IAEA
International Atomic Energy Agency

ANNUAL REPORT

2024

Atoms for Peace and Development

FOREWORD

by IAEA Director General Rafael Mariano Grossi

In an increasingly interconnected and rapidly evolving world, the International Atomic Energy Agency serves as a beacon of scientific excellence, international cooperation and innovation, and as a watchdog guarding against the proliferation of nuclear weapons. In 2024, we broadened and deepened our support to Member States, assisting them in harnessing nuclear science and technology to achieve their development goals and address some of the world's most pressing challenges.

Our flagship initiatives Rays of Hope, ZODIAC and NUTEC Plastics are well into their implementation phase. Under Rays of Hope, the Agency facilitated the delivery of life-saving cancer care equipment to numerous countries and more than doubled the number of regional anchor centres, creating hubs of cancer care excellence around the world. In the fight against zoonotic disease outbreaks, the ZODIAC initiative delivered important diagnostic equipment and support to its growing global network. I started 2024 by travelling to the Antarctic to launch an important NUTEC Plastics research project, the results of which have shown that microplastics have reached as far as this remote and pristine environment. Meanwhile, Atoms4Food, our joint initiative with the Food and Agriculture Organization of the United Nations, is well defined and under way, having garnered much interest from Member States looking to improve food safety, food security and agricultural practices.

Towards the end of the year, our Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme underscored our important partnership with Member States in this area.

In Seibersdorf, the refurbishment of the Agency's unique laboratories entered its final stage, with all new facilities expected to be operational in 2025.

For nuclear energy, 2024 was a milestone year as the Agency co-organized with Belgium the first ever Nuclear Energy Summit, where 30 Heads of State and high-level government officials agreed on concrete steps to boost nuclear capacity. As both governments and companies turned their attention to nuclear power, the Agency again raised its projections for nuclear capacity in 2050. We also redoubled our support to Member States, about 50 of which are interested in nuclear energy. Many are looking to small modular reactors (SMRs) and find useful information through our SMR Platform. Meanwhile, facilitating the prompt and safe deployment of SMRs remained the focus of our Nuclear Harmonization and Standardization Initiative and was an important theme at our International Conference on SMRs and their Applications.

As the war in Ukraine entered its third calendar year, the Agency steadfastly supported nuclear safety through its continued presence at nuclear power plant sites in order to prevent a nuclear accident. Despite considerable on-the-ground challenges, including a direct attack on one of our vehicles, the Agency completed 86 staff rotations and published 64 updates in 2024. Deliveries of nuclear safety and security related equipment totalled more than €13 million by the end of the year.

At the Fukushima Daiichi Nuclear Power Station, the Agency introduced additional measures, further building trust and transparency by expanding international involvement in our independent analysis of water samples to ensure that water discharge levels are, and will continue to be, in strict compliance and consistent with international safety standards.

In 2024, the Agency conducted over 3150 in-field verification activities at more than 1380 facilities and locations around the world. As a result, it was able to draw safeguards conclusions for 175 States for which it applied safeguards.

As momentum grew for the advancement of fusion energy from laboratory to commercialization, our inaugural World Fusion Energy Group, and two key publications — the *IAEA World Fusion Outlook 2024* and *Fusion Key Elements* — supported international cooperation, which is crucial to fusion energy's success.

Through the IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes, we again increased the number of women joining and thriving in the sector, and within the Secretariat women made up half of the staff in the Professional and higher categories by the end of 2024.

The IAEA is a global vehicle for peace, progress and economic development, serving the interests of every one of our 180 Member States.

Reflecting on the Agency's achievements over the year gives me a renewed sense of purpose, and I hope it does the same for you.

NOTES

- The *IAEA Annual Report 2024* aims to summarize only the significant activities of the Agency during the year in question. The main part of the report, starting on page 36, generally follows the programme structure as given in *The Agency's Programme and Budget 2024–2025* (GC(67)/5). 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, 'In Focus 2024', covers specific Agency activities — which in some instances are cross-cutting in nature — with a focus on notable developments during the year. More detailed information can be found in the latest editions of the Agency's *Nuclear Safety Review*, *Nuclear Security Review, Nuclear Technology Review*, *Technical Cooperation Report* and *Safeguards Statement and Background to the Safeguards Statement*.

- Tables annexed to this report are 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 9 June 2025, the Board of Governors approved the *Annual Report for 2024* for transmission to the General Conference.

