ICERR programme, scientists from Algeria had a chance to collaborate with the CEA and to access CEA facilities, including its dosimetry laboratory in Cadarache. Algeria operates two research reactors for uses such as isotope production, radiography and training.

"Research reactor specialists from Algeria increased their knowledge in nuclear safety and methods for measuring neutron fluxes and spectra," said Abdelhamid Mellah, Head of the Algerian Atomic Energy Commission (COMENA). "They will use this knowledge to

An Agency initiative enables researchers from different countries to conduct experiments and work at research reactor facilities in other countries, including at the Jordan Research and Training Reactor.



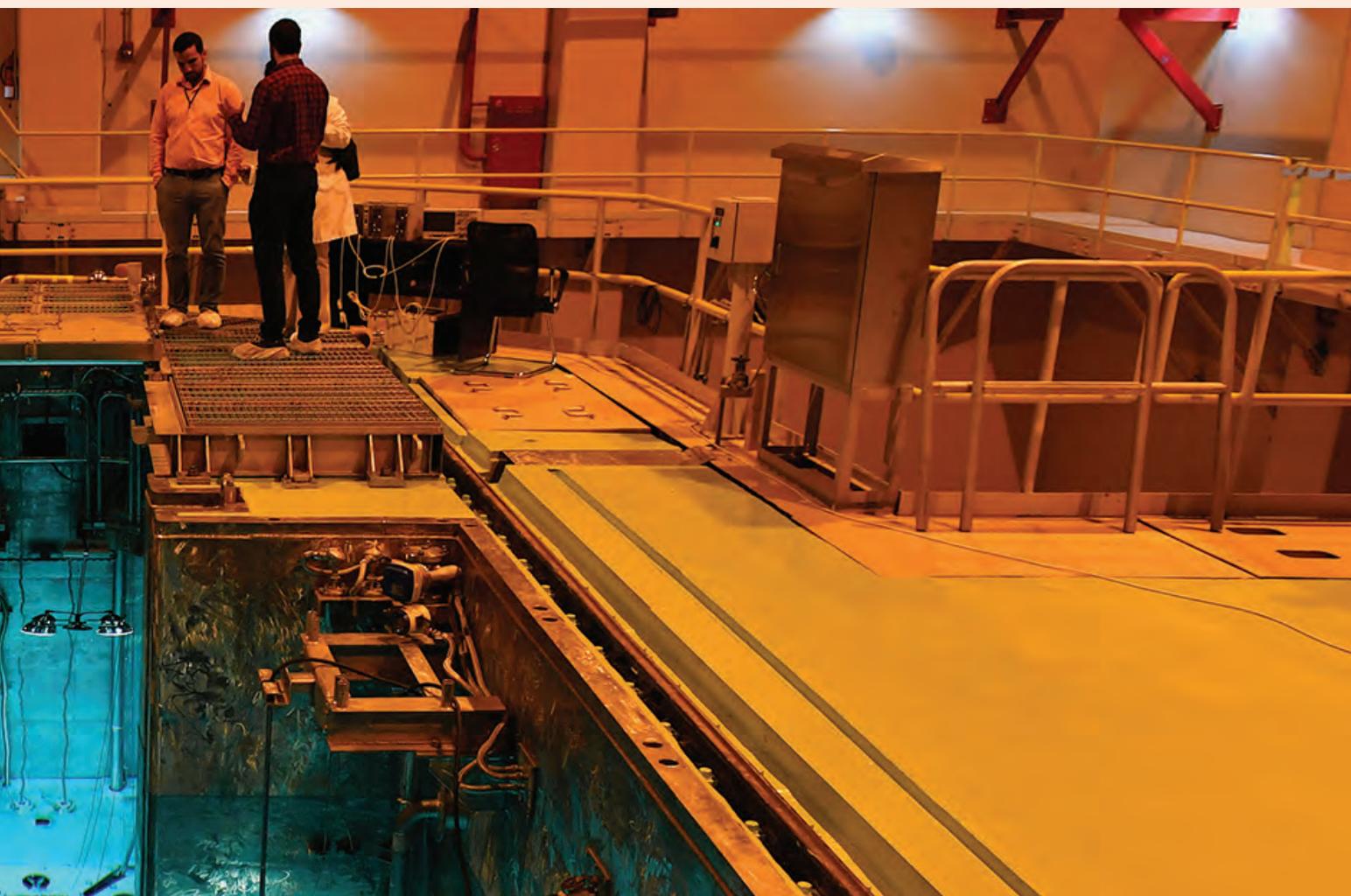
enhance our own reactor safety and utilization, including radioisotope production, material research and optimization of fuel consumption.”

Over the past five years, the CEA has organized 66 scientific visits for scientists from Algeria, Azerbaijan, Bangladesh, Indonesia, Israel, Jordan, Kenya, Malaysia, Myanmar, Philippines, Poland, Saudi Arabia, Turkey and Viet Nam. It has also hosted 13 interns from Argentina, Benin, Jordan, Mauritania, Tunisia and Viet Nam. In 2020, an ICERR tour was organized jointly by CEA and the Belgian Nuclear Research Centre (SCK·CEN) for 13 participants from ten countries.

“We consider human capacity building key in the peaceful use of nuclear energy and sciences,” said Gilles Bignan, International Affairs Manager at the Jules Horowitz Reactor. “In the last five years, CEA has been able to successfully collaborate with institutes from seven countries to create and enhance links between scientists and engineers and promote research.”

A Slovenian researcher recalls his experience using the scheme to advance his work on characterization of the gamma radiation field inside a nuclear reactor: “ICERR has enabled me to get in contact with the leaders in my research field, both on an experimental and modelling front. This helped me immensely with my PhD thesis about novel techniques in radiation measurements and simulations related to reactor materials, safe operation and decommissioning, and nuclear fusion research. It also was a great opportunity to be involved in research in laboratories abroad, as well as to sample and experience the culture.”

About 230 research reactors currently operate in 54 countries. ICERRs include research reactors and associated facilities in Belgium, France, the Republic of Korea, Romania, the Russian Federation and the United States of America.



Nuclear Techniques for Development and Environmental Protection

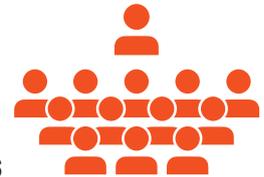
participation in

38 conferences and symposiums



51

technical, consultancy and research coordination meetings



81

coordinated research projects



88

webinars

20 

databases in total

2 new

databases in 2020

ORION • IMAGINE

Human Health Campus



93 865

users

including **20 076**
returning users

231



Agency web articles
and newsletters



publications



37

guidelines, manuals
and protocols



273

journal articles

37



active Collaborating Centres

within the Department of
Nuclear Sciences and Applications



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

Food and Agriculture

Objective

To support Member States in improving efficiency and sustainable intensification of agricultural production and the improvement of global food security through capacity building through technology transfer to Member States. To use nuclear technique to increase the resilience of livelihoods to threats and crises that impact agriculture, livestock and food security, including climate change, biothreats, food safety risks, and nuclear or radiological emergencies.

Support for International Standards on Application of Irradiation Technology

Phyosanitary irradiation has opened the way for fruit exports from Viet Nam to the United States of America worth US \$20 million a year. In 2020, Viet Nam entered into bilateral agreements allowing trade in irradiated fruits with Australia. This trade is only possible because gamma, electron beam and X ray irradiation provides a chemical free way to prevent hitch-hiking pests from establishing themselves in importing regions while ensuring that high quality fruits retain their appearance, texture and taste (Fig. 1).

In 2020, the Agency focused on revising the International Standard for Phyto-sanitary Measures No. 18, which provides guidance on the use of irradiation as a phyto-sanitary measure, to give technical requirements for the process and raise the maximum permitted X ray energy for food irradiation from 5 MeV to 7.5 MeV. The proposed change to 7.5 MeV X rays would approximately double the efficiency with which an electron beam is converted into X rays, with no implications for efficacy or food safety. This would allow more commodity throughput and reduce processing costs, making X rays more economical and sustainable.

Enhancing Agricultural Water Management

Soil moisture is an important variable in irrigation management, hydrological modelling, and flood and drought forecasting. In 2020, the Agency developed the cosmic ray neutron sensor (CRNS) nuclear technology by combining it with satellite images from Sentinel-1 synthetic aperture radar to produce high resolution soil moisture maps to support better agricultural water management.

This major step in the monitoring of soil moisture at a high spatial and temporal resolution by combining remote sensing and CRNS nuclear technology can improve the soil moisture data estimated by remote sensing. These research and development activities, carried out at the IAEA Seibersdorf laboratories, constitute an important element of the coordinated research project entitled 'Enhancing Agricultural Resilience and Water Security Using Cosmic-Ray Neutron Technology'.



FIG. 1. Boxes filled with lychee fruits being prepared for irradiation in Viet Nam. (Photograph courtesy of the Hanoi Irradiation Center.)

Impacts of Phosphorus Fertilizers on Agriculture and the Environment

Phosphorus fertilizers are known to increase crop productivity; however, they can cause serious environmental pollution when applied excessively. Monitoring phosphorus pollution in natural environments using stable isotopes has proven difficult because phosphorus has only one stable isotope (phosphorus-31), meaning tracing is not an option.

To assess phosphorus pollution in freshwater ecosystems and the environment, the Agency, through technical support from a coordinated research project and applied research and development at the IAEA Seibersdorf laboratories, modified a technique developed in 2018 involving the stable isotopes of oxygen in phosphate ($\delta^{18}\text{O}_p$). The method involves extracting phosphorus from the soil, purifying it and converting it to silver phosphate (Ag_3PO_4). Member States have begun using the modified technique in water quality investigations to identify the origin of phosphorus, allowing them to develop appropriate remediation strategies.

Development of a DNA Chip for Camel Improvement

Traditionally, livestock improvement has relied on the slow, expensive process of selecting and breeding superior animals. Today, advances in nuclear and related genomic technologies make it possible to estimate the breeding potential of an animal on the day of its birth, simply by looking at its deoxyribonucleic acid (DNA).

Genome maps pinpoint the location of specific features on an animal's chromosomes – so-called DNA markers – that are important for food production. These genome maps are produced using a nuclear technique known as radiation hybrid mapping. Once the full genome is mapped, tens of thousands of such markers are combined onto a DNA chip, which can then be used to determine an animal's breeding potential as soon as it is born. This can help to speed up the annual genetic gain and increase animal productivity in a short time.

In 2020, the Agency, in collaboration with the University of Veterinary Medicine Vienna (Austria), Cardiff University (United Kingdom) and International Camel Consortium for Genetic Improvement and Conservation (ICC-GIC) (Algeria, China, Egypt, Mongolia, Morocco, Pakistan, Sudan and the United Arab Emirates), developed a multispecies camelid DNA chip for selection and breeding of high producing camels and increased productivity (Fig. 2). The chip is now being validated and field tested through the ICC-GIC.



FIG. 2. Double humped domestic Bactrian camels in Mongolia. (Photograph courtesy of Mohammed Shamsuddin.)

Strengthening the Plant Mutation Breeding Network

In 2020, technical support from the Agency resulted in the development of 25 new and improved crop varieties in Member States. These results led to the formation of the pilot Plant Mutation Breeding Network in the Asia-Pacific region. Member States in the Latin America and Caribbean region also expressed their interest in forming a similar network. Induced genetic variation through irradiation and physical mutagenesis facilitates steep changes in crop performance that are beyond the feasible limits of conventional breeding, using a clean non-chemical approach. Coupled with precise phenotyping for selection using phenomic tools developed and tailored to each trait of interest, the technology offers great potential for improved crop performance and food security in the face of a rising population and changing climate.

Developments in the Sterile Insect Technique and Post-harvest Treatments

Five years ago, the Agency began developing the sterile insect technique (SIT) package for spotted wing drosophila. Since then, the radiation biology and dose responses for this package have been established and methods for rearing the fruit flies have been developed. In 2020, the Agency began pilot trials to assess the feasibility of integrating the SIT with other control methods to manage spotted wing drosophila populations in confined cropping systems.

Since early 2018, the Agency has been supporting Chile in developing the SIT package for the European grapevine moth (*Lobesia botrana*) (Fig. 3), integrated with other pest control measures. During 2020, in a pilot trial more than 750 000 sterile moths were released over a selected area of infestation.

Agency research on post-harvest treatments contributed to the development of international standards to facilitate fruit trade. Such standards support safer trade, which allows exporting countries easier market access, and reduce the risk of pest introduction to importing countries.



FIG. 3. Damage caused by *Lobesia botrana* larvae. (Photograph courtesy of Hernán Donoso, Agriculture and Livestock Service, Chile.)

Human Health

Objective

To support Member States in enhancing their capability to address needs relating to nutrition and the prevention, diagnosis and treatment of health problems through the development and application of nuclear and related techniques within a quality assurance framework.

New Agency Medical Imaging and Nuclear Medicine Global Resources Database (IMAGINE)

The Agency's new IMAGINE database is the first comprehensive global database on medical imaging and nuclear medicine. Developed in 2020, it contains detailed information from over 170 countries and territories on the availability of medical imaging and nuclear medicine equipment, and of human resources for both modalities (Fig. 1).

Using maps and graphs to display its findings, IMAGINE provides valuable information to support strategic planning in Member States and to better plan the Agency's assistance for and advice on addressing health needs through the appropriate use of radiology and nuclear medicine.

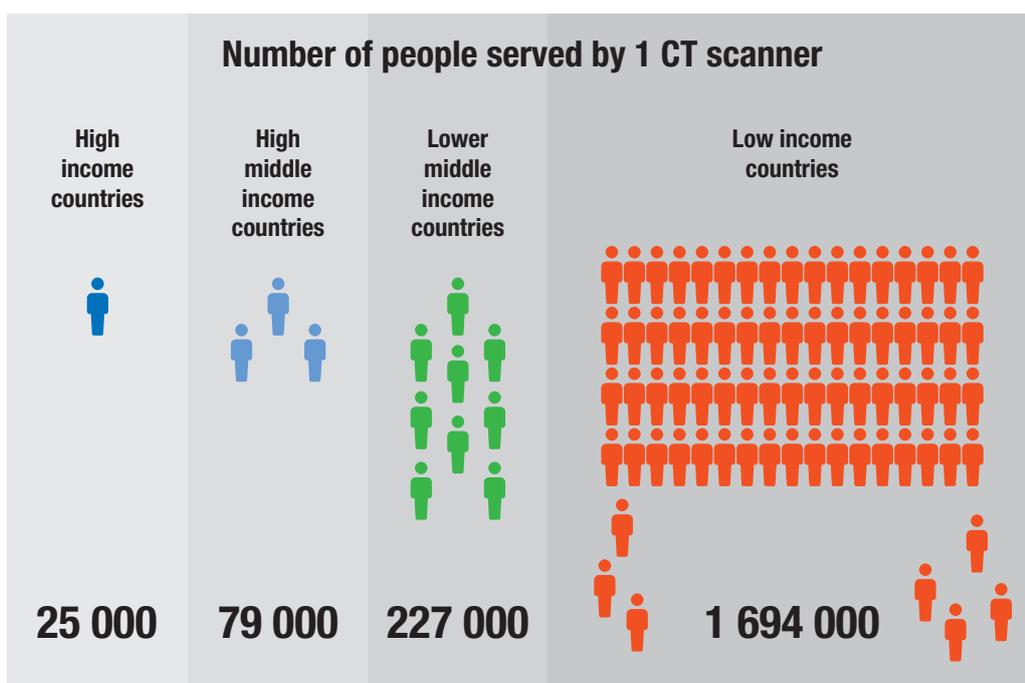


FIG. 1. The IMAGINE database contains detailed information on the availability of medical imaging equipment from over 170 countries and territories.

New Research Agenda on Diet Quality in the Context of Climate Change

In 2020, the Agency developed a framework to enable the adoption of a ‘seed to fork to human health’ food system value chain to better understand the links between climate change, food systems, diet quality and human health outcomes. Critical entry points for nuclear techniques are plant breeding; soil and water management; crop nutrient composition; and nutrient absorption and related nutritional and health outcomes such as body composition, breast milk output and individual nutrient status. Moreover, by taking advantage of an ongoing Agency coordinated research project, nuclear techniques may also help generate data on true protein digestion and improve understanding of the impact of climate change on gut function. A breath test under validation will enable the diagnosis of environmental enteric dysfunction, a disorder linked to growth failure in low and middle income countries.

United Nations Joint Global Programme on Cervical Cancer Prevention and Control

In addition to the work done in partnership with the World Health Organization, in 2020 the Agency continued to develop evidence to help Member States fight cervical cancer. An ongoing coordinated research project on the implementation of image guided brachytherapy gathered additional data on the global availability of brachytherapy. The data will be used to calculate the differences between the optimal and actual brachytherapy utilization rates to guide investment efforts in Member States. Qualitative methods to identify barriers to and facilitators of brachytherapy implementation in Member States are also being used. A planned costing exercise will analyse the budget impact of implementation and identify financing gaps. The results of this project will assist policy making in Member States.

Assistance to professionals in Member States included a virtual workshop on the use of brachytherapy in the treatment of cervical cancer, and work began on a comprehensive e-learning module on the topic. Guidelines for best practices were disseminated and access to e-contouring licenses was provided to participating professionals.

New High Dose Rate Brachytherapy Facility at the Dosimetry Laboratory

Following calibration of the Agency dosimetry standards and the development of appropriate safety and quality management system procedures, the first calibration certificates were issued to secondary standards dosimetry laboratories in Member States. This will enable the laboratories to calibrate the dosimeters used by hospitals to calibrate their own high dose rate brachytherapy units, thus ensuring optimized and safer treatments for patients. A new coordinated research project to develop an audit methodology for high dose rate gynaecological brachytherapy was initiated. This research, which seeks to advance the quality of care for cervical cancer patients who undergo brachytherapy treatment, is facilitated by the recently installed treatment planning system for the high dose rate brachytherapy unit at the Agency’s Dosimetry Laboratory in Seibersdorf.

SPECT/CT Atlas of Quality Control and Image Artefacts

SPECT–CT (single proton emission computed tomography–computed tomography) technologies provide a wealth of diagnostic information; however, it is important that practitioners understand the principles of image formation and be fully aware of the

potential pitfalls and image artefacts that can be encountered in clinical practice. A new Agency publication entitled *SPECT/CT Atlas of Quality Control and Image Artefacts* presents an overview of these potential pitfalls as well as the quality control procedures and standards required in SPECT-CT. Figure 2 provides an example of the 39 well illustrated case studies demonstrating image artefacts from different sources, ranging from hardware malfunctions to user- and patient-induced artefacts. In addition, descriptions are given of their causes and the techniques used to identify them and avoid their recurrence. The Atlas will support the continuous improvement in the quality of SPECT-CT imaging scans that is sought by professionals in the field and improve the likelihood of reaching the correct clinical diagnosis.