IAEA
International Atomic Energy Agency

IAEA ANNUAL REPORT 2024

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 2024.

GC(69)/3

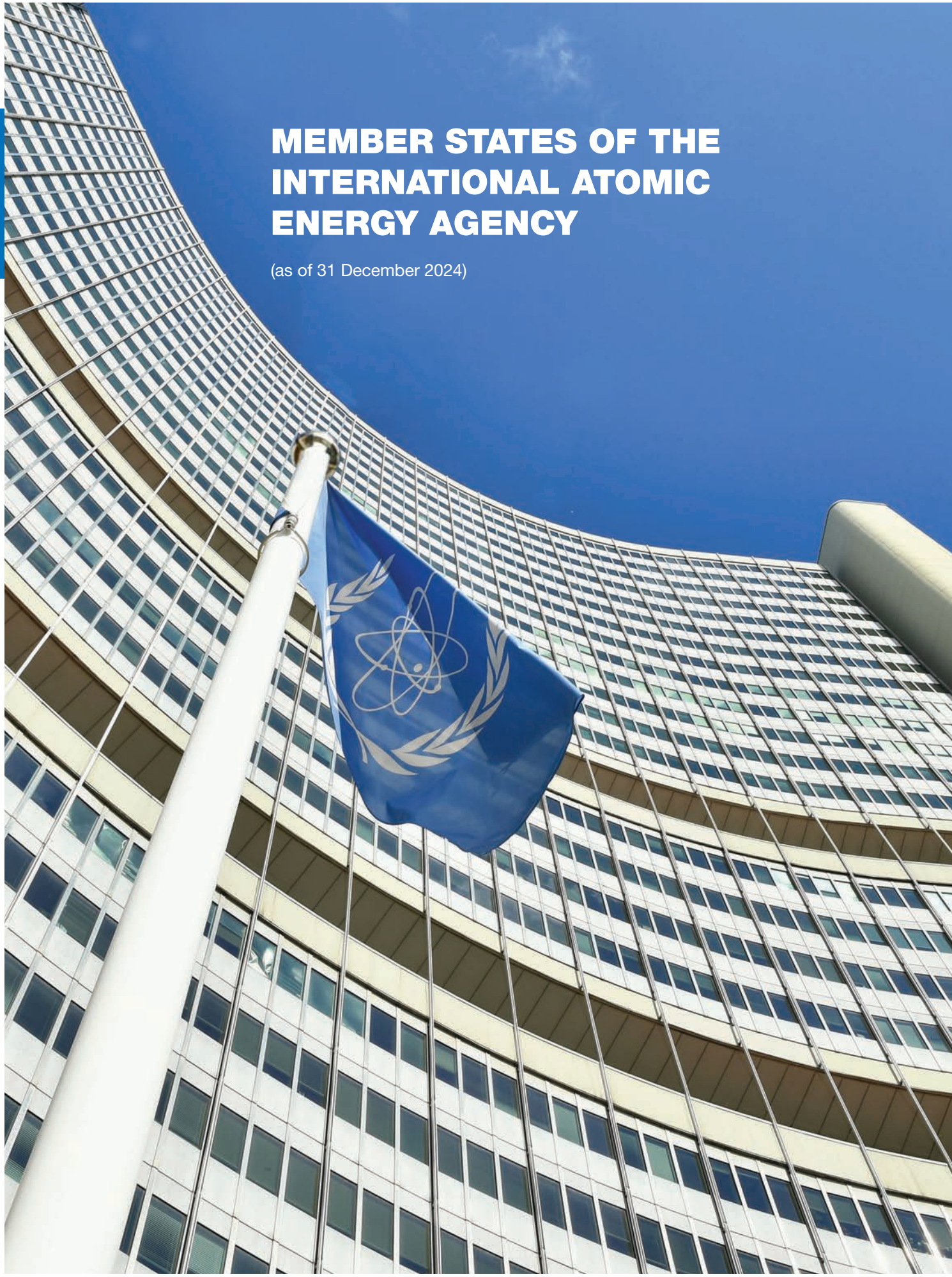
CONTENTS

ANNEX

Scan the QR code to access the Annex to this report.

MEMBER STATES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

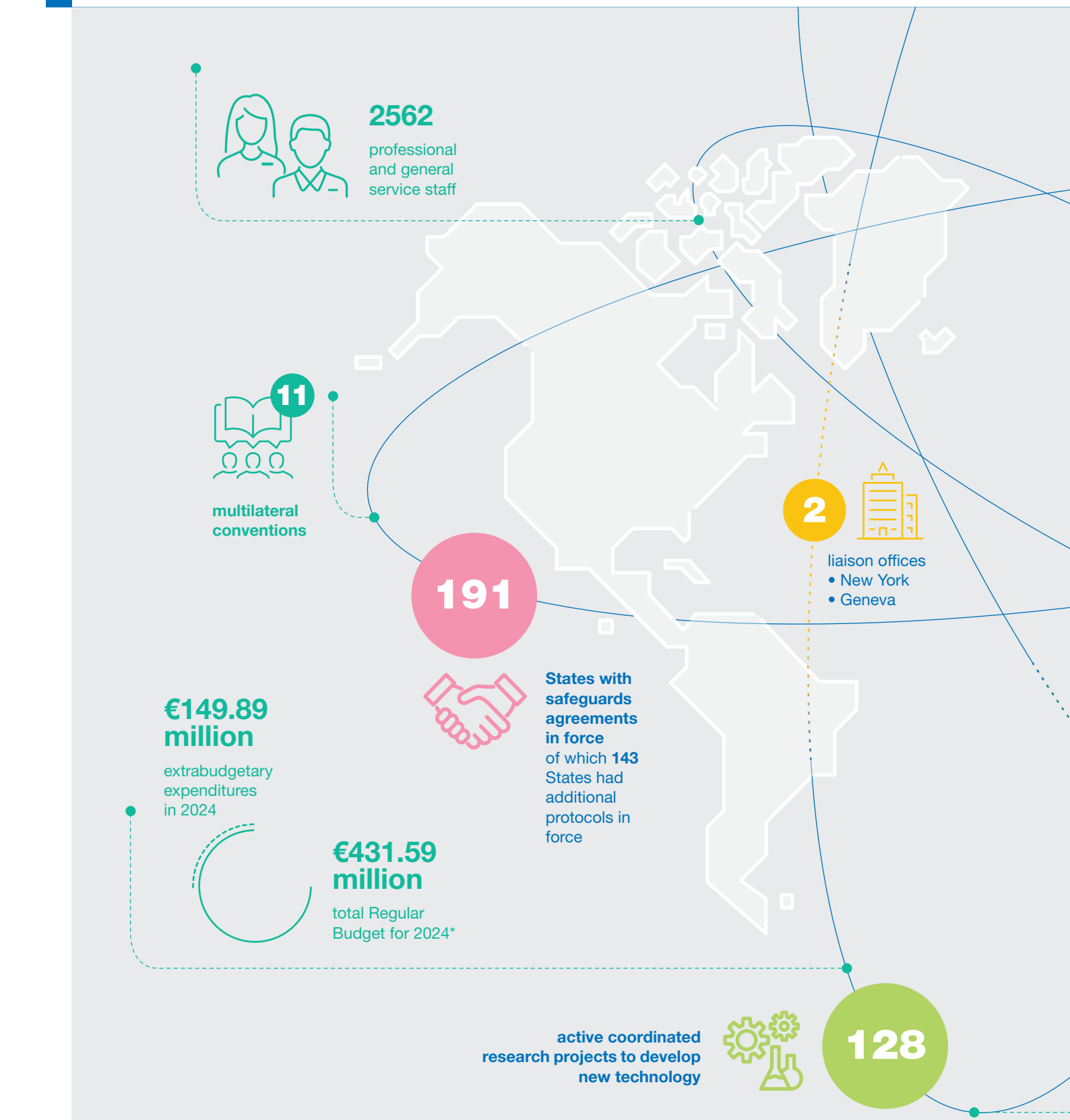
(as of 31 December 2024)