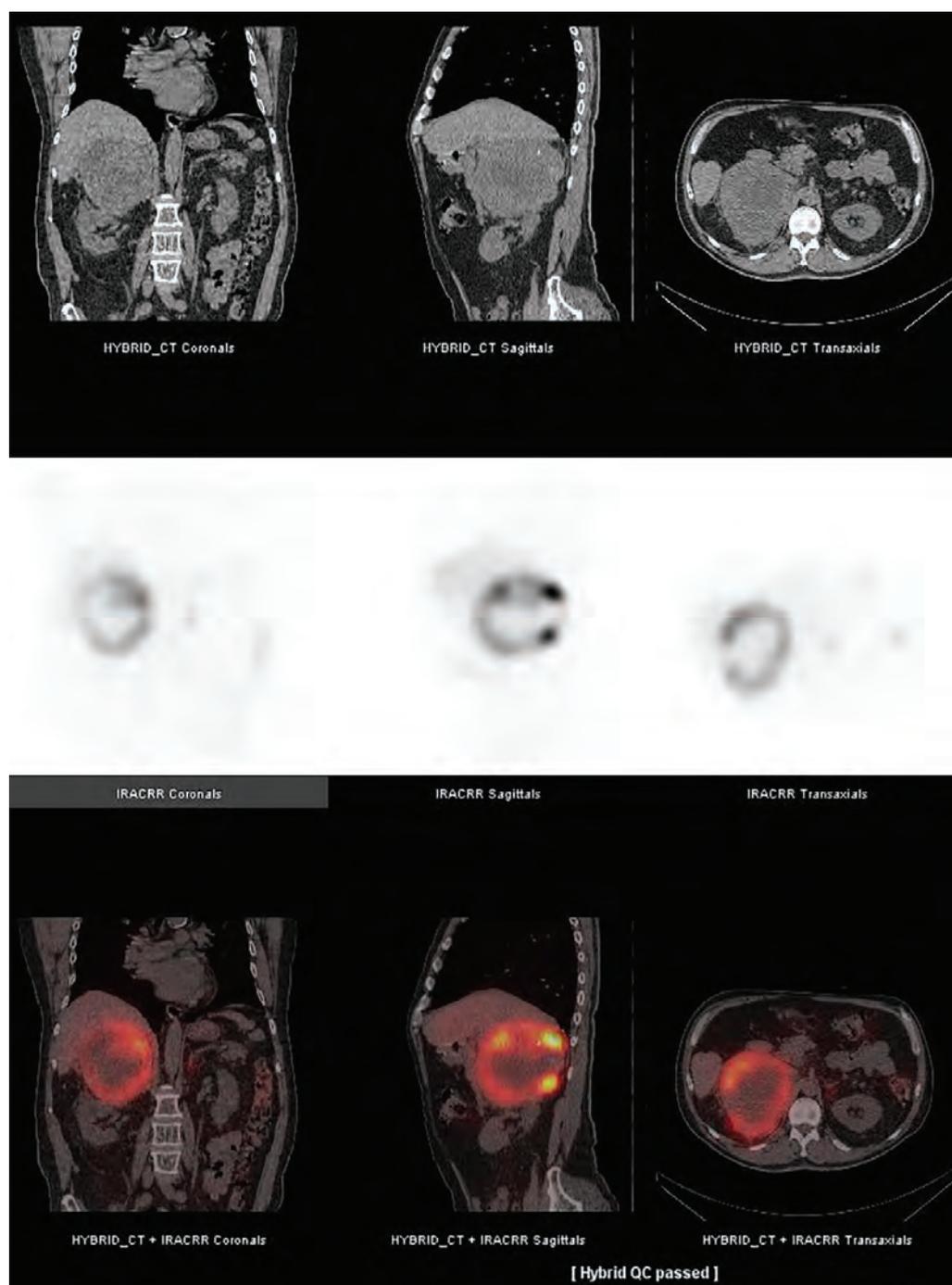


FIG. 2. CT images of a patient (top), SPECT images of the same patient (middle) and SPECT-CT images fused with each other (bottom), showing how the hybrid technologies complement each other to provide more information for a nuclear medicine physician to arrive at a diagnosis. (Photograph courtesy of J. Dickson, University College London, United Kingdom.)

CASE STUDY

Accurate Dosimetry for Quality Cancer Care

More than half of cancer patients require radiotherapy at some point during their treatment. The outcome of treatment can change significantly if the amount of radiation differs by even as little as 5% from the intended radiation dose. To provide patients with highly accurate doses of radiation, it is essential that measurement equipment be set up and operated properly — a task the Agency has been coordinating for decades.

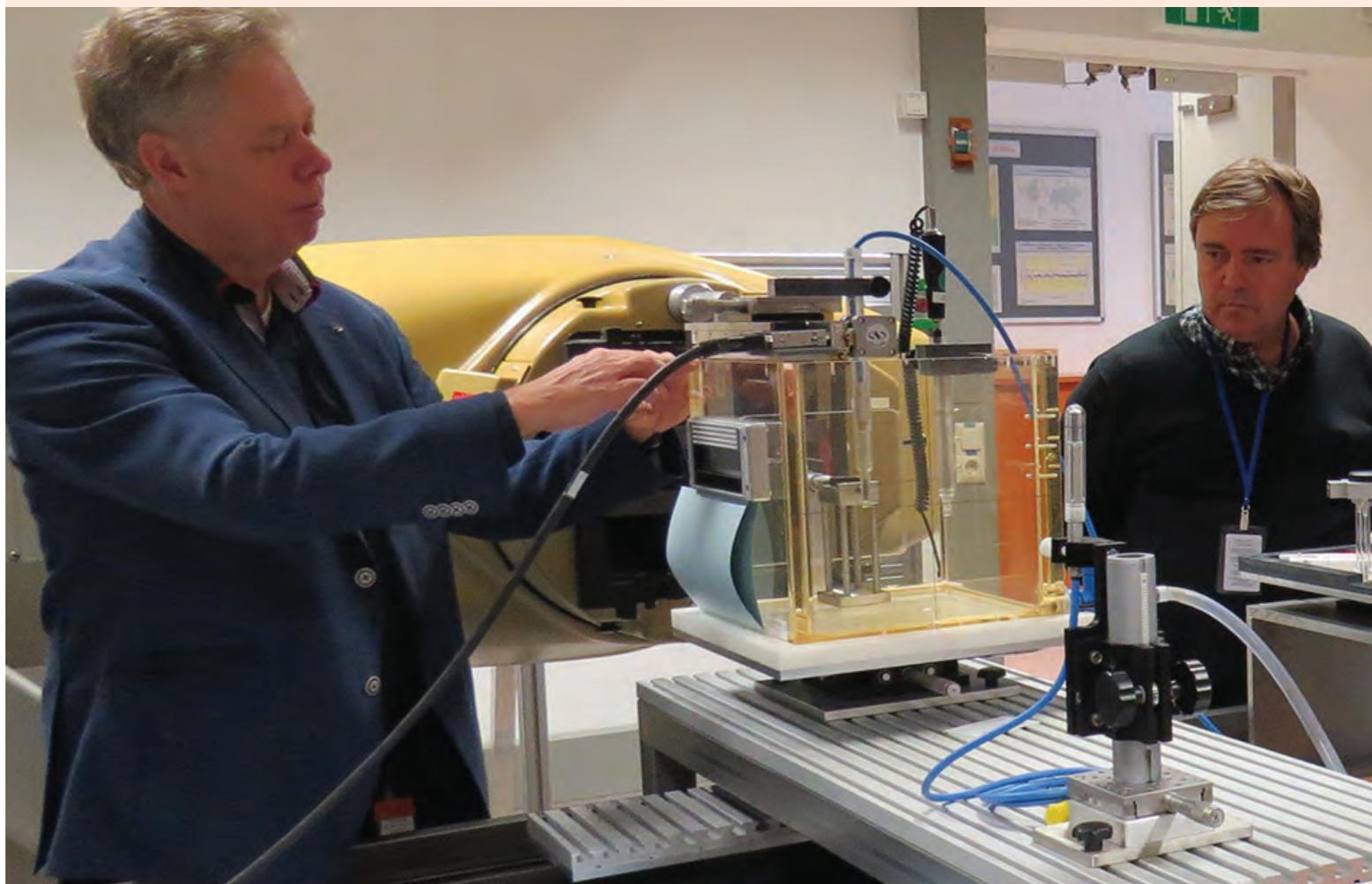
“Accurate dosimetry is a crucial part of radiation therapy,” said Sibusiso Jozela, Section Head of Dosimetry Standards at the National Metrology Institute of South Africa. “If the radiation dose is too low, the cancer might not be cured, and, on the other hand, if it is too high, it can have harmful side effects.”

Radiation doses are measured using specific equipment called dosimeters. To ensure accurate dosimetry, and ultimately accurate dosage, measuring equipment needs to be calibrated regularly. This is done by cross-checking the devices’ performance against national reference standards maintained by national calibration laboratories, such as secondary standards dosimetry laboratories (SSDLs).

A network of SSDLs was set up by the Agency and the World Health Organization (WHO) in 1976 to help countries improve accuracy in dosimetry. Currently this network comprises 87 SSDLs, located in 74 countries, that provide calibrations for dosimeters. The objective of the IAEA/WHO SSDL Network is to improve accuracy and consistency in radiation dosimetry and to promote cooperation among countries.

“Training and sharing skills are vital for this field, as technology is developing very quickly,” Jozela said, adding that “some developing countries are only now establishing

The Agency’s Dosimetry Laboratory, in Seibersdorf, Austria, provides practical training in how to perform accurate calibrations for dosimetry.



their own national calibration laboratories, and the SSDL Network provides the precise support required.”

The Agency’s Dosimetry Laboratory in Seibersdorf, Austria, acts as the central laboratory of the SSDL Network. The measurement standards of countries are calibrated, free of charge, at the laboratory, particularly for countries that do not have direct access to primary standards dosimetry laboratories, which are laboratories that establish quantities used for radiation dose measurements.

The Dosimetry Laboratory also provides postal dosimetry audit services to calibration laboratories and for more than 3400 medical linear accelerators (linacs) in hospitals in low and middle income countries. Linacs — machines that use electricity to create beams of high energy X rays or electrons — are most commonly used for treating cancer with radiotherapy. In 2020, 620 hospitals and 89 dosimetry laboratories participated in the postal dosimetry audit. The Agency is also helping to ensure that quality diagnostic imaging and radiation treatment are available to promote the health of women and girls. It supports an initiative to reduce deaths from cervical cancer by 30% by 2030 in participating countries. The Agency is working within the United Nations Joint Global Programme on Cervical Cancer Prevention and Control as one of seven United Nations agencies conducting joint inception missions, resulting in joint workplans that stretch all the way from prevention to diagnosis, treatment and palliative care. As a continuation of this collaboration, the Agency is cooperating with WHO within the framework of the recently launched WHO global strategy to accelerate the elimination of cervical cancer as a public health problem; one of the targets aims at ensuring that, by 2030, 90% of women identified with cervical disease receive treatment.



Water Resources

Objective

To support Member States in using isotope hydrology for assessment and management of their water resources, including characterization of climate change impacts on water availability.

Assessment of Mining Impacts on Water Resources Utilization and Pollution

Two technical cooperation projects completed in 2020 in Argentina and Chile illustrated the contribution of isotope hydrology tools to evaluating and minimizing the impact of mining activities in adjacent water bodies. In Argentina, a remediation project at the abandoned uranium mine of Los Gigantes used geochemical and isotope tools to characterize and map the groundwater's interconnection with local rivers. The study informed local authorities on the suitability of the remediation measures adopted at the mining complex. In Chile, a mining company used environmental isotopes to manage a tailings dam by tracking and mapping groundwater origin and movement. Stable isotopes of sulphur and nitrogen identified the sources of salinity affecting both surface water and groundwater. Isotope tools were also instrumental in proving a hydraulic barrier's correct performance, effectively controlling the release of heavy metals to the nearby freshwater aquifers.

The development and application of stable isotope and radioisotope based approaches to better manage water resources in mining operations is the focus of a new coordinated research project entitled 'Development and Application of Isotope Techniques for Efficient Water Resources Management in Mining Areas'. Isotope methods will provide data to evaluate mining impacts on water pollution, such as discharge of acid mine drainage into rivers (Fig. 1).

Application of Machine Learning Tools for Global Isotope Hydrology Networks

During 2020, machine learning models were developed to improve the spatial resolution of collated global stable isotope data. The new models fill in gaps in long term data records to produce improved isoscape maps of seasonal, monthly, annual and regional variations in oxygen and hydrogen isotopes in global precipitation.

Development of these improved models allowed analysis of 60 years of monthly oxygen isotope data in global precipitation that revealed distinctive long term (decadal) patterns and break points. The findings reveal that coordinated long term monitoring of stable isotopes in precipitation, coupled with basic meteorological parameters such as air temperature and precipitation amount, is essential to better understand the impact of larger scale hydroclimate variation on regional and local climate variability, and to help interpret long term hydroclimatic changes (Fig. 2).



FIG. 1. Pascua-Lama is an open pit mine producing gold, silver, copper and other minerals located in the Andes Mountains, in the southern reaches of the Atacama Desert, straddling the border between Chile and Argentina at an altitude of over 4500 metres. (Photograph courtesy of Albert Soler, University of Barcelona, Spain.)

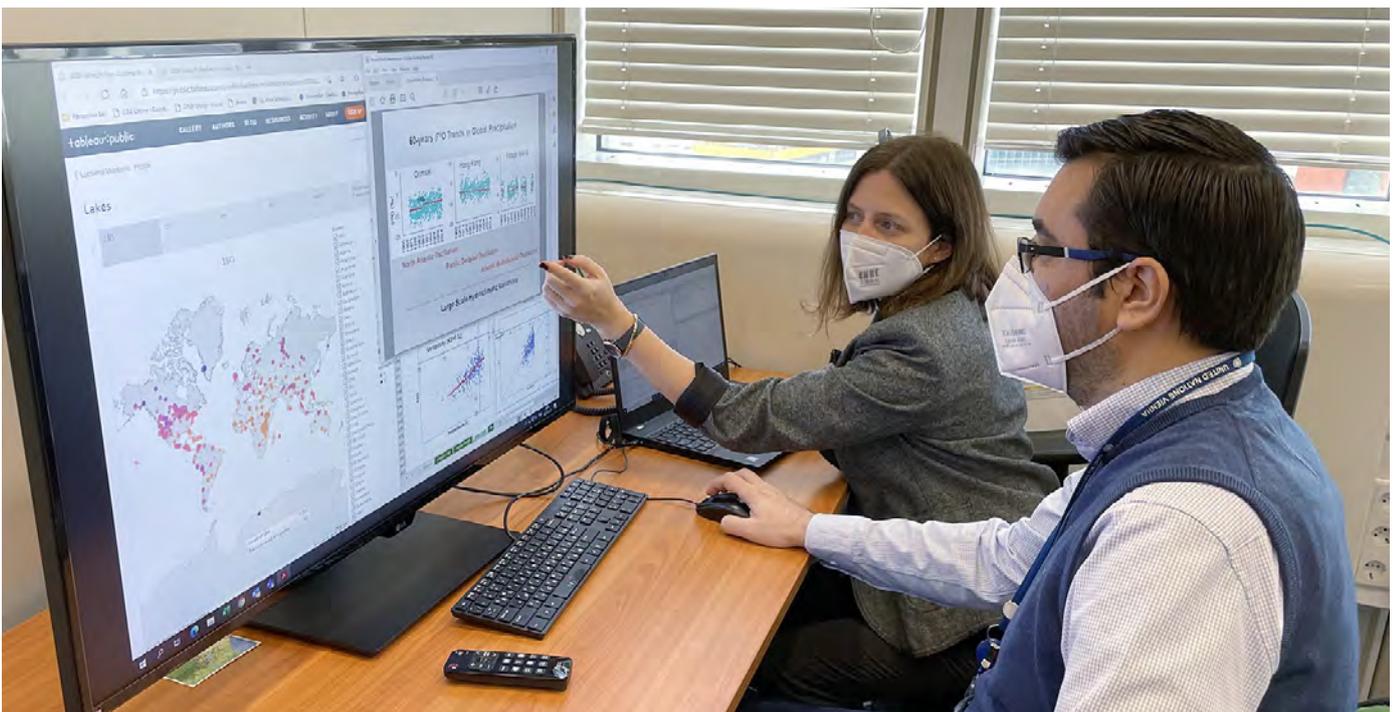


FIG. 2. Analysis of machine learning outputs for interpretation of global stable isotope precipitation records.

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 support Member States in enhancing their capability to develop strategies for sustainable management of terrestrial, marine and atmospheric environments and their natural resources in order to effectively and efficiently address their environment related development priorities.

Evidence of Positive Effects of Global Restriction of Contaminant Releases

Regulating pollution in coastal environments is vital to reducing ecosystem degradation; however, monitoring the effectiveness of such regulation remains a challenge. In 2020, the Agency coordinated a report of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) — an independent instrument of ten United Nations organizations — evaluating contaminant levels in coastal ecosystems. The report revealed that, while the diversity and volume of contaminants are increasing at an alarming rate, the strict regulation of toxic and persistent organic contaminants such as polychlorinated biphenyls (PCBs) and mercury is effective in decreasing contamination levels. This illustrates the success of national policies and regulations, international agreements such as the Stockholm Convention on Persistent Organic Pollutants and the Minamata Convention on Mercury, and heightened environmental awareness. For the report, GESAMP Working Group 39 on Global Trends in Pollution of Coastal Ecosystems: Retrospective Ecosystem Assessment examined data extending back to the pre-industrial period. The dating of sediment at such timescales can be achieved using radionuclides that are present in the environment, such as excess lead-210, caesium-137 and plutonium isotopes. In late 2020, a new GESAMP Working Group — initiated by the Agency and supported by the Intergovernmental Oceanographic Commission, the International Maritime Organization, the United Nations Environment Programme and the World Meteorological Organization — was established to focus on climate change and greenhouse gas related impacts on contaminants in the ocean.



FIG. 1. Oil spill reaching the coast of the Île aux Aigrettes, a small island off the coast of Mauritius of high ecological value. (Photograph courtesy of the Mauritian Wildlife Foundation.)

Mauritius Oil Spill Emergency Response to Assess Effects on Coral Reef Ecosystems and Seafood Safety

The Agency, at the request of the Government of Mauritius, initiated an emergency response to support activities to address potential environmental consequences of an oil spill along the country's coast (Fig. 1). After technical consultations, the Agency advised the Government of Mauritius to develop and implement a comprehensive long term programme to monitor the impacted coastal waters, sediment, biota and air. Each oil spill sample has a unique 'fingerprint' characterizing a mixture of chemicals that can potentially be toxic to marine life. These petroleum residues can be identified using specialized gas chromatography coupled with mass spectrometry. The procurement of dedicated laboratory equipment combined with specialized training of local staff will ensure that the national laboratories are capable of monitoring the oil spill in the marine environment and associated volatile organic compounds in the air, and of assessing their potential toxicological impacts. Many of these contaminants, like polycyclic aromatic hydrocarbons, usually persist in the environment and can potentially be toxic to marine life and humans.

CASE STUDY

Agency Research Records Dramatic Increase in Microplastic Pollution in the Eastern Tropical Pacific Ocean

Eight million tonnes of plastic waste end up in the oceans each year, damaging ecosystems and wildlife. To help anticipate and better address marine pollution scenarios in the eastern tropical Pacific Ocean, scientists from the Agency and Ecuador have completed a decade long study of plastic particle abundance in the country's coastal waters.