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

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

THE AGENCY AT A GLANCE



2562
professional and general service staff

11
multilateral conventions

2
liaison offices
- New York
- Geneva

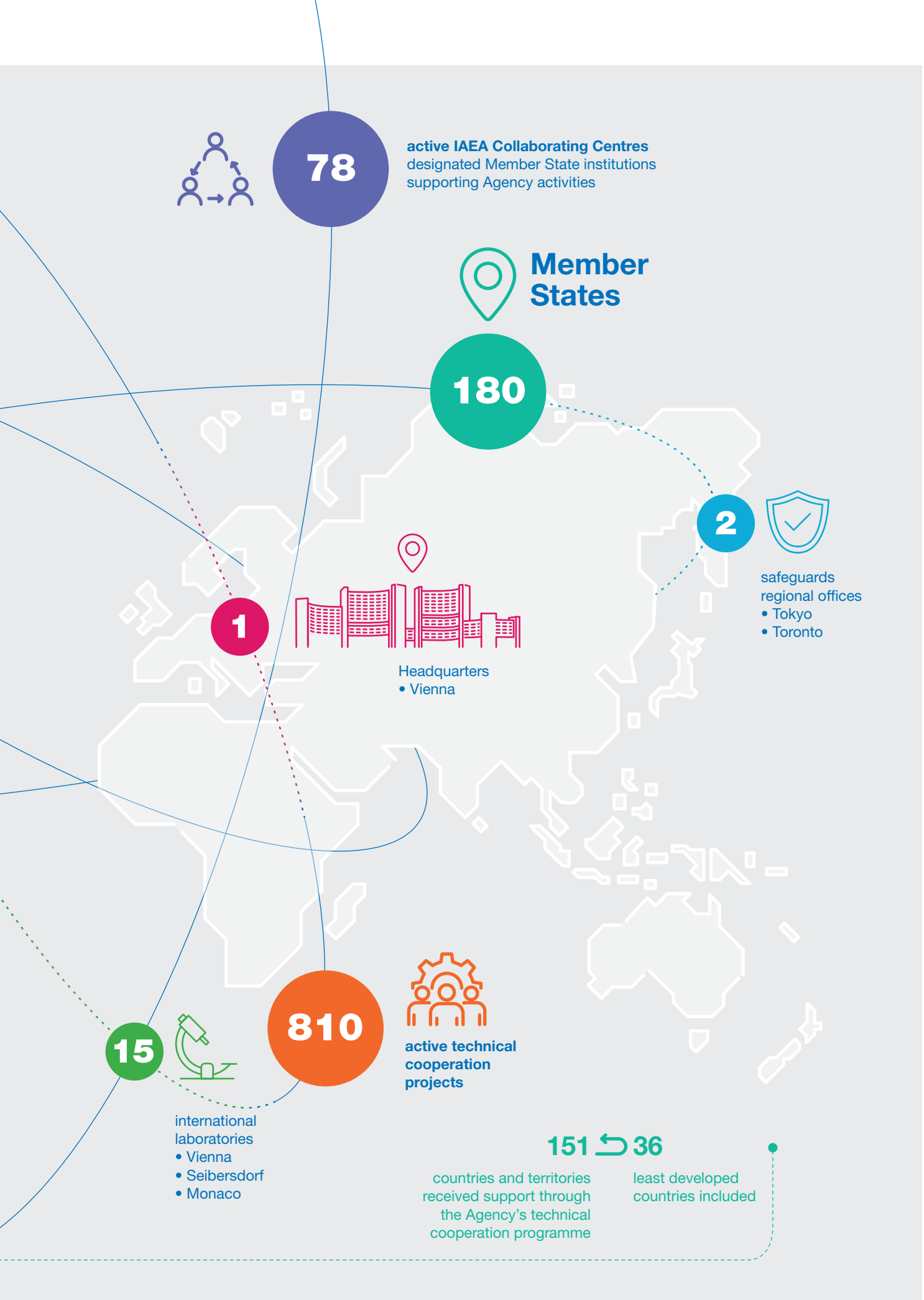
191
States with safeguards agreements in force
of which **143** States had additional protocols in force

€149.89 million
extrabudgetary expenditures in 2024

€431.59 million
total Regular Budget for 2024*

128
active coordinated research projects to develop new technology

* At the United Nations average rate of exchange of US $0.923 to €1.00. The total Regular Budget was €436.16 million at the US $1.00 to €1.00 rate


78
active IAEA Collaborating Centres
designated Member State institutions
supporting Agency activities
Member States
180
2
safeguards
regional offices
• Tokyo
• Toronto
1
Headquarters
• Vienna
15
international
laboratories
• Vienna
• Seibersdorf
• Monaco
810
active technical
cooperation
projects
151
countries and territories
received support through
the Agency's technical
cooperation programme