The eastern tropical Pacific is home to some of the world's most unique marine reserves, including Cocos Island in Costa Rica, the Galapagos Islands in Ecuador and the Coiba National Park in Panama — all on the World Heritage List. This research has revealed that microplastic pollution in the eastern tropical Pacific is set to continue to increase in the coming decades. Plastic particles below 5 mm in length — called microplastics — can be consumed by marine organisms and thus make their way to the food chain.

The amount of microplastics in the region is expected to increase by some 3.9 times by 2030 compared with 2008 levels. By 2050, it could almost double again, rising by 6.4 times compared with 2008 levels. And by 2100, the amount of plastics in the ocean is projected to be more than ten times higher than in 2008, unless action is taken to change this trajectory.

One of the crucial findings of this study, published in 2020, is that the change in the microplastic abundance over time increases systematically and identically at all the sampling sites. This implies that the source of microplastics pollution is not local, but rather regional and maybe even global in scale.

Plastic waste on the Galapagos coast. Sunlight, wind and waves break down large plastic debris into smaller and smaller pieces to become microplastics. In addition, some very tiny pieces used as exfoliants in the health and beauty industry and synthetic fibres from clothes are contributing to microplastic pollution.



“It is sad but not surprising to see such a steep increase of microplastic abundance in the region,” said Rafael Bermúdez Monsalve, Investigator Scientist from Ecuador. “This data is crucial for the understanding of future oceanic scenarios, and such studies can help policy makers on the implementation of adequate plastic life cycle management.”

Plastics are by design tough and resistant to degradation and have been found even in the deepest marine trenches. In our oceans, plastic fragments are broken down continuously by ultraviolet light, by the corrosive nature of seawater and by the constant physical erosion due to waves and shear. This continuous degradation supplies a stream of tiny micro and nano-sized plastic particles that can be consumed by marine organisms and introduced into the food chain.

Some of the particles have been found to travel as far as 10 000 kilometres in the Pacific Ocean, polluting pristine waters around the Galapagos Islands.

“As we continue to develop our research on marine plastics, nuclear and isotopic techniques are playing a particularly important role in advancing both the science and knowledge on the subtle, sustained impacts of microplastic pollution in the marine realm,” said Peter Swarzenski, Head of the Agency’s Radioecology Laboratory.

By using radiotracers such as carbon-14, Agency researchers study how pollutants ‘attach’ themselves to microplastics in the environment and whether they can dissociate or ‘detach’ from these plastics when ingested by marine animals. Agency researchers also use radiotracers to study the movement and fate of microplastics within the animals to understand how exactly these are taken up.



Radioisotope Production and Radiation Technology

Objective

To support Member States in strengthening their capability to produce radioisotopes and radiopharmaceuticals. To support Member States in applications of radiotracers and radiation technology for industrial use, environmental remediation, preservation of cultural heritage artefacts and production of novel high performance, environmentally friendly materials for diverse purposes.

Recycling of Polymer Waste Using Ionizing Radiation

Pollution caused by plastics and rubber has become an issue of global concern. Radiation technology can help alleviate this problem by converting plastic waste into a variety of useful materials — such as fillers and binders for concrete and asphalt, and fuel and additives — presenting powerful opportunities for increased environmental sustainability and material innovations (Fig. 1). The Agency launched a new five year coordinated research project entitled ‘Recycling of Polymer Waste for Structural and Non-Structural Materials by Using Ionizing Radiation’ aimed at optimizing the recycling of plastic waste using radiation technologies by supporting applied research and development on the topic and generating feasibility studies for developing pilot recycling plants.

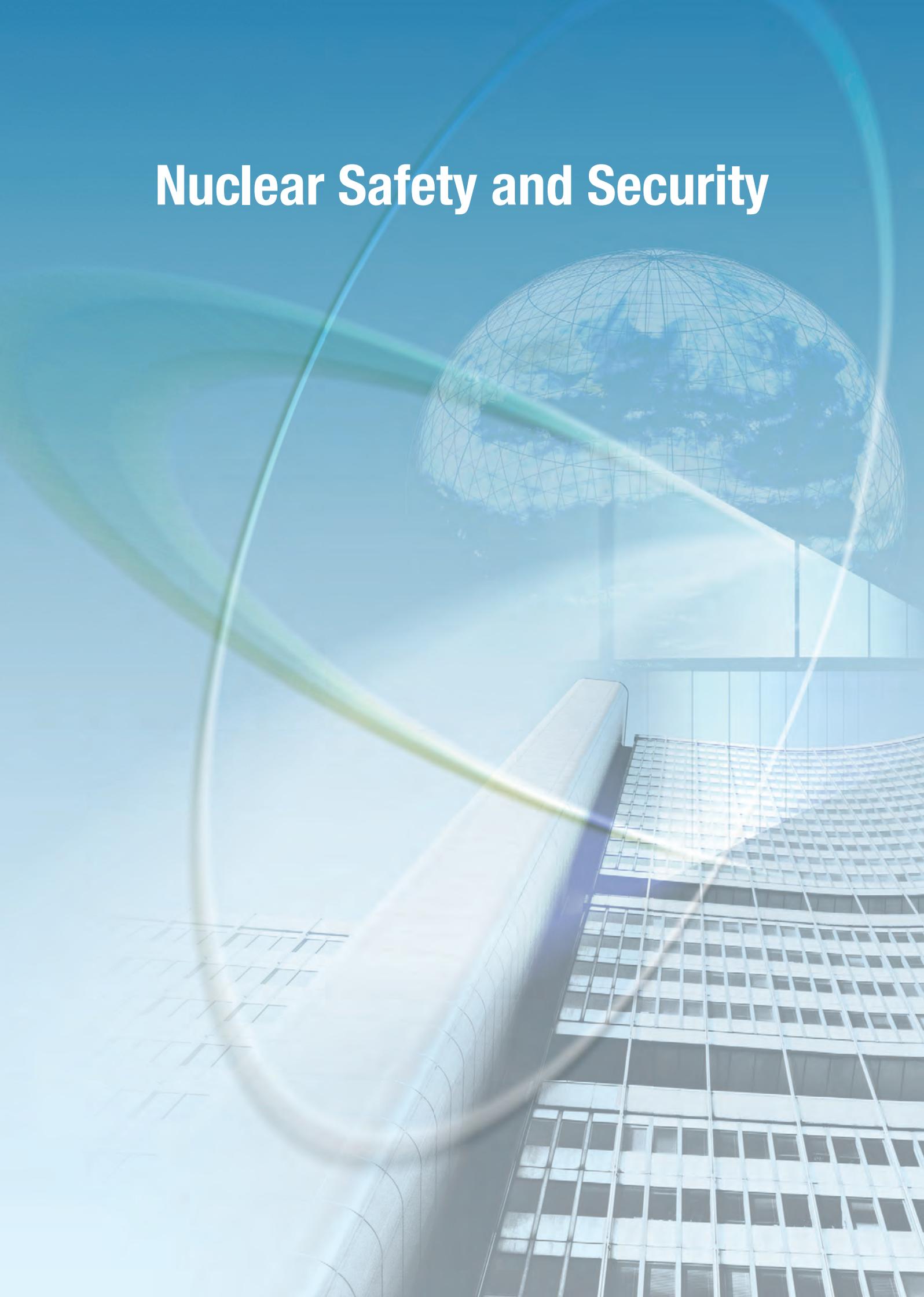
Production of Cyclotron Based Gallium-68 Radioisotope and Related Radiopharmaceuticals

Gallium-68 (^{68}Ga) is a positron emitter with a half-life of 68 minutes that has become one of the most important medical radioisotopes for theranostic applications in nuclear medicine. The use of ^{68}Ga radiopharmaceuticals for early detection of and follow-up for prostate, gastrointestinal and breast cancers has become routine nuclear medicine practice worldwide. A new coordinated research project entitled ‘Production of Cyclotron-Based Gallium-68 Radioisotope and Related Radiopharmaceuticals’ was launched in 2020 to focus on the production of ^{68}Ga without the use of a germanium-68 (^{68}Ge)– ^{68}Ga generator, allowing Member States to produce it locally. The widespread availability of cyclotron technology, as reflected in the Agency’s Database of Cyclotrons for Radionuclide Production, provides a great opportunity for such local production of crucial ^{68}Ga radiopharmaceuticals. Moreover, recent approvals of cyclotron produced ^{68}Ga -DOTATOC by the Food and Drug Administration in the United States of America and of accelerator produced ^{68}Ga chloride solution for radiolabelling by the European Medicines Agency attest to the quality of products prepared through this route, bringing immediate benefits to patients in Member States. The new project aims at formulating guidelines and promoting networks to enable cyclotron based production of ^{68}Ga radiopharmaceuticals for human use.



FIG. 1. Radiation technology can be used to convert plastic waste into useful materials, helping to address the global problem of plastic pollution.

Nuclear Safety and Security



Nuclear Safety and Security



205
safety related
capacity building events



42
security related
training events



15
peer review and
advisory service
missions

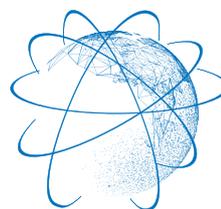


**Physical Protection
Upgrades**
completed at

3 nuclear
facilities 

 **13** hospitals

2 international
conferences 



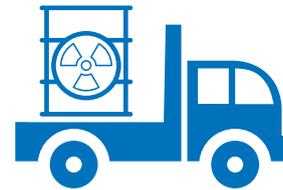
ICONS 2020

included a record
53 ministers

**International Conference
on Radiation Safety**

virtual

125 incidents reported
to the Incident and Trafficking Database



IAEA publications
issued in 2020

3 IAEA Nuclear
Security Series
10 IAEA Safety
Standards Series

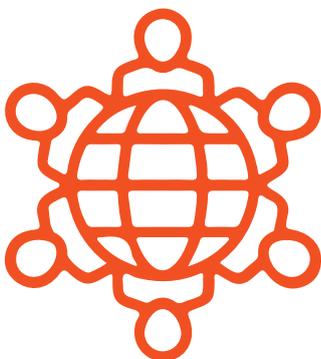


Convention on Nuclear Safety

1 new Party **89** total

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

1 new Party **83** total



Convention on the Physical Protection of Nuclear Material

3 new Parties **162** total

Amendment to the Convention on the Physical Protection of Nuclear Material

3 new Parties **125** total

Incident and Emergency Preparedness and Response

Objective

To maintain and further enhance efficient Agency, national and international [emergency preparedness and response] capabilities and arrangements for effective response to nuclear or radiological incidents and emergencies independent of the triggering event(s). 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 response to nuclear or radiological incidents and emergencies, independent of the triggering events.

Strengthening Emergency Preparedness Arrangements

The Agency, responding to the growing interest in emergency preparedness and response (EPR) guidance for new reactors, organized a virtual Technical Meeting on Next Generation Reactors and Emergency Preparedness and Response in September. It also held a virtual research coordination meeting for the coordinated research project entitled 'Development of Approaches, Methodologies and Criteria for Determining the Technical Basis for Emergency Planning Zone for Small Modular Reactor Deployment', in August.

The Agency continued to support the implementation of the requirements established in *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GSR Part 7) by developing technical guidance and conducting capacity building activities. A total of 10 training events at the regional and interregional levels and 11 training events at the national level were implemented. In addition, 100 webinars with a total of over 12 000 attendees were conducted in Arabic, English, French, Russian and Spanish.

Response Arrangements with Member States

The Response and Assistance Network (RANET) Joint Assistance Team exercise that was scheduled for August in Fukushima Prefecture, Japan, was conducted as a virtual five day tabletop exercise. The event included assessment and prognosis, the use of the International Radiation Monitoring Information System (IRMIS) and activities relating to the coordination and delivery of international assistance through the RANET mechanism.

The Agency conducted a total of eight Level 2 Convention Exercises (ConvEx-2) in 2020.

The Agency supported nine Member States in conducting and evaluating their national emergency exercises. Member States used the Unified System for Information Exchange in Incidents and Emergencies (USIE) Exercise web site for 84 of their exercises in 2020.

Response to Events

The Agency was informed by the competent authorities responsible for implementing the Convention on Early Notification of a Nuclear Accident and/or the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency on behalf of national governments and international organizations, or became aware through earthquake alerts or media reports, of 177 events involving or suspected to involve ionizing radiation (Fig. 1). It interacted with Member States in 54 of these events. It made one offer of good offices — a process which denotes that the Agency is available to provide or arrange assistance, if requested by a Member State — and conducted one assistance mission upon request from Lebanon.

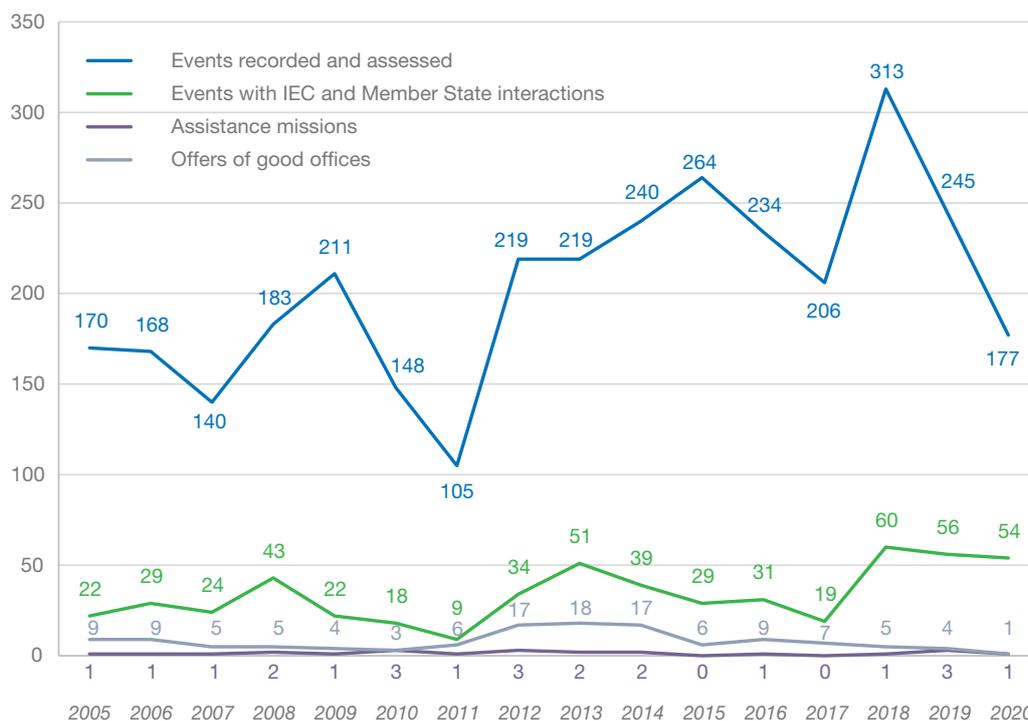


FIG. 1. Number of radiation events the Agency's Incident and Emergency Centre (IEC) recorded and assessed, and Agency responses, since 2005.

Inter-Agency Coordination

The Agency conducted a ConvEx-2f exercise in December with the involvement of the public information officers of Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE) participating organizations.

In-house Preparedness and Response

The Agency organized a comprehensive programme of training classes and exercises to enhance the skills and knowledge of Agency staff members serving as qualified responders in the Incident and Emergency System. The programme offered 143 hours of training during the year, including 78 classes for 191 Agency staff responders. It successfully implemented blended and virtual learning, such that 53 classes comprising 85 hours of training were offered virtually. In addition, the Agency held five partial or full response exercises.

CASE STUDY

Agency Assistance to Lebanon in the Aftermath of the Beirut Blast

Early in the evening of 4 August 2020, a huge blast tore through Beirut. As the city reeled from its devastating impact, the Lebanese authorities requested the Agency's assistance to determine if radiation levels had increased as a result of the blast.

The Agency sent an Assistance Mission to Lebanon to provide support with radiation surveying, sampling and analysis. The Lebanese authorities had conducted radiation surveys and collected food, seawater, soil and building material samples at the scene of the blast. They recorded no unusual radiation values. The mission was requested to conduct independent radiation monitoring to confirm these measurements.

The Assistance Mission's radiation surveys did not find any unexpected radiation levels, only natural background radiation, and no evidence of artificial radionuclides. The team's findings confirmed those previously reported by the Lebanese authorities. Even though the mission took place more than a month after the explosion, it would still have detected any subsequent increase in radiation.

"The IAEA Assistance Mission was an important step in our process to reassure the public that the explosion did not result in any increased radiation levels in the environment," said Bilal Nsouli, Director of the Lebanese Atomic Energy Commission.

The team, comprising four experts from Denmark and France and four Agency staff members, measured radiation levels at several locations and assessed the impact of the explosion on the safety and security of radioactive material and sources at the port and in nearby hospitals and scrapyards.

The mission was conducted through the Agency's Response and Assistance Network (RANET), a network of States that offer assistance, on request, to minimize the actual or potential radiological consequences of a nuclear or radiological emergency.

In addition to on-site measurements, the environmental samples collected by the Lebanese authorities were analysed in laboratories in France and Switzerland as part of the Agency's assistance. These laboratories confirmed that there were no elevated radiation levels in the samples.

The Agency team also assessed the impact of the blast on radioactive material and sources stored in two hospitals close to the blast epicentre, assisting Lebanese authorities to confirm that radioactive sources at two hospitals were safe and secure.

The team recommended further actions to be taken in scrapyards, hospitals and the port to strengthen nuclear safety and security. These include training for scrapyards workers, better signage to indicate the presence of radioactive material and increased security for the storage of such material. Supporting the authorities with equipment was an important part of the mission, and during the mission the Agency team provided training in the use of handheld radiation detection equipment, which was also donated to the country.

"As Lebanon faces this challenging period, after the Beirut explosion and in the presence of COVID-19, we welcome the support the IAEA Assistance Mission provided to our response efforts," said Mr Nsouli. "We look forward to continuing to cooperate with the IAEA as we strengthen nuclear safety and security in the country."

In addition to support in nuclear safety and security, the Agency also worked with Lebanese national authorities to assess the damage to the health sector and the city's infrastructure. The Agency provided support on radiology and non-destructive testing to determine the safety of damaged buildings. It also shipped mobile X ray units and additional sets of real-time RT-PCR equipment and supplies for the diagnosis of COVID-19.



Experts from the Agency's Assistance Mission to Lebanon measure radiation levels at a scrapyard in Beirut on 14 September 2020.

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 and maintenance of an up to date set of safety standards and providing for their effective application. To support Member States in establishing and enhancing their safety infrastructure through review services, and in improving the safety of nuclear installations by assisting their adherence to, and facilitating implementation of, the Convention on Nuclear Safety and the Code of Conduct on the Safety of Research Reactors. To support Member States in capacity building through education and training, and by encouraging the exchange of information and operating experience and international cooperation, including enhanced coordination of research and development activities.

Regulatory Infrastructure for Safety

The Agency conducted three virtual expert missions to Egypt, Morocco and South Africa to review the integrated management system of each country's regulatory body.

A working group was established to take forward the lessons learned from previous Integrated Regulatory Review Service (IRRS) missions to review the implementation of the Tailored Module for Countries Embarking on Nuclear Power Programmes. Guidance for the IRRS Tailored Module was also developed to improve its effectiveness.

Convention on Nuclear Safety

The Agency facilitated a meeting for the Officers of the Eighth Review Meeting of the Contracting Parties to the Convention on Nuclear Safety to consider the conduct of the Eighth Review Meeting and all related issues thereto. However, owing to the COVID-19 pandemic travel restrictions, and after extensive consultations the Review Meeting was postponed twice during the year, until 2023.

Design Safety and Safety Assessment

The Agency held a Technical Meeting on Safety Aspects of Using Smart Digital Devices in Nuclear Systems. It also organized a Technical Meeting on Current Practices in Performing Comprehensive Evaluations of Safety and Periodic Safety Reviews of Nuclear Power Plants.

At the virtual Technical Meeting on the Application of the New IAEA Principles for Design Safety of New Nuclear Power Plants, Member States shared their national practices in the implementation of Agency Safety Requirements and supporting Safety Guides

in the design and licensing of new nuclear power plants. The Agency also organized a virtual Technical Meeting on the Enhancement of Methods, Approaches and Tools for Development and Application of Probabilistic Safety Assessments.

The Agency completed a Technical Safety Review of Nigeria's draft regulations for the design and construction, commissioning, safety of operation, and decommissioning of nuclear power plants.

The Agency continued developing publications relating to safety assessment and analysis of small modular reactors and published *Applicability of Design Safety Requirements to Small Modular Reactor Technologies Intended for Near Term Deployment* (IAEA-TECDOC-1936).

Safety and Protection against External Hazards

The Agency held a virtual Technical Meeting on Accident Management for Advanced Reactors where participants discussed the applicability of *Accident Management Programmes for Nuclear Power Plants* (IAEA Safety Standards Series No. SSG-54) to advanced reactor designs, either water cooled or non-water cooled.

The Agency held a Technical Meeting on Protection of Nuclear Installations Against External Hazards. It also published *Methodologies for Seismic Safety Evaluation of Existing Nuclear Installations* (Safety Reports Series No. 103).

Operational Safety of Nuclear Power Plants

The Agency organized a Technical Meeting on Use of Periodic Safety Reviews in Support of Long Term Operation Safety Assessments. It also held a meeting of the International Generic Ageing Lessons Learned (IGALL) Steering Committee as well as nine workshops and eight IGALL meetings to support operators, regulators and other organizations in ageing management and long term operation.

At a virtual technical meeting of the national coordinators of the Incident Reporting System for nuclear installations (co-organized with the Nuclear Energy Agency), participants shared operating experience from significant events reported through the system. The seventh edition of the joint Agency–Nuclear Energy Agency report *Nuclear Power Plant Operating Experience* was published, providing an overview of lessons learned by operators during the 2015–2017 period.

The Agency organized a CANDU Senior Regulators Meeting to share operating and regulatory experience of Canada deuterium–uranium (CANDU) type reactors.

The Agency published *Safety Culture Practices for the Regulatory Body* (IAEA-TECDOC-1895) as well as 'A Harmonized Safety Culture Model', jointly developed with the World Association of Nuclear Operators and the Institute of Nuclear Power Operations. The model is a comprehensive tool intended for all organizations that deal directly or indirectly with ionizing radiation, enabling them to set goals, implement changes and measure progress.

The Agency held the International School of Nuclear and Radiological Leadership for Safety in Tokyo. It also conducted other activities to assist Member States in strengthening leadership, safety management and safety culture for nuclear facilities and regulatory bodies, including an expert mission on leadership and management for safety to the Zaporizhzhya nuclear power plant in Ukraine (Fig. 1) as well as two virtual training courses.



FIG. 1. Agency expert mission on leadership and management for safety to Ukraine in January.

Safety of Research Reactors and Fuel Cycle Facilities

The Agency provided further guidance on the implementation of the Code of Conduct on the Safety of Research Reactors, including a new publication entitled *Reliability Data for Research Reactor Probabilistic Safety Assessment* (IAEA-TECDOC-1922). In addition, the Agency published *Periodic Safety Review for Research Reactors* (Safety Report Series No. 99), providing guidance on and examples of this review process.

The Agency held the eighth Annual Meeting of the Regional Advisory Safety Committee for Research Reactors in Asia and the Pacific as a virtual event. It also conducted a virtual workshop to share information on regulatory review, assessment and inspection of research reactors between the Arab Network of Nuclear Regulators and the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology.

An eight day Integrated Safety Assessment of Research Reactors (INSARR) mission to the 10 MW LVR-15 research reactor operated by the Research Centre Řež in the Czech Republic was the first Agency peer review and advisory service mission held on-site since the start of the COVID-19 pandemic.

The Agency held a virtual Technical Meeting for the National Coordinators of the Joint IAEA–OECD/NEA Fuel Incident Notification and Analysis System (FINAS). At this meeting, participants discussed important lessons learned from events reported to FINAS and shared their views on further enhancement of operating experience effectiveness. The Agency also issued the new publication *Operating Experience from Events Reported to the IAEA/NEA Fuel Incident Notification and Analysis System (FINAS)* (IAEA-TECDOC-1932), covering the feedback from operating experience of nuclear fuel cycle facilities since the establishment of FINAS.

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 by 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 Supplementary Guidance, as well as 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

Two Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources were held at the Agency affiliated regional training centres in Africa. A virtual train-the-trainer event on the course was held for lecturers from Malaysia.

The Agency contributed to the preparation of a position statement entitled 'Managing Exposure Due to Radon at Home and at Work' by the Inter-Agency Committee on Radiation Safety. The document summarizes the committee's understanding of strategies for the use of the new dose conversion factor for occupational exposure to radon, as recommended by the International Commission on Radiological Protection, and includes the outcomes of the Technical Meeting on the Implications of the New Dose Conversion Factors for Radon.

The Agency organized the virtual International Conference on Radiation Safety: Improving Radiation Protection in Practice in cooperation with the European Commission, the Food and Agriculture Organization of the United Nations, the International Labour Organization, the Nuclear Energy Agency, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization. The conference, held in November, took stock of the worldwide radiation safety situation as well as lessons learned from applying *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (IAEA Safety Standards Series No. GSR Part 3) and improvements to be considered to further facilitate its application.

Participants in a virtual Technical Meeting on the Justification and Optimization of Protection of Patients Requiring Multiple Imaging Procedures reviewed the latest data on patient exposure from recurrent radiological imaging and agreed on a joint position statement and call for action.

The Agency published *Occupational Radiation Protection Appraisal Service (ORPAS) Guidelines* (IAEA Services Series No. 43), which draws on the experiences and lessons learned from past missions. The Agency also continued to develop a global survey of the Information System on Occupational Exposure in Medicine, Industry, and Research: Industrial Radiography and published, for the first time, an annual report on the survey.

A new Dose Management System developed by the Agency for use by individual monitoring services in Member States was released through the Occupational Radiation Protection Networks web platform.

The Agency developed and launched the Scrap Metal Tool Kit, a new collaboration platform for the exchange of information on controlling radioactive material inadvertently incorporated into scrap metal and semi-finished products of the metal recycling industries (Fig. 1). The Agency simultaneously launched a supporting e-learning course entitled 'Control of Radioactive Material Inadvertently Incorporated into Scrap Metal'.

Regulatory Infrastructure

The Agency conducted a 17 day Integrated Regulatory Review Service (IRRS) follow-up mission to Lithuania. This was the first peer review mission to be organized completely on-line, owing to the restrictions relating to the COVID-19 pandemic.

A virtual Technical Meeting on the Implementation of the IAEA's Self-Assessment Methodology and Tools was held to exchange views on the latest developments of the Integrated Review of Infrastructure for Safety component of the Self-Assessment of Regulatory Infrastructure for Safety on-line tool.



FIG. 1. Radioactive material may be inadvertently incorporated into scrap metal.

The Agency created a dedicated area on the Cyber Learning Platform for Network Education and Training (CLP4NET) to host materials from the virtual School for Drafting Regulations on Radiation Safety.

Transport Safety

The Agency launched Version 2 of Modules 1–4 of the e-learning course on the safe transport of radioactive material, to reflect the requirements established in *Regulations for the Safe Transport of Radioactive Material* (IAEA Safety Standards Series No. SSR-6 (Rev. 1)).

Radiation Safety Information Management System

Two virtual interregional workshops were held to train Radiation Safety Information Management System (RASIMS) national coordinators in the use of the RASIMS 2. By the end of 2020, 87% of nationally appointed RASIMS 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 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 geologic repositories for high level waste, decommissioning, remediation and environmental releases through peer reviews and advisory services, and to assist their adherence to, and facilitating implementation of, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. 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

On the basis of lessons identified 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), the Agency finalized guidance to support efficient implementation of future IRRS–ARTEMIS combined missions. The Agency also held a virtual technical meeting to assess the Self-Assessment of Regulatory Infrastructure for Safety (SARIS) on-line system.

Decommissioning and Remediation Safety

The Agency continued to support the activities of the Coordinated Group for Uranium Legacy Sites (CGULS) (Fig. 1). The group's annual meeting was held virtually and focused on information exchange and remediation project updates. The Agency is currently updating the Strategic Master Plan for Environmental Remediation of Uranium Legacy Sites in Central Asia. Member States in Central Asia and international organizations participating in CGULS are being consulted and have provided up to date information on the commencement of remediation of the uranium legacy sites in Kyrgyzstan and on progress towards establishing the necessary mechanisms to remediate the legacy sites in Tajikistan and Uzbekistan.

The Agency held the Second Technical Meeting of the International Project on Decommissioning of Small Facilities (MIRDEC) and the Third Technical Meeting of the International Project on Completion of Decommissioning (COMDEC). The MIRDEC meeting resulted in further collection, review and exchange of experiences, knowledge and lessons on decommissioning of small medical industrial and research facilities. COMDEC furthered knowledge sharing and lessons regarding completion of decommissioning; that is,



FIG. 1. German, Kyrgyz and Uzbek experts perform joint laboratory analysis of environmental samples collected at a uranium legacy site as part of the CGULS capacity building activities in Central Asia. (Photograph courtesy of C. Kunze, IAF-Radioökologie GmbH.)

the actions taken to prepare sites for reuse and for termination of regulatory authorization. Both meetings resulted in contributions to the respective project reports.

Joint Convention

Preparations for the Seventh Review Meeting of the Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) were impacted by the COVID-19 pandemic. The President of the Seventh Review Meeting of the Joint Convention sent a letter to the Contracting Parties proposing the postponement of the Seventh Review Meeting because of the COVID-19 restrictions, and the Contracting Parties decided by consensus to hold the Seventh Review Meeting in 2022. The Organizational Meeting for the Seventh Review Meeting of the Contracting Parties to the Joint Convention was held as a virtual meeting in September–October 2020.

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)

In February, the Agency successfully organized the International Conference on Nuclear Security: Sustaining and Strengthening Efforts (ICONS 2020). The conference, held in Vienna, brought together more than 1900 participants, including a record number of 53 ministers, from 141 Member States, 4 non-Member States and 25 international organizations, to share experiences and achievements, and to formulate and exchange views on current approaches, future directions and priorities for nuclear security, including cybersecurity. Member States adopted a Ministerial Declaration by consensus reaffirming their support for nuclear security and delivered 109 national statements.



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

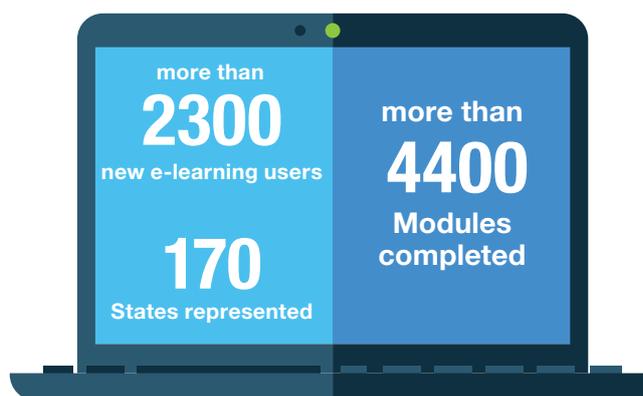
In line with Article 16.1 of the Convention on the Physical Protection of Nuclear Material (CPPNM), as amended in 2005, the Secretariat continued to facilitate preparations for the Conference of the Parties to the Amendment to the CPPNM. A meeting of the Preparatory

Committee, tasked with undertaking formal preparations for the Conference, took place virtually during the week of 7–11 December.

The Agency continued to encourage universal adherence to and effective implementation of the CPPNM and its Amendment and provided technical and legislative assistance, upon request. The Director General wrote to States not party to the CPPNM, as well as to those party to the CPPNM but not its Amendment, to encourage further adherence to the Amendment. In February, a ministerial side event and a technical session on the universalization of the CPPNM and its Amendment were organized on the margins of ICONS 2020. The Agency organized two webinars on the CPPNM and its Amendment, attended by more than 300 participants from 81 States. It also organized the sixth Technical Meeting of the Representatives of Parties to the Convention on the Physical Protection of Nuclear Material and its Amendment in December.

Nuclear Security Guidance

One new IAEA Nuclear Security Series guidance publication and two revisions of existing publications were issued. The new publication addresses exercising nuclear security systems and measures for nuclear and other radioactive material out of regulatory control. At the end of 2020, the IAEA Nuclear Security Series comprised 39 publications.



Needs Assessment and Capacity Building

Four Member States approved Integrated Nuclear Security Support Plans, bringing the total number of approved plans to 90. The Agency conducted 42 training events, most virtually, for 576 participants. The Agency continued to provide related e-learning opportunities for nearly 9000 users representing 170 Member States, including 2353 new users, and delivered a new computer security incident response course.

Risk Reduction

The Agency continued to support Member States in protecting nuclear and other radioactive material during and after use. It assisted in the consolidation of nine high activity disused radioactive sources in one Member State and continued its support for the removal of 53 disused sources from various countries. The Agency completed physical protection upgrades in two Member States at two research reactors, a nuclear power plant and 13 hospitals. It also provided assistance in drafting nuclear security regulations to 18 Member States.

Incident and Trafficking Database

In 2020, States reported 125 incidents to the Incident and Trafficking Database: 112 involved radioactive sources and radioactively contaminated material and 17 involved nuclear material, with 4 incidents involving both nuclear material and radioactive sources. One reported incident involved acts of trafficking or malicious use.

Nuclear Security Fund

The Agency accepted extrabudgetary pledges and other contributions to the Nuclear Security Fund amounting to €50 million from 15 Member States as well as from one international organization and other contributors in 2020.

CASE STUDY

Colombia Enhances Safety and Security of Disused Sealed Radioactive Sources

Despite restrictions in place owing to the global pandemic, several disused sealed radioactive sources (DSRSs) were successfully brought to a safe and secure storage facility in Colombia at the end of 2020, with support from the Agency. The sources had been used in cancer treatment but had reached the end of their useful life. Their transfer represents a major milestone in ongoing efforts to increase the safety and security of disused sources in the country.

Sealed radioactive sources are used worldwide in areas such as health care, industry, research and agriculture. Although these sources are usually managed safely and securely while in use, it is equally important to manage them safely and securely once they become disused. This is essential to reduce radiation hazards to the public and the environment.

“Disused sealed radioactive sources can remain radioactive for a long time and present both security and safety challenges,” said Muhammad Khaliq, Head of the Nuclear Security of Materials and Facilities Section of the Agency’s Division of Nuclear Security. “Appropriate management of these sources helps protect against accidental radiation exposure and intentional use for malicious purposes.”

As part of the implementation of Colombia’s national action plan to secure all radioactive material in use and storage, within the framework of its Integrated Nuclear Security

Experts dismantle a teletherapy head used for cancer care in Colombia in preparation for its safe and secure storage.



Support Plan, the Agency supported the dismantling and consolidation of all high activity DSRs from various facilities within the country and their transportation to a safe and secure storage facility for further management.

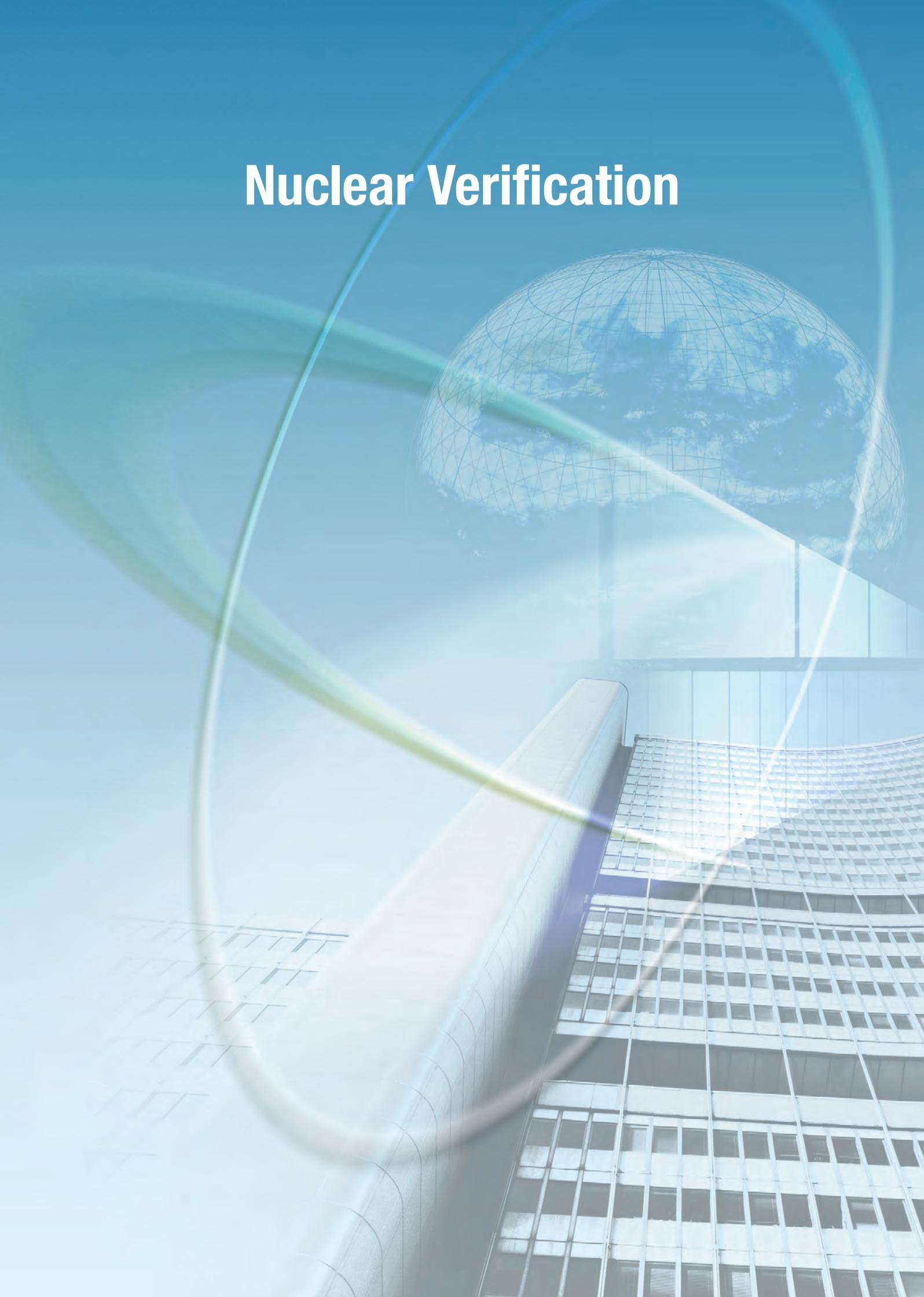
Performing complex field operations such as the transfer of radioactive sources at the end of their life cycle — when they are especially vulnerable — to a safe and secure storage facility requires highly specialized expertise and poses technical challenges. This was further complicated by health and safety measures in place during the ongoing COVID-19 pandemic. To ensure adherence to the national pandemic restrictions, plans had to be adjusted, including the development of a biosafety protocol regulating sanitary cleaning and disinfection and the introduction of physical distancing protocols.

“Operations were performed with the highest standards of radiological safety and security, but also with unprecedented biosecurity measures due to the current COVID-19 health emergency,” said Miguel Lotero Robledo, Colombia’s Vice Minister of Energy. “The dedication of all national stakeholders, such as our ministry, the National Police of Colombia and the Colombian Geological Service, demonstrates our country’s undeniable commitment towards enhancing nuclear safety and security.”

The Agency is supporting more than 20 countries, on their request, to improve the security and safety of national inventories of DSRs through large scale field operations and complementary capacity building for enhanced sustainability.



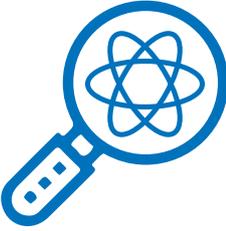
Nuclear Verification



Nuclear Verification



184 States with safeguards agreements in force of which
136 States had additional protocols in force



over
2 850 verification activities undertaken



1 321 nuclear facilities and locations outside facilities under safeguards



over
221 000 significant quantities of nuclear material under safeguards



over
12 700 days of in-field verification and



almost
2 400 days spent in quarantine

Conclusions

**72
States**

**all nuclear material
remained in
peaceful activities**

**103
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 2020

Implementing safeguards and other verification activities in 2020 was much more of a challenge as a result of the global COVID-19 pandemic. Nevertheless, with considerable extra effort and adaptation to the new circumstances, the Agency conducted almost the same level of verification activities as in the previous year. The Agency carried out over 2 850 verification activities (2 953 in 2019) and spent more than 12 700 days in the field conducting those activities (13 140 in 2019). This ensured that the Agency was able to draw soundly based conclusions for all States in which safeguards were implemented by the Agency for 2020.

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 2020, 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 force⁵ (see Fig. 1), the Agency drew the broader conclusion that *all* nuclear material remained in peaceful activities for 72 States⁶; for the remaining 59 States, as the necessary evaluation regarding the absence of undeclared nuclear

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.

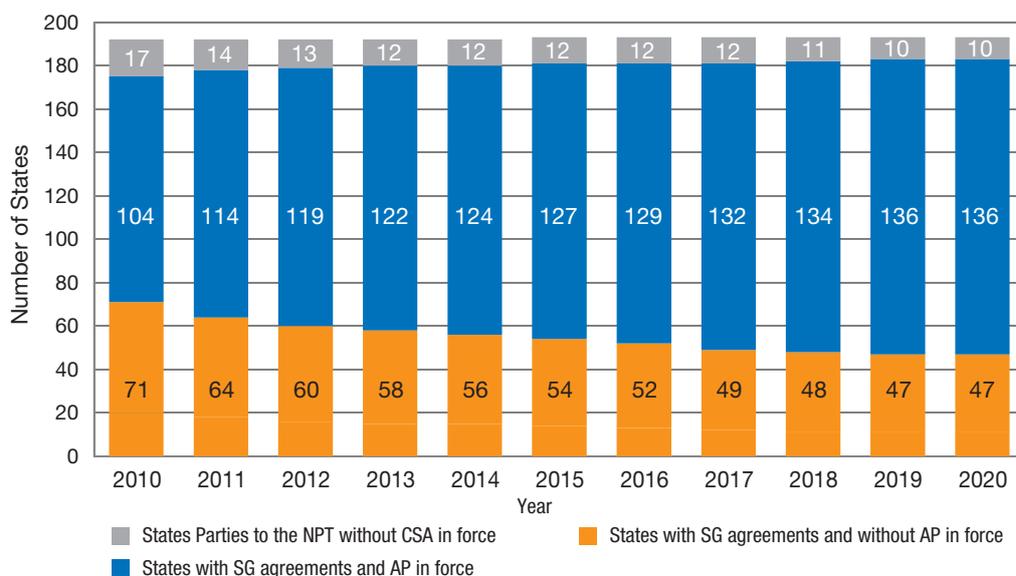


FIG. 1. Number of APs for States with safeguards agreements in force, 2010–2020 (the Democratic People’s Republic of Korea is not included).

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 safeguards obligations. Integrated safeguards were implemented for the whole of 2020 for 66 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 party 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 2020, 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.

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, the Republic of Korea, Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Madagascar, Mali, Malta, Mauritius, Monaco, Montenegro, the Netherlands, New Zealand, North Macedonia, Norway, Palau, Peru, Philippines, Poland, Portugal, Romania, Seychelles, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Tajikistan, the United Republic of Tanzania, Uruguay, Uzbekistan and Viet Nam.

⁸ And Taiwan, China.

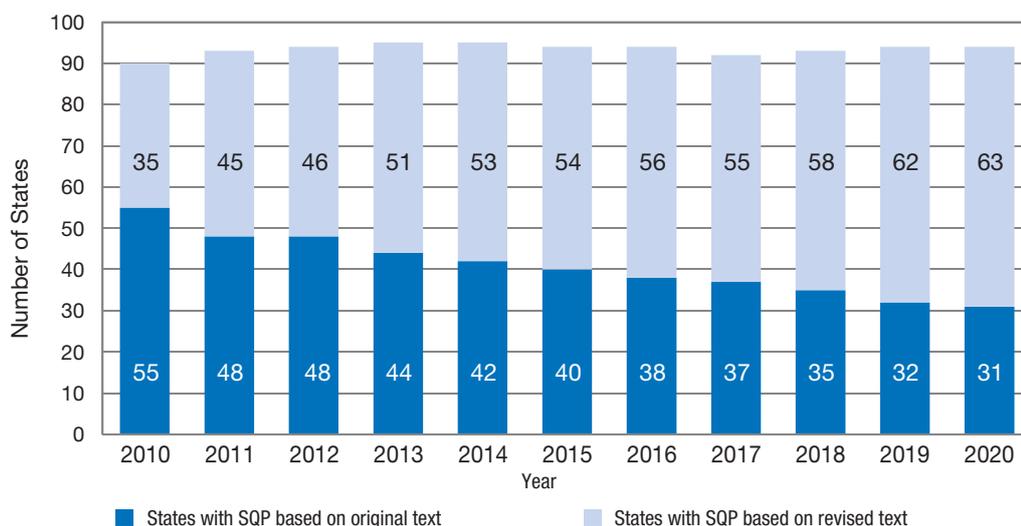


FIG. 2. Number of States with SQPs, 2010–2020.

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

The status of safeguards agreements and APs as of 31 December 2020 is shown in Table A6 in the Annex to this report. During 2020, a CSA with a small quantities protocol (SQP) and an AP was approved by the Board of Governors for Eritrea. A voluntary offer agreement and an AP entered into force for the United Kingdom. An SQP was amended for Haiti.

The Agency continued to facilitate the conclusion of safeguards agreements and APs (Fig. 1), and the amendment or rescission of SQPs. In 2020, the Director General wrote to 31 States with SQPs based on the original standard text calling upon them to amend or rescind them. The Director General stressed that this was essential to address a weakness in the Agency’s safeguards system recognized by the Board of Governors 15 years ago, and that the old standard SQP was inadequate for the current safeguards system. By the end of 2020, 69 States had accepted the revised SQP text (which was in force for 63 of these States) and 8 States had rescinded their SQPs (Fig. 2). The Agency continued to implement the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2020.

Islamic Republic of Iran (Iran)

Throughout 2020, the Agency, in light of United Nations Security Council resolution 2231 (2015), 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, the Director General submitted to the Board of Governors and in parallel to the United Nations Security Council four quarterly reports, and four reports providing updates on developments in between the issuance of the quarterly reports, entitled *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)*.

During 2020, the Agency interacted with Iran to clarify information relating to the correctness and completeness of Iran’s declarations under its Safeguards Agreement and AP. A full and prompt explanation for the presence of uranium particles of anthropogenic origin, including isotopically altered particles of low enriched uranium, at a location in Iran not declared to the Agency, was still pending at the end of the year. Iran’s denial of access to Agency inspectors to two other locations in Iran not declared to the Agency led to

a visit to Tehran by the Director General in August. Access was provided soon thereafter. Three reports were submitted by the Director General to the Board of Governors entitled *NPT Safeguards Agreement with the Islamic Republic of Iran*.

Syrian Arab Republic (Syria)

In September 2020, the Director General submitted a report to the Board of Governors entitled *Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic*. The 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.⁹ In 2020, the Director General urged Syria to cooperate fully with the Agency in connection with all unresolved issues and expressed his willingness to engage with Syria to take concrete steps towards a mutually acceptable solution.

Democratic People's Republic of Korea (DPRK)

In September 2020, the 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 2020, 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 the operational status or configuration/design features of the facilities or locations, or the nature and purpose of the activities conducted therein. 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

State-level safeguards implementation

The Agency continued to enhance consistency and to develop more robust methods for evaluating the effectiveness of safeguards implementation through a project aimed at improving the development of State-level safeguards approaches (SLAs) using a structured approach. During 2020, the Agency developed SLAs for two States with a CSA and an AP in force, and an SLA for a State with a voluntary offer agreement and an AP in force, based on the updated internal procedures and guidance, following consultations with the States concerned on practical arrangements. These SLAs will be implemented in 2021.

⁹ 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.

Cooperation with State and regional authorities

Due to the COVID-19 pandemic, in 2020 the Agency had to postpone many of its international, regional and national training courses aimed at assisting States in building capacity for implementing their safeguards obligations. To address the training needs of States, the Agency developed new safeguards e-learning courses, including a course entitled 'Basics of Safeguards', as well as several modules on nuclear material accounting. Since its launch in September 2020, over 300 people have accessed this course.

To further help States strengthen the effectiveness of their State or regional authority responsible for safeguards implementation (SRA) and of their respective State system of accounting for and control of nuclear material (SSAC), the Agency launched the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) project to provide assistance and services tailored to the needs of the State. The Agency also conducted an on-line regional training course on SSACs together with counterparts in Japan; an on-line webinar on safeguards in bulk handling facilities for staff of the Egyptian Atomic Energy Authority and Nuclear and Radiological Regulatory Authority; and supported two on-line workshops on safeguards implementation in the United Kingdom. In total, 67 experts from 8 countries took part in on-line training events.

Safeguards equipment and tools

Despite the COVID-19 pandemic, in 2020 the Agency ensured that instrumentation and monitoring equipment used by inspectors during in-field verification activities or installed in nuclear facilities continued to function as required. At the end of the year, 1611 unattended safeguards data streams were collected remotely from 142 facilities in 31 States around the world. The Agency also had 1530 cameras operating or ready to use at 260 facilities in 37 States. The transition to the next generation surveillance system (NGSS), to replace earlier generation cameras that have reached the end of their lifecycle, neared completion. By the end of 2020, there were 1180 DCM-C5/DCM-A1 based cameras¹⁰ installed in 33 States.

In 2020, Member State Support Programmes (MSSPs) were essential to enabling the evaluation, design, testing and preparation of new safeguards technology to address new verification challenges. The passive gamma emission tomography (PGET) capability to verify spent fuel was established with the support of the MSSP of the Russian Federation. In 2020, PGET data analysis algorithms were further enhanced with active support from the MSSP of the United States of America.

The Agency continued to develop new sealing technologies and improve the overall security of these instruments. To enhance its sealing systems, the Agency conducted an industry wide search for innovative technologies to serve as a new passive seal. The prototypes were received in late 2020 and evaluated for reliability, ease of use, security and safeguards specific requirements.

Despite pandemic related restrictions, the Agency, in close collaboration with MSSPs, managed to complete the development cycle of the next generation Cherenkov viewing device (XCVD) and authorized the first version for spent fuel verification in Japan. An initial version of a robotized unmanned surface vehicle able to transport the XCVD was successfully tested. Use of a state of the art X ray fluorescent and laser-induced breakdown spectroscopy instrument for verification activities was authorized.

Safeguards analytical services and methodologies

The Agency's Network of Analytical Laboratories consists of the Agency's Safeguards Analytical Laboratories and 24 other qualified laboratories in various

¹⁰ Formerly referred to as NGSS cameras.



FIG. 3. An Agency safeguards analytical chemist analyses nuclear material at the Safeguards Analytical Laboratories.

Member States (Fig. 3). During the year, six additional laboratories for sample analysis and reference material provision were in the process of qualification.

In 2020, the Agency collected 489 nuclear material samples, which were analysed by the Agency's Nuclear Material Laboratory, and 9 heavy water samples, analysed by the Network of Analytical Laboratories. The Agency also collected 460 environmental samples, resulting in analysis of 1013 subsamples.

A new Statistical Evaluation Platform for Safeguards (STEPS) was completed, providing the Agency with a state of the art analytical environment supporting, inter alia, material balance evaluation with upgraded methodologies and streamlined processes. The fourth International Technical Meeting on Statistical Methodologies for Safeguards, aimed at gathering new expertise and extending the network of experts on advanced statistical methodologies and innovative approaches, gathered 27 external participants from 11 countries, as well as internal participants, in an innovative format.

New processes and newly available commercial services, some of them introduced as a result of the global lockdown conditions, allowed the Agency to extend the benefit of commercial satellite imagery and other geospatial data analysis to safeguards implementation. In particular, broader use of synthetic aperture radar sensors and high revisit imagery satellites complemented the now traditional use of high resolution optical imagery.



FIG. 4. Director General Grossi meets with safeguards trainees at the Agency's Headquarters in Vienna in November 2020.

Developing the Safeguards Workforce

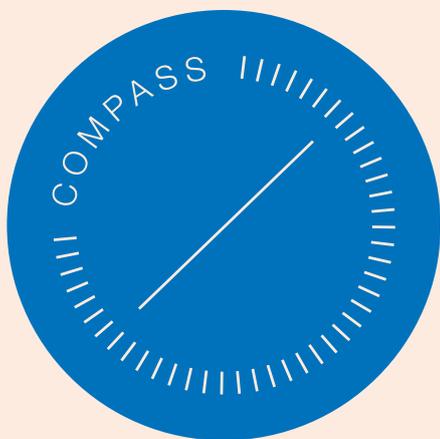
In 2020, the Agency conducted 39 safeguards training courses to provide safeguards inspectors, analysts and supporting staff with the necessary competencies. Re-development and re-design of training courses enabled the delivery of some blended and on-line courses to safeguards staff, including part of the inspector induction training, departmental basic training and safety training (Fig. 4). An industrial safety component has been integrated into the inspector induction training as part of the ongoing effort to design an industrial safety training module. Six 'Introduction to Safeguards' workshops were held for 90 non-safeguards staff.

Preparing for the Future

As part of its strategic foresight and planning activities for nuclear safeguards, the Agency held a workshop to identify new opportunities, explore challenges and deepen its understanding of emerging technologies. The workshop generated ideas relating to the use of artificial intelligence in reviewing data from Agency surveillance cameras, novel approaches for verifying spent nuclear fuel, visualization techniques for analysis, and imagery and multimedia data for the detection of undeclared nuclear material and activities. The workshop informs the *Research and Development (R&D) Plan and the biennial Development and Implementation Support Programme for Nuclear Verification* that communicate to Member States the support needed to improve the Agency's technical capabilities.

CASE STUDY

A New Initiative to Strengthen Accounting for and Controlling Nuclear Material



Nuclear material accountancy and control is a key measure in the implementation of Agency safeguards, which ensures that nuclear material remains in peaceful use. States are required to establish and maintain effective national systems of accounting for and control of nuclear material subject to safeguards.

A new initiative launched by the Agency in 2020 provides further support to national authorities responsible for accounting for and controlling nuclear material and providing safeguards declarations to the Agency for its independent verification. The initiative, called COMPASS, uses a tailored approach for each participating State to build on the Agency's existing support to countries in the area of nuclear safeguards.

"Robust cooperation between the IAEA and the State is essential to perform safeguards effectively and efficiently, and COMPASS will strengthen this," said Bernardo Ribeiro, an Agency Safeguards Officer and point of contact for the COMPASS initiative. "Using existing capacity development programmes as a foundation, this initiative will identify areas for further collaboration and offer customized assistance packages."

The establishment and maintenance of State systems of accounting for and control of nuclear material (SSACs), set up by State or regional authorities responsible for safeguards implementation (SRAs), form the basis for a State's reporting to the Agency on nuclear material subject to safeguards. COMPASS, which stands for the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs, supports this key part of a State's safeguards responsibilities.

"Over the years, the IAEA has offered States support in safeguards implementation," said Susan Pickett, Head of the Safeguards Training Section at the Agency. "What COMPASS does is build further on this history of assistance to States and optimize the provision of various forms of assistance in one package."

An SSAC is a set of technical measures established by a State to account for and control nuclear material. Such measures include, for example, the establishment of a measurement system for determining the quantities of nuclear material received, produced, shipped, lost or removed from an inventory and reporting such nuclear material to the Agency. Such reporting, in turn, provides the basis for applying Agency safeguards and verifying independently such nuclear material.

"Through COMPASS, Malaysia is proud to be at the forefront of States in strengthening both SRA and SSAC capabilities", said Ibrahim Muhamad, Director of the Nuclear Installation Division at the Atomic Energy Licensing Board, an agency under the Malaysian Ministry of Science, Technology and Innovation. "Malaysia continues to demonstrate its commitment to effective and efficient nuclear safeguards, and the peaceful use of nuclear material to promote nationwide economic growth."

By identifying specific areas of engagement between a particular State and the Agency, COMPASS will address the individual needs of States to enhance the capacity of their SSAC and SRA.

By the end of 2020, the COMPASS pilot phase was under way in cooperation with seven countries. Upon successful completion of this pilot phase, the initiative will be made available, upon request, to every State that has concluded a safeguards agreement with the Agency.

Technical Cooperation



Management of Technical Cooperation for Development

146
countries and territories
receiving support through the
Agency's technical cooperation programme
including **35** least developed countries

54
22 virtual
regional and
interregional
training courses

Technical Cooperation Fund

€88.1 million
target for voluntary contributions



€80.2 million received
91.1% rate of attainment

3 imPACT
review missions

527
10 virtual
fellows and
scientific visitors



1212
521 virtual
training course
participants



1139

active projects



778

projects closed or in
closure at the end of 2020



113

Country Programme
Frameworks valid

4118

purchase
orders issued



value of purchase orders issued

€81.1 million



Management of Technical Cooperation for Development

Objective

To develop and implement a need-based, responsive technical cooperation programme in an effective and efficient manner, and thus 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 targets underpinning the Sustainable Development Goals (SDGs), and encourages cooperation between Member States and with partners.

The main areas of technical cooperation in 2020 were nuclear knowledge development and management, health and nutrition, and food and agriculture (Fig. 1).

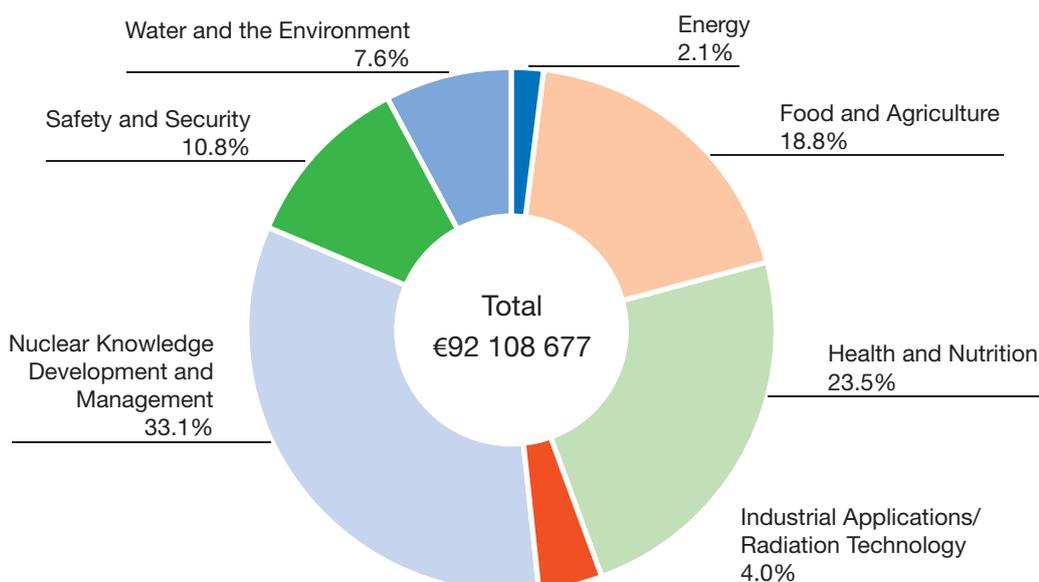


FIG. 1. Technical cooperation programme disbursements (actuals) by technical field for 2020. (Percentages do not add up to 100% owing to rounding.)

Financial highlights

Payments to the 2020 Technical Cooperation Fund totalled €84.5 million (including National Participation Costs and miscellaneous income; no assessed programme cost arrears were received in 2020), against the target of €88.1 million. The rate of attainment on payments at the end of 2020 was 91.1% (Fig. 2). The Technical Cooperation Fund implementation rate was 80.4%.

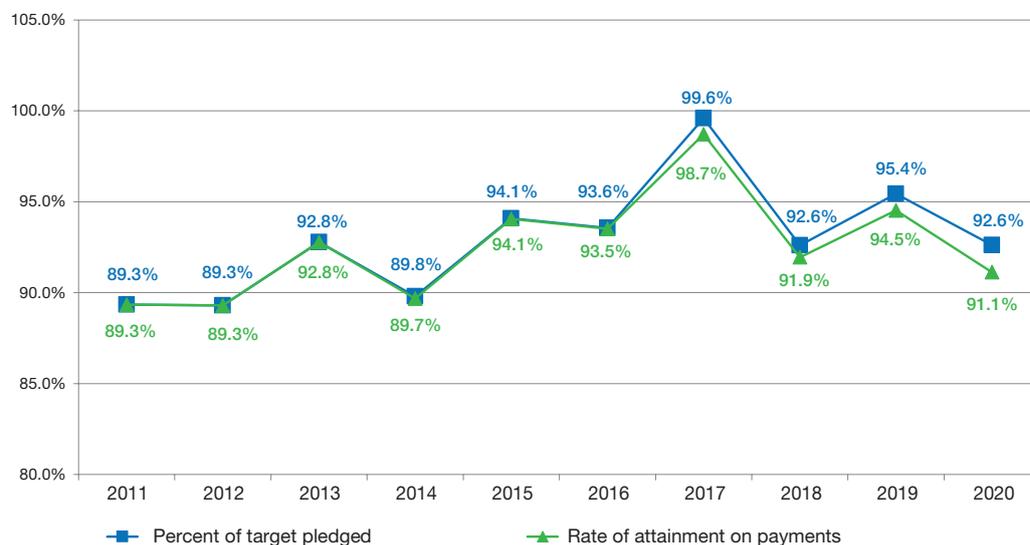


FIG. 2. Trends in the rate of attainment, 2011–2020.

Country Programme Frameworks and Revised Supplementary Agreements

The number of valid Country Programme Frameworks (CPFs) stood at 113 at the end of 2020.

The total number of Revised Supplementary Agreements Concerning the Provision of Technical Assistance by the International Atomic Energy Agency (RSAs) was 141.

CPFs signed in 2020

Chad	Indonesia	Mauritania	Republic of
Chile	Lao People's	Mauritius	Moldova
Croatia	Democratic	Panama	Sudan
Georgia	Republic		Togo

Regional Cooperative Agreements and Regional Programming

Africa

The programme of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) contributes significantly to training a new generation of African scientists who will foster nuclear science and technology for African development. In 2020, for example, ten candidates pursued master's degrees in nuclear science and technology at Alexandria University (Egypt) and the University of Ghana through the two year AFRA master's programme

in nuclear science and technology, while seven regional training courses and 16 meetings were conducted within the framework of AFRA projects.

AFRA State Parties conducted a mid-term review of the AFRA Regional Strategic Cooperative Framework for 2019–2023, considering emerging priority areas such as climate change adaptation, sustainable energy development and human nutrition. These areas will be addressed in the 2022–2023 AFRA programme.

Asia and the Pacific

Following publication of the socioeconomic impact assessment of its mutation breeding programme, the Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific (RCA) initiated a socioeconomic impact assessment of the RCA radiotherapy and industrial application programmes. Development of the RCA Medium Term Strategy 2024–2029 and the regional programming framework began, and preparations for the commemoration of RCA's 50th anniversary, to be held in Hanoi, got under way.

The Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) named five new resource centres in secondary standards dosimetry, expanding the ARASIA resource centres in human health and enhancing access across the region to science and technology for development.



FIG. 3. The Agency dispatched equipment to countries around the world to enable them to use real-time reverse transcription–polymerase chain reaction, a nuclear derived technique, to rapidly detect the coronavirus that causes COVID-19. Here, equipment donated by the Agency is delivered to the Nuclear Medicine School Foundation (FUESMEN) in Mendoza, Argentina. (Photograph courtesy of FUESMEN.)

Europe

The technical cooperation programme continued to strengthen human resources and institutional capacity in countries in Europe and Central Asia in 2020, in line with CPFs, the Europe Regional Profile 2018–2021 and the Strategic Framework for the Technical Cooperation Programme in the Europe Region 2019–2025. Consultation with traditional donors in the region on expanding partnerships continued, including hosting of technical cooperation events and financial contributions. Participation in the Global Mountain Sustainability Forum 2020 and in a conference organized by the International Water Resources Association enabled outreach on Agency work on climate change in high mountain areas and on enhancing capacity for isotope based assessment of water resources in the context of adapting to climate change.

To further strengthen collaborative efforts to implement technical cooperation projects during the pandemic, five interactive webinars (delivered in English and Russian) were held for Member States in Europe and Central Asia to give a comprehensive overview of technical cooperation projects. The webinars also highlighted the roles and responsibilities of the Secretariat and technical cooperation stakeholders in Member States.

At a virtual meeting with representatives and National Liaison Officers from Member States in Europe and Central Asia on the margins of the 64th regular session of the General Conference, participants were given an overview of the implementation of the 2020–2021 technical cooperation programme, and of regional project proposals under development for the 2022–2023 cycle. It was agreed that the Europe Regional Profile 2018–2021 would be reviewed and updated.

Latin America and the Caribbean

The Regional Strategic Profile of the Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL), 'Agenda ARCAL 2030', was finalized in 2020. Designed to align closely with the SDG targets, the document establishes common needs and priorities in the region that can be addressed using nuclear applications and will guide the development and implementation of regional projects for the coming decade.

Cooperative actions under the 2020–2026 Regional Strategic Framework for technical cooperation with Caribbean Community member countries began in the fields of radiation safety, marine environment, food safety and radiation medicine.

Programme of Action for Cancer Therapy (PACT)

Six imPACT (integrated missions of PACT) Review missions were initiated, with three completed (Central African Republic, Mali and Senegal), using a virtual modality. Thirteen Member States received support in reviewing their progress in implementing cancer control efforts and imPACT Review recommendations through the PACT partnership. Targeted outreach to traditional and non-traditional donors was conducted to mobilize direct and indirect resources for unfunded cancer related activities in Member States, totalling nearly €1 million. Over thirty virtual briefing sessions were held with donor countries and others to present opportunities for contributions to the Agency's cancer related efforts.

Burkina Faso, the Islamic Republic of Iran, Lebanon, Nigeria and Sri Lanka received support in cancer control assessment and planning, and Bangladesh, Chad, Mozambique, Sierra Leone and Uzbekistan received support in developing bankable documents.

Key partners in cancer control, including representatives of the International Agency for Research on Cancer and the World Health Organization, met with the Agency to strengthen the planning and delivery of joint activities and improve country level coordination.

Collaboration with the City Cancer Challenge foundation and the Union for International Cancer Control was strengthened in the areas of impACT Reviews and national cancer planning.

Strengthening the Quality of the Technical Cooperation Programme

Guidelines for the Planning and Design of the IAEA 2022–2023 Technical Cooperation Programme were issued in January. The TC Programme Quality Criteria — the foundations of the results based management of the technical cooperation programme — were updated.

The technical cooperation project report processing system platform now includes a cumulative reporting towards target feature. This facilitates evidence based tracking of progress and allows for aggregated portfolio reporting at the outcome and output level. The submission rate of Project Progress Assessment Reports for the 2019 reporting period was 71%.

Training materials on the results based management of the technical cooperation programme were made available on the Programme Cycle Management Framework IT platform, covering the technical cooperation project document template, the logical framework approach (in English and Spanish) and the technical cooperation project workplan and budget. The new on-line tutorial on using the logical framework approach had more than 2300 views by the end of 2020.

Outreach and Communication

A new information product — a series of country overviews — was launched and is being made available on-line. The Agency’s COVID-19 assistance was covered extensively in outreach efforts. In December, the Agency was profiled as Partner of the Month on the South–South Galaxy platform of the United Nations Office for South–South Cooperation.

The annual seminar on technical cooperation for the Vienna diplomatic corps attracted 100 participants.

The Agency supported the establishment of the Women in Nuclear (WiN) regional chapter in Africa (WiN Africa), and ARCAL and the Agency launched a project to support the establishment of a new regional WiN chapter in Latin America and the Caribbean. National WiN chapters were established with Agency support in Africa (Ghana, Lesotho, Nigeria and Tunisia) and in Latin America (Chile, Ecuador and Peru).

Technical Cooperation outreach in 2020

145+ IAEA web articles on technical cooperation

6441 @IAEATC Twitter followers (17% increase),
over 322 @IAEATC tweets

1882 @iaeapact Twitter followers (36% increase),
286 tweets (since June)

1686 LinkedIn TC Alumni Group members

Cooperation with the United Nations System

The Agency participated in the preparation of the annual Financing for Sustainable Development Report, a joint product of the Inter-Agency Task Force on Financing for Development. The 2020 Report highlighted results obtained via the use of the sterile insect technique (SIT) — an environmentally friendly method of pest control — in animal and human health, and in food production and trade.

Practical Arrangements were signed with the United Nations Industrial Development Organization allowing common Member States increased access to nuclear science and technology to support their sustainable industrial development efforts. The Arrangements address agricultural value chains for increased food security, better management of environmental stressors such as plastics, and energy planning tools and services.

The Agency signed a Memorandum of Understanding with the Joint United Nations Programme on HIV/AIDS (UNAIDS) to tackle cervical cancer in HIV-positive women in low and middle income countries.

Partnership Agreements and Practical Arrangements

The Agency concluded 12 new and extended 2 existing partnerships related to technical cooperation, focused mainly on expanding collaboration with various partners for the achievement of the SDGs and on tackling the COVID-19 pandemic.

Takeda pharmaceutical company committed to donating 500 million yen (around €4.1 million) to support the Agency's global initiative to help countries combat the COVID-19 pandemic.

The new partnership between the Agency and the Global Access to Cancer Care Foundation focuses on oncology training in low and middle income countries to tackle the shortage of cancer care professionals. Practical Arrangements with the Union for International Cancer Control were also concluded, to enhance the quality of and access to radiation medicine services.

The Agency and the Sovereign Military Order of Malta signed Practical Arrangements to collaborate on outreach and resource mobilization for Agency activities in nuclear medicine, radiation medicine, radiation oncology, radiotherapy and palliative care.

Practical Arrangements between the Agency and the French Society of Nuclear Medicine were signed, providing a framework for enhanced collaboration on capacity building in the areas of nuclear medicine, molecular imaging and allied disciplines, particularly for professionals from French speaking countries.

Activities and actions under existing agreements

The 9th project review meeting between the Agency and the European Union under the 2016 Delegation Agreement reviewed the implementation of the Agency's six ongoing European Union funded projects, three of which are technical cooperation projects. Implementation of the 2019 Delegation Agreement began.

The Agency presented the uses of nuclear science and technology in Africa at the African Union Commission meeting for ministers in charge of science, technology and innovation. The Agency continued to support the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign, with virtual platforms used to maintain the network of participating countries.

Under the Practical Arrangements signed with the Association of Southeast Asian Nations in 2019, cooperative activities continued under an existing regional project on emergency preparedness and response. In 2020, the Agency strengthened existing collaboration with the European Society for Radiotherapy and Oncology and Inholland Academy. A total of

111 medical practitioners (61% female) participated in virtual training courses offered by the two organizations in areas including brachytherapy, image guided radiotherapy and volumetric modulated arc therapy.

The Practical Arrangements with the University of the West Indies at Mona, Jamaica, focus on training professionals in medical radiation physics and radiation safety. In 2020, the University collaborated with national stakeholders to develop an action plan for the formulation of a national education and training strategy in radiation safety.

The Agency continued its collaboration with the Latin American Network for Education in Nuclear Technology (LANENT) and the Spanish Nuclear Industry Forum on implementation of the 'NUCLEANDO' project, which supports STEM (science, technology, engineering and mathematics) education by promoting nuclear science to high school students in the region, offering a series of interactive materials.

The Women's Cancers Partnership Initiative with the Islamic Development Bank (IsDB) advanced, with 17 countries preparing funding proposals for support to address women's cancers. The Agency and IsDB jointly held several events to mobilize additional resources for the Initiative.

Legislative Assistance

The Agency continued to provide legislative assistance to Member States through workshops, missions and meetings to raise awareness, advise and train on developing and revising national legislation and adhering to and implementing the relevant international legal instruments. Twelve Member States received country specific bilateral legislative assistance through written comments and advice on drafting national nuclear legislation. As an on-line alternative to some in-person activities, four virtual activities on different aspects of nuclear law were held for Bahrain, Costa Rica, Turkmenistan and Viet Nam. Further, one regional workshop on harmonizing national nuclear law with international and European law was held in person. Belize, Djibouti, Nepal and Togo enacted nuclear legislation, having benefitted from bilateral legislative drafting assistance from the Agency.

Owing to COVID-19 related restrictions, the 2020 session of the annual Nuclear Law Institute (NLI) interregional training event had to be postponed until 2021. A video celebrating the tenth anniversary of the NLI was launched on the margins of the 64th regular session of the General Conference. The video highlighted the impact of the NLI programme over the past decade in helping Member States to acquire a solid understanding of nuclear law and to develop the necessary skills to draft, amend and review national nuclear legislation.

A new series of interactive webinars on nuclear law amassed over 2500 streams, with participation from officials from over 100 countries. Given the success of this series and in response to expressed interest from industry, law firms, non-governmental organizations, civil society and academia, a webinar was held for the general public entitled 'Nuclear Law in Practice: The IAEA Perspective'.

Treaty Event

The annual Treaty Event took place during the 64th regular session of the General Conference, providing Member States with an additional opportunity to deposit their instruments of ratification, acceptance, or approval of, or of accession to, the multilateral treaties deposited with the Director General. The event focused on the multilateral treaties relating to nuclear safety and security and to civil liability for nuclear damage.

CASE STUDY

Nuclear Techniques Help Madagascar Villagers Access Clean Drinking Water

Amid the penetrating smells of rotting and burning garbage, constantly chased by thousands of flies, live the 4000 residents of Ambaniala, a village built right on the edge of the Andralanitra municipal waste site of Antananarivo, Madagascar's capital. But — thanks to the use of nuclear and isotopic techniques — at least the villagers now know which wells in the settlement can be used for getting drinking water and which are contaminated from effluent from the adjacent open air landfill, which provides their livelihood.

“It is much easier now, and nobody gets sick,” said Josiane Ranoroosa, a member of the village council. “Some of us need to walk farther for water, but it is at least drinkable.” A few of the wells in the contaminated area are used to draw water for washing and cleaning, she added.

Madagascar is one of the countries that uses nuclear techniques to help ensure that the water people drink is clean. Whether the water in a well is clean or contaminated can be determined using conventional chemical analysis, but such an analysis would need to be repeated constantly to provide reassurance that the water remains safe. Understanding the flow and dynamics of the groundwater, and knowing whether it could contain surface water that is potentially contaminated, is only possible with the help of isotopes.

Isotopes are versions of ‘ordinary’ atoms, containing the same number of protons and electrons but one or more additional neutrons. Chemically they exhibit the same behaviour, but they have a different atomic weight and some are unstable, emitting a tiny amount of

The main street of Ambaniala, with Madagascar's largest landfill at the end of the street. Groundwater contamination from the landfill is polluting some of the village's wells. Scientists using isotopic techniques have helped to show the villagers which well is safe to use.



radiation, which can be measured. This way the isotopes are used as tracers by scientists known as isotope hydrologists.

“We determined that a 300 meter wide strip of the ground underneath the settlement contains contaminated or potentially contaminated groundwater, while the effluent from the garbage disposal site does not reach the rest of the water under ground in the area,” said Joël Rajaobelison, an isotope hydrologist and Director General of Madagascar’s National Institute for Nuclear Science and Technology (INSTN), which has received equipment and training for its staff from the Agency to use isotopic techniques for water analysis. “It is therefore safe to use.”

The sensitive equipment that Rajaobelison’s team uses, donated by the Agency through its technical cooperation programme, is able to detect the difference in the isotopic makeup of surface water and groundwater, and thus identify infiltration. To further increase the capacity of INSTN’s isotope hydrology lab, the Agency in 2020 initiated the procurement of a laser machine. “If the groundwater contains surface water, it may easily get polluted from the effluent even if it is clean now,” he explained.

Using another isotopic technique, the team can tell whether any body of water is coming from the landfill site or flowing toward it.

When his office was initially alerted to the problem in Ambaniala by a private citizen, who heard about the use of isotopic techniques through a national outreach campaign, his staff knew right away that INSTN could help. “For us it is a simple, routine analysis performed over a number of weeks,” Rajaobelison said. “For them it is a lifesaver.”



CASE STUDY

Bosnia and Herzegovina, Serbia Succeed in COVID-19 Virus Characterization with Agency/FAO Support

Veterinary laboratories in Bosnia and Herzegovina and Serbia where scientists have been trained by the Agency and the Food and Agriculture Organization of the United Nations (FAO) are able to use genome sequencing to characterize the virus that causes COVID-19. This technology allows them to see where the virus originated and support contact tracing efforts and transmission analysis. The veterinary laboratories are helping health authorities in their efforts to localize and contain outbreaks.

The real-time reverse transcription–polymerase chain reaction (real-time RT–PCR) is a nuclear derived technology that has been widely used in the detection of the virus that causes COVID-19. With this method, fluorescent dyes are used to detect the presence of specific genetic material and provide scientists with almost immediate results on the presence of a virus. Building on this technology, whole genome sequencing is used to find out more about the virus, which enables experts to understand when it was contracted and where.

“Through genome sequencing, we are able to understand more about the virus, how virulent it is and if there are any changes in the virus over time,” said Goran Čerkez, Assistant Minister at the Federal Ministry of Health in Bosnia and Herzegovina.

Tanja Jovanovic, a virologist and professor at the University of Belgrade’s Faculty of Medicine, said, “It is very important to have collaboration while assisting public health authorities in order to evaluate effective intervention and how this will change according to changes in the virus. By comparing the sequences obtained in Serbia with neighbouring

Real-time RT–PCR is the most accurate method to detect the COVID-19 virus.

The FAO/IAEA Animal Production and Health Laboratory has been helping countries use this technique to detect zoonotic (animal to human) diseases like COVID-19 and Ebola for decades.



countries, we are better able to navigate the virus and predict which containment measures should be in place.”

The Agency’s assistance, delivered through its Veterinary Diagnostic Laboratory (VETLAB) Network and technical cooperation programme, included webinars and advisory services, as well as equipment and consumables for the detection of COVID-19.

“At the beginning of the pandemic, veterinary laboratories were somewhat better prepared than human health laboratories, because we had experience in animal and zoonotic diseases and massive testing,” said Teufik Goletic, a professor in the Department for Avian Diseases and Management and Head of the Molecular Diagnostics and Research Laboratory at the University of Sarajevo. “By exchanging information and working under a One Health approach, we can collaborate with decision making bodies and better plan control measures and estimate the impact of COVID-19.”

At the Veterinary Specialist Institute in Kraljevo, Serbia, more than 13 000 human samples were tested for the COVID-19 virus. RNA was taken and analysed using whole genome sequencing at the beginning of the COVID-19 pandemic. So far, 150 whole genomes have been obtained. Using these samples, scientists found that there were multiple lines of COVID-19 viruses in Serbia, originating from several countries.

Data from whole genome sequencing are uploaded to the National Center for Biotechnology Information database, a bioinformatics web site, allowing further research by scientists around the world. When scientists perform whole genome sequencing and upload this information to the database, connections can be made globally, resulting in more in-depth and accurate phylogenetic trees. This way, the introduction of a virus can be traced to a certain place and strain.



Annex

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Note: Tables A28–A33 are available on-line only at www.iaea.org/publications/reports.

Table A1. Regular Budget allocation and utilization of resources in 2020 by Programme and Major Programme (in euros)

Major Programme (MP)/Programme	Original budget US \$1/€1	Adjusted budget US \$1/€0.878	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	3 307 427	3 247 752	2 955 862	91.0%	291 890
Nuclear Power	9 093 995	8 901 469	8 099 120	91.0%	802 349
Nuclear Fuel Cycle and Waste Management	7 801 710	7 646 867	6 365 406	83.2%	1 281 461
Capacity Building and Nuclear Knowledge for Sustainable Energy Development	10 759 795	10 548 163	9 309 896	88.3%	1 238 267
Nuclear Science	10 449 764	10 305 152	9 483 586	92.0%	821 566
Total Major Programme 1	41 412 691	40 649 403	36 213 870	89.1%	4 435 533
MP2 — Nuclear Techniques for Development and Environmental Protection					
Overall management, coordination and common activities	8 280 760	8 203 634	8 063 054	98.3%	140 580
Food and Agriculture	12 065 296	11 901 052	11 999 287	100.8%	(98 235)
Human Health	8 848 499	8 694 307	8 638 502	99.4%	55 805
Water Resources	3 753 133	3 703 630	3 682 967	99.4%	20 663
Environment	6 692 542	6 590 447	6 339 535	96.2%	250 912
Radioisotope Production and Radiation Technology	2 473 852	2 439 142	1 942 414	79.6%	496 728
Total Major Programme 2	42 114 082	41 532 212	40 665 759	97.9%	866 453
MP3 — Nuclear Safety and Security					
Overall management, coordination and common activities	4 081 889	3 996 018	3 886 385	97.3%	109 633
Incident and Emergency Preparedness and Response	4 468 227	4 381 982	4 292 404	98.0%	89 578
Safety of Nuclear Installations	10 702 937	10 457 120	9 473 891	90.6%	983 229
Radiation and Transport Safety	7 664 881	7 499 063	7 205 937	96.1%	293 126
Radioactive Waste Management and Environmental Safety	3 865 473	3 785 366	3 615 961	95.5%	169 405
Nuclear Security	6 305 773	6 150 539	5 650 243	91.9%	500 296
Total Major Programme 3	37 089 180	36 270 088	34 124 821	94.1%	2 145 267
MP4 — Nuclear Verification					
Overall management, coordination and common activities	14 125 413	13 947 926	14 123 864	101.3%	(175 938)
Safeguards Implementation	131 398 052	128 815 350	127 913 247	99.3%	902 103
Other Verification Activities	3 185 925	3 091 385	2 988 988	96.7%	102 397
Total Major Programme 4	148 709 390	145 854 661	145 026 099	99.4%	828 562
MP5 — Policy, Management and Administration Services					
Policy, Management and Administration Services	81 376 955	80 358 706	78 442 829	97.6%	1 915 877
Total Major Programme 5	81 376 955	80 358 706	78 442 829	97.6%	1 915 877
MP6 — Management of Technical Cooperation for Development					
Management of Technical Cooperation for Development	26 731 414	26 250 394	25 519 686	97.2%	730 708
Total Major Programme 6	26 731 414	26 250 394	25 519 686	97.2%	730 708
Total Operational Regular Budget	377 433 712	370 915 464	359 993 064	97.1%	10 922 400
Major Capital Investment Funding Requirements***					
MP1 — Nuclear Power, Fuel Cycle and Nuclear Science	—	—	—	—	—
MP2 — Nuclear Techniques for Development and Environmental Protection	2 034 000	2 029 202	47 466	2.3%	1 981 736
MP3 — Nuclear Safety and Security	305 100	305 100	—	—	305 100
MP4 — Nuclear Verification	1 017 000	1 017 000	—	—	1 017 000
MP5 — Policy, Management and Administration Services	2 745 900	2 745 900	844 966	30.8%	1 900 934
MP6 — Management of Technical Cooperation for Development	—	—	—	—	—
Total Capital Regular Budget	6 102 000	6 097 202	892 432	14.6%	5 204 770
Total Agency Programmes	383 535 712	377 012 666	360 885 496	95.7%	16 127 170
Reimbursable Work for Others	3 129 353	3 129 353	3 194 505	102.1%	(65 152)
Total Regular Budget	386 665 065	380 142 019	364 080 001	95.8%	16 062 018

* General Conference resolution GC(63)/RES/3 of September 2019 original budget at US \$1/€1.

** Original budget revalued at the United Nations operational average rate of exchange of €0.878 to US \$1 in 2020.

*** Additional information about the Major Capital Investment Fund can be found in note 39d of *The Agency's Financial Statements for 2020*.

Table A2. Extrabudgetary regular programme fund resource utilization in 2020 by Programme and Major Programme (in euros)

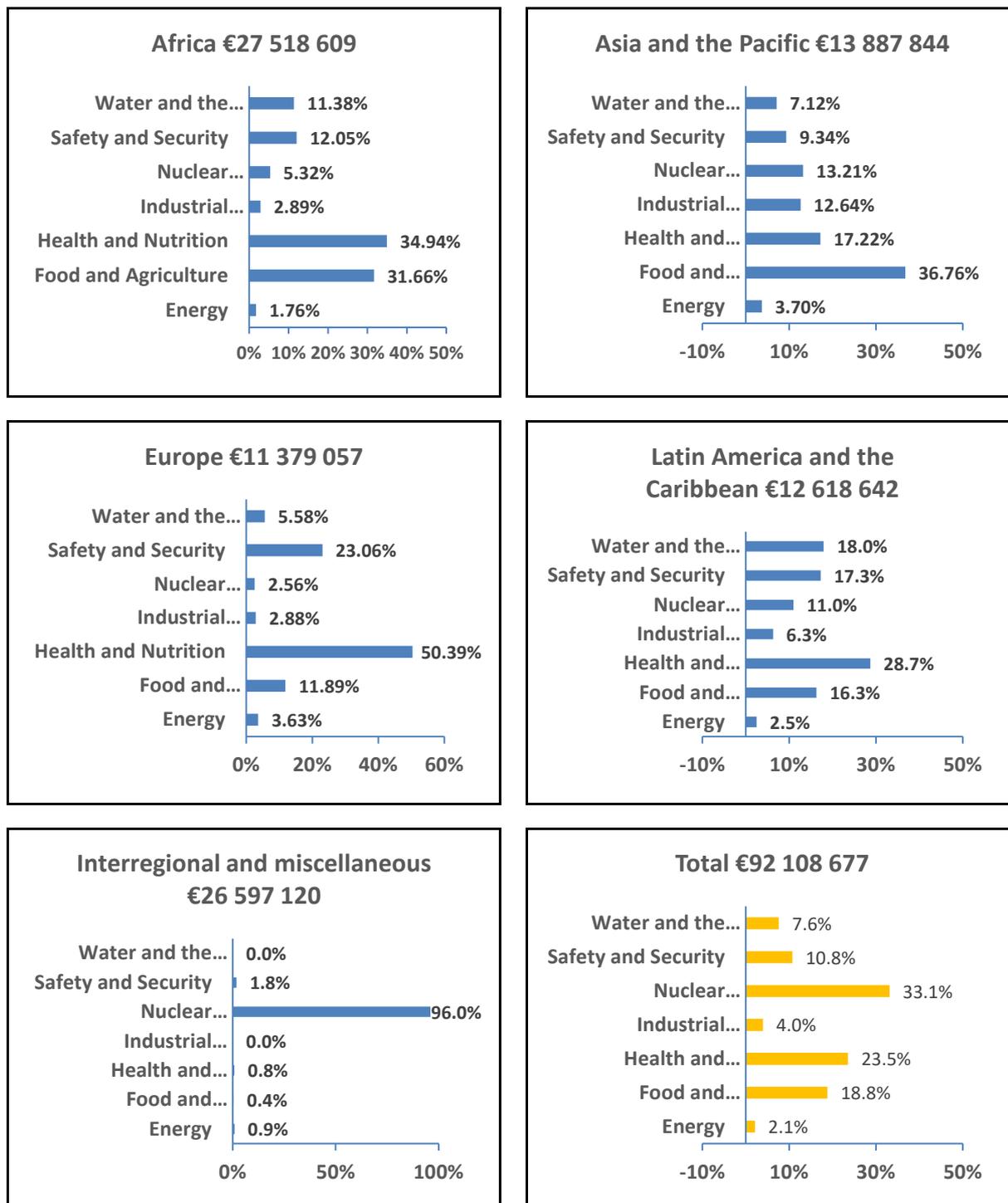
Major Programme (MP)/Programme	2020 net expenditure
MP1 — Nuclear Power, Fuel Cycle and Nuclear Science	
Overall management, coordination and common activities	50 212
Nuclear Power	2 800 315
Nuclear Fuel Cycle and Waste Management	2 565 940
Capacity Building and Nuclear Knowledge for Sustainable Energy Development	577 033
Nuclear Science	2 779 119
Total Major Programme 1	8 772 619
MP2 — Nuclear Techniques for Development and Environmental Protection	
Overall management, coordination and common activities	1 257 888
Food and Agriculture	4 271 857
Human Health	239 204
Water Resources	34 599
Environment	1 042 236
Radioisotope Production and Radiation Technology	293 384
Total Major Programme 2	7 139 168
MP3 — Nuclear Safety and Security	
Overall management, coordination and common activities	2 609 699
Incident and Emergency Preparedness and Response	584 999
Safety of Nuclear Installations	2 665 476
Radiation and Transport Safety	709 216
Radioactive Waste Management and Environmental Safety	942 470
Nuclear Security	14 781 286
Total Major Programme 3	22 293 146
MP4 — Nuclear Verification	
Overall management, coordination and common activities	1 896 797
Safeguards Implementation	20 172 908
Other Verification Activities	4 765 219
Total Major Programme 4	26 834 924
MP5 — Policy, Management and Administration Services	
Policy, Management and Administration Services	1 590 861
Total Major Programme 5	1 590 861
MP6 — Management of Technical Cooperation for Development	
Management of Technical Cooperation for Development	371 953
Total Major Programme 6	371 953
Total extrabudgetary programme funds	67 002 671

Table A3(a). Disbursements (actuals) of the Technical Cooperation Fund by technical field and region in 2020

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	484 354	513 619	413 277	314 814	228 070	0	1 954 133
Food and Agriculture	8 713 334	5 105 342	1 352 496	2 057 465	115 280	0	17 343 917
Health and Nutrition	9 613 849	2 391 799	5 733 910	3 621 776	222 611	107 405	21 691 349
Industrial Applications/ Radiation Technology	796 608	1 755 598	328 278	793 491	0	0	3 673 975
Nuclear Knowledge Development and Management	1 464 558	1 834 813	291 250	1 386 277	25 537 890	0	30 514 788
Safety and Security	3 315 245	1 297 294	2 624 561	2 178 183	488 621	0	9 903 904
Water and the Environment	3 130 660	989 380	635 285	2 266 637	4 648	0	7 026 610
Total	27 518 609	13 887 844	11 379 057	12 618 642	26 597 120	107 405	92 108 677

^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 2020 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	148 124	3 174	21 056	172 354
Separated plutonium outside reactor cores	1 261	5	10 971	12 237
High enriched uranium (equal to or greater than 20% U-235)	155	1	0	156
Low enriched uranium (less than 20% U-235)	19 216	366	1 237	20 819
Source material ^c (natural and depleted uranium and thorium)	11 571	1 741	2 536	15 848
U-233	18	0	0	18
Total SQs of nuclear material	180 345	5 287	35 800	221 432

Amount of heavy water under Agency safeguards at the end of 2020 by type of agreement

Non-nuclear material ^d	Comprehensive safeguards agreement	INFCIRC/66-type agreement	Voluntary offer agreement	Quantity in tonnes
Heavy water (tonnes)		423.3		424.0^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 2020

Type	Comprehensive safeguards agreement ^a	INFCIRC/66-type agreement ^b	Voluntary offer agreement	Total
Power reactors	245	17	1	263
Research reactors and critical assemblies	146	3	1	150
Conversion plants	17	0	0	17
Fuel fabrication plants	37	3	1	41
Reprocessing plants	10	0	1	11
Enrichment plants	16	0	3	19
Separate storage facilities	133	2	4	139
Other facilities	77	0	0	77
Facility subtotals	681	25	11	717
Material balance areas containing locations outside facilities ^c	603	1	0	604
Total	1284	26	11	1321

^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 65 material balance areas in States with amended small quantities protocols.

Table A6. Conclusion of safeguards agreements, additional protocols and small quantities protocols (status as of 31 December 2020)

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	Amended: 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
<i>Cabo Verde</i>	<i>Amended: 27 Mar. 2006</i>	<i>Signed: 28 Jun. 2005</i>		<i>Signed: 28 Jun. 2005</i>
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
<i>Equatorial Guinea</i>	<i>Approved: 13 Jun. 1986</i>	<i>Approved: 13 Jun. 1986</i>		
<i>Eritrea</i>	<i>Approved: 11 Mar. 2020</i>	<i>Approved: 11 Mar. 2020</i>		<i>Approved: 11 Mar. 2020</i>
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
<i>Guinea</i>	<i>Signed: 13 Dec. 2011</i>	<i>Signed: 13 Dec. 2011</i>		<i>Signed: 13 Dec. 2011</i>
<i>Guinea-Bissau</i>	<i>Signed: 21 Jun. 2013</i>	<i>Signed: 21 Jun. 2013</i>		<i>Signed: 21 Jun. 2013</i>
Guyana ²	X	In force: 23 May 1997	543	
Haiti ²	Amended: 22 Jan. 2020	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
India¹⁹		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	
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
Malta ²³		Accession: 1 Jul. 2007	193	Accession: 1 Jul. 2007
Marshall Islands		In force: 3 May 2005	653	In force: 3 May 2005

State ^a	Small quantities protocols ^b	Safeguards agreements ^c	INFCIRC	Additional protocols
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
<i>Micronesia, Federated States of</i>	<i>Signed: 1 Jun. 2015</i>	<i>Signed: 1 Jun. 2015</i>		
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	
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

State ^a	Small quantities protocols ^b	Safeguards agreements ^c	INFCIRC	Additional protocols
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	
<i>Sao Tome and Principe</i>	<i>Approved: 21 Nov. 2019</i>	<i>Approved: 21 Nov. 2019</i>		<i>Approved: 21 Nov. 2019</i>
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	
<i>Somalia</i>				
South Africa		In force: 16 Sep. 1991	394	In force: 13 Sep. 2002

State ^a	Small quantities protocols ^b	Safeguards agreements ^c	INFCIRC	Additional protocols
Spain		Accession: 5 Apr. 1989	193	In force: 30 Apr. 2004
Sri Lanka		In force: 6 Aug. 1984	320	Approved: 12 Sep. 2018
<i>State of Palestine</i> ³²	<i>Signed: 14 Jun. 2019</i>	<i>Signed: 14 Jun. 2019</i>		
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
<i>Timor-Leste</i>	<i>Signed: 6 Oct. 2009</i>	<i>Signed: 6 Oct. 2009</i>		<i>Signed: 6 Oct. 2009</i>
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 ³⁵ Signed: 6 Jan. 1993 ¹⁵ In force: 31 Dec. 2020 ³⁶	175 263* 951*	In force: 30 Apr. 2004 ³⁵ In force: 31 Dec. 2020 ³⁶
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
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

State ^a	Small quantities protocols ^b	Safeguards agreements ^c	INFCIRC	Additional protocols
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 (reproduced in INFCIRC/133) and 6 December 1971 (reproduced in INFCIRC/158), respectively.

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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in INFCIRC/176/Add.1).
- ¹³ The application of safeguards for Estonia under the NPT bilateral safeguards agreement (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in INFCIRC/211), in force since 30 September 1971, was suspended as of 20 March 2015. The application of safeguards for India under the safeguards agreements between the Agency and India reproduced in the following INFCIRCs 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in INFCIRC/118), was suspended as of 14 September 1973.
- ²⁵ Whereas the NPT safeguards agreement and SQP with New Zealand (reproduced in INFCIRC/185) also apply to Cook Islands and Niue, the additional protocol thereto (reproduced in 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 (reproduced in INFCIRC/185/Mod.1).
- ²⁶ The application of safeguards for Poland under the NPT bilateral safeguards agreement (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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 (reproduced in 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.
- ³⁵ The voluntary offer safeguards agreement between the United Kingdom, Euratom and the Agency (reproduced in INFCIRC/263) and the additional protocol thereto (reproduced in INFCIRC/263/Add.1) terminated on 31 December 2020 at 23:00 GMT.
- ³⁶ The voluntary offer safeguards agreement between the United Kingdom and the Agency (reproduced in INFCIRC/951) and the additional protocol thereto (reproduced in INFCIRC/951/Add.1) entered into force on 31 December 2020 at 23:00 GMT.

Table A7. Participation in multilateral treaties for which the Director General is the depositary (status as of 31 December 2020)

	State/Organization ^a	P&I	ENC	AC	CNS	JC	CPPNM	A/CPNPM	VC	PVC	CSC	JP
*	Afghanistan						X					
*	Albania	X	X	X	X	X	X	X				
*	Algeria		X	X			X	X				
	Andorra						X					
*	Angola		X		X		X	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/GPPNM	VC	PVC	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			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/GPPNM	VC	PVC	CSC	JP
	Equatorial Guinea						X					
*	Eritrea	X	X	X		X	X	X				
*	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	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	PVC	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/GPPNM	VC	PVC	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			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	PVC	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/GPPNM	VC	PVC	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		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/CPNM	VC	PVC	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/CPNM	Amendment to the Convention on the Physical Protection of Nuclear Material
VC	Vienna Convention on Civil Liability for Nuclear Damage
PVC	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 (RSA) Concerning the Provision of Technical Assistance by the Agency (status as of 31 December 2020)^a

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

^a In 2020, no State concluded an RSA with the Agency. 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 2020)^a

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

^a In 2020, no State accepted the Amendment to Article VI of the Agency's Statute. By the end of the year, there were 62 States.

**Table A10. Acceptance of Amendment to Article XIV.A of the Agency's Statute
(status as of 31 December 2020)^a**

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

^a In 2020, no State accepted the Amendment to Article XIV.A of the Agency's Statute. By the end of the year, there were 60 States.

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 2020, there was 1 new Party to the Agreement. By the end of the year, there were 91 Parties.

Convention on Early Notification of a Nuclear Accident (reproduced in INFCIRC/335). Entered into force on 27 October 1986. In 2020, there were 3 new Parties to the Convention. By the end of the year, there were 127 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 2020, there were 3 new Parties to the Convention. By the end of the year, there were 122 Parties.

Convention on Nuclear Safety (reproduced in INFCIRC/449). Entered into force on 24 October 1996. In 2020, there was 1 new Party to the Convention and 1 new Contracting State. By the end of the year, there were 89 Parties and 1 Contracting State.

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 2020, there was 1 new Party to the Convention. By the end of the year, there were 83 Parties.

Convention on the Physical Protection of Nuclear Material (reproduced in INFCIRC/274/Rev.1). Entered into force on 8 February 1987. In 2020, there were 3 new Parties to the Convention. By the end of the year, there were 162 Parties.

Amendment to the Convention on the Physical Protection of Nuclear Material. Entered into force on 8 May 2016. In 2020, there were 3 new Parties to the Amendment. By the end of the year, there were 125 Parties.

Vienna Convention on Civil Liability for Nuclear Damage (reproduced in INFCIRC/500). Entered into force on 12 November 1977. In 2020, there was 1 new Party to the Convention. By the end of the year, there were 43 Parties.

Optional Protocol Concerning the Compulsory Settlement of Disputes (reproduced in INFCIRC/500/Add.3). Entered into force on 13 May 1999. In 2020, 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 2020, there was 1 new Party to the Protocol. By the end of the year, there were 15 Parties.

Convention on Supplementary Compensation for Nuclear Damage (reproduced in INFCIRC/567). Entered into force on 15 April 2015. In 2020, the status of the Convention remained unchanged with 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 2020, there was 1 new Party to the Protocol. By the end of the year, there were 31 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 2020, there were 2 new Parties to the Agreement. By the end of the year, there were 19 Parties.

African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) (reproduced in INFCIRC/935). Entered into force on 4 April 2020. By the end of the year, there were 11 Parties.

Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) (Second Extension) (reproduced in INFCIRC/582/Add. 5). Entered into force on 5 September 2020. By the end of the year, there were 15 Parties.

Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) (reproduced in INFCIRC/929). Entered into force on 28 July 2020. By the end of the year, there were 4 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 2020, 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 2020, 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 2020)^a**

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2020		Total operating experience through 2020	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW-h	% of total	Years	Months
Argentina	3	1 641	1	25	10.0	7.5	91	2
Armenia	1	415			2.6	34.5	46	8
Bangladesh			2	2 160				
Belarus	1	1 110	1	1 110	0.3	1.0	0	2
Belgium	7	5 942			32.8	39.1	310	7
Brazil	2	1 884	1	1 340	13.2	2.1	59	3
Bulgaria	2	2 006			15.9	40.8	169	3
Canada	19	13 624			92.2	14.6	788	6
China	50	47 528	13	12 565	344.7	4.9	418	8
Czech Republic	6	3 934			28.4	37.3	176	10
Finland	4	2 794	1	1 600	22.4	33.9	167	4
France	56	61 370	1	1 630	338.7	70.6	2 337	0
Germany	6	8 113			60.9	11.3	852	7
Hungary	4	1 902			15.2	48.0	142	2
India	22	6 255	7	4 824	40.4	3.3	548	11
Iran, Islamic Republic of	1	915	1	974	5.8	1.7	9	4
Japan	33	31 679	2	2 653	43.1	5.1	1 932	6
Kazakhstan							25	10
Korea, Republic of	24	23 150	4	5 360	152.6	29.6	596	2
Mexico	2	1 552			10.9	4.9	57	11
Netherlands	1	482			3.9	3.3	76	0
Pakistan	5	1 318	2	2 028	9.6	7.1	87	5
Romania	2	1 300			10.6	19.9	37	11
Russian Federation	38	28 578	3	3 459	201.8	20.6	1 372	5
Slovakia	4	1 837	2	880	14.4	53.1	176	7

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2020		Total operating experience through 2020	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW·h	% of total	Years	Months
Slovenia	1	688			6.0	37.8	39	3
South Africa	2	1 860			11.6	5.9	72	3
Spain	7	7 121			55.8	22.2	350	1
Sweden	6	6 882			47.4	29.8	474	0
Switzerland	4	2 960			23.0	32.9	228	11
Turkey			2	2 228	NA	NA		
Ukraine	15	13 107	2	2 070	71.5	51.2	533	6
United Arab Emirates	1	1 345	3	4 035	1.6	1.1	0	5
United Kingdom	15	8 923	2	3 260	45.7	14.5	1 634	7
United States of America	94	96 553	2	2 234	789.9	19.7	4 600	10
Total ^{b,c}	442	392 612	52	54 435	2 553.2		18 772	10

Note: NA = Not applicable.

^a Data are from the IAEA's Power Reactor Information System (PRIS) (www.iaea.org/pris) as of 1 June 2021.

^b The total figures include the following data from Taiwan, China: 4 units, 3844 MW(e) in operation.

^c 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 (232 years, 8 months).

Table A13. Member State participation in selected Agency activities in 2020

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
Afghanistan					
Albania	2			6	
Algeria	6				
Angola					
Antigua and Barbuda					
Argentina	46	1	2	3	
Armenia	2				
Australia	42	1	3		
Austria	9		4		
Azerbaijan	2				
Bahamas	1				
Bahrain					
Bangladesh	17				
Barbados					
Belarus	6		1		
Belgium	17		2		
Belize					
Benin	1				
Bolivia, Plurinational State of	1				
Bosnia and Herzegovina	1		3	7	
Botswana	1				
Brazil	58	3	4		
Brunei Darussalam					
Bulgaria	7		2	19	
Burkina Faso	9	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
Burundi					
Cambodia				3	
Cameroon	5				1
Canada	35		3		
Central African Republic					
Chad	1				
Chile	12		1		
China	100	2	3		
Colombia	5				
Congo					
Costa Rica	10	1	1		
Côte d'Ivoire	1				
Croatia	13		2	12	1
Cuba	14		3		
Cyprus			1	3	1
Czech Republic	8		1		
Dem. Rep. of the Congo					
Denmark	4		1		
Djibouti					
Dominica					
Dominican Republic					
Ecuador	7		1		
Egypt	20	1	1		
El Salvador					
Eritrea					
Estonia	4		1	4	

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
Eswatini					1
Ethiopia	9		1	2	
Fiji					
Finland	12		1		
France	58	2	5		
Gabon					
Georgia	1				
Germany	44		6		3
Ghana	14				
Greece	18		6		
Grenada					
Guatemala	7			2	
Guyana					
Haiti					
Holy See					
Honduras				2	
Hungary	20	2	3	21	1
Iceland			1		
India	72	1	3	6	
Indonesia	27	2	1	9	
Iran, Islamic Republic of	17		3		
Iraq			1	8	
Ireland	2		1		1
Israel	11		2	12	
Italy	41	3	8		
Jamaica	7		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
Japan	43	2	5		
Jordan	5		1	3	
Kazakhstan	1		1		
Kenya	15		1	4	1
Korea, Republic of	37	2	2		
Kuwait	6	1	1		
Kyrgyzstan	2				
Lao People's Dem. Rep.	1				
Latvia			1	5	
Lebanon	7		1	9	
Lesotho					
Liberia					
Libya				4	
Liechtenstein					
Lithuania	9		3	9	
Luxembourg	1		1		
Madagascar	3		1		
Malawi					
Malaysia	25	1	1	25	
Mali	1				
Malta					
Marshall Islands					
Mauritania					
Mauritius	5				
Mexico	32	2	3	13	
Monaco					
Mongolia	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
Montenegro	1		1		
Morocco	23	1	1		
Mozambique				3	
Myanmar	4		1	6	
Namibia	2			1	1
Nepal	1			15	
Netherlands	11	1	4		2
New Zealand	6		1		
Nicaragua	1				
Niger					1
Nigeria	4			1	1
North Macedonia	5		1	3	
Norway	3	1	2		
Oman					
Pakistan	39	1	1	12	
Palau					
Panama	1		1		
Papua New Guinea	1				
Paraguay					
Peru	9		1		
Philippines	12	1	1		
Poland	24	1	6		
Portugal	12	1	1		
Qatar			1		
Republic of Moldova				3	
Romania	19		4	32	
Russian Federation	52	1	4		

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
Rwanda					
Saint Lucia					
Saint Vincent and the Grenadines					
San Marino					
Saudi Arabia	6	1	1	8	
Senegal	7			3	1
Serbia	10		5	16	1
Seychelles					
Sierra Leone					
Singapore	9		3		
Slovakia	7		3		
Slovenia	10		1	4	
South Africa	30		3	16	
Spain	42	2	2		
Sri Lanka	12		1	13	
Sudan	7			3	
Sweden	9		2		
Switzerland	10	2	3		
Syrian Arab Republic	9		1		
Tajikistan			1	1	
Thailand	27	1	2	33	
Togo					1
Trinidad and Tobago	1			2	
Tunisia	17		1	4	
Turkey	20		2	21	
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
Uganda	6				
Ukraine	24		1	4	
United Arab Emirates	2	1	3		
United Kingdom	43	1	5		
United Republic of Tanzania	3			1	1
United States of America	107	1	7		
Uruguay	8		1		1
Uzbekistan			1		
Vanuatu					
Venezuela, Bolivarian Republic of			2		
Viet Nam	21	1	3		
Yemen					
Zambia	7		1		3
Zimbabwe	3				
Total	1710	46	192	396	23

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

Table A14. Advisory Missions on Regulatory Infrastructure for Radiation Safety (AMRAS) in 2020

Type	Country
AMRAS	Myanmar

Table A15. Education and Training Appraisal (EduTA) missions in 2020

Type	Country
EduTA	Jordan

Table A16. IAEA-designated International Centres based on Research Reactors (ICERR)

Type	Organization/Research Centre	Country	Year of designation
ICERR	Institute for Nuclear Research Pitesti	Romania	2020
ICERR redesignation	Research Centres of Saclay and Cadarache, in partnership with the Institute for Radiological Protection and Nuclear Safety	France	2020
ICERR	Korea Atomic Energy Research Institute	Republic of Korea	2019
ICERR	Nuclear Research Centre SCK•CEN	Belgium	2017
ICERR	Idaho and Oak Ridge National Laboratories of the US Department of Energy	United States of America	2017
ICERR	Research Institute of Atomic Reactors	Russian Federation	2016
ICERR	Research Centres of Saclay and Cadarache	France	2015

Table A17. Integrated missions of the Agency's Programme of Action for Cancer Therapy (imPACT) in 2020

Type	Country
imPACT	Central African Republic
imPACT	Mali
imPACT	Senegal

Table A18. Integrated Nuclear Infrastructure Review (INIR) missions in 2020

Type	Country
INIR Phase 3	Belarus

Table A19. International Nuclear Management Academy (INMA) members designated in 2020

Type	Organization/Research Centre	Country	Year of designation
INMA	Budapest University of Technology and Economics	Hungary	2020
INMA	North-West University	South Africa	2020
INMA	University of the Witwatersrand	South Africa	2020

Table A20. Integrated Safety Assessment of Research Reactors (INSARR) missions in 2020

Type	Country
INSARR	Czech Republic

Table A21. Integrated Regulatory Review Service (IRRS) missions in 2020

Type	Country
IRRS follow-up	Japan
IRRS follow-up	Lithuania
IRRS follow-up	Malta

Table A22. Knowledge Management Assist Visit (KMAV) missions in 2020

Type	Organization/nuclear power plant	Country
KMAV	Chilean Nuclear Energy Commission	Chile
KMAV	Radioactive Waste Management Organization (PURAM)	Hungary
KMAV	Radioactive Waste Management Organization (ANDR)	Romania
KMAV	National organizations involved with developing the national nuclear programme	Uzbekistan
KMAV	National organizations involved with nuclear technology and potential future new nuclear power programmes	Viet Nam

Table A23. Operational Safety Review Team (OSART) missions in 2020

Type	Country
OSART	Pakistan
OSART follow-up	Finland

Table A24. Peer Review of Operational Safety Performance Experience (PROSPER) missions in 2020

Type	Country
PROSPER	Belgium

Table A25. Safety Aspects of Long Term Operation (SALTO) missions in 2020

Type	Country
SALTO	Romania
SALTO follow-up	Sweden

Table A26. Technical Safety Reviews (TSRs) in 2020

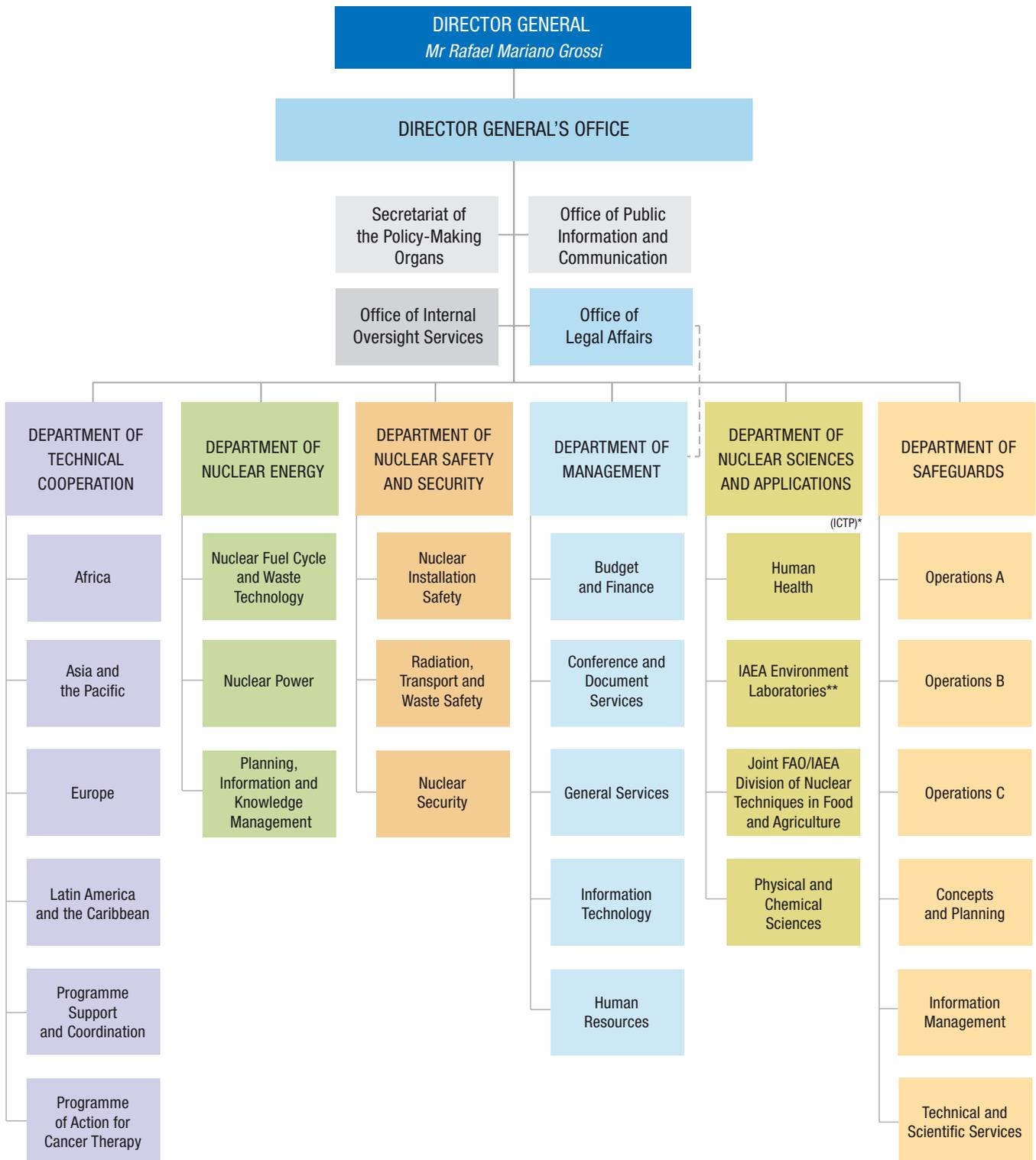
Type	Country
Safety Requirements Review	Nigeria
Design Safety Review	Hungary

Table A27. Safety Culture Continuous Improvement Process (SCCIP) missions in 2020

Type	Country
SCCIP	Russian Federation

ORGANIZATIONAL CHART

(as of 31 December 2020)



* 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.

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“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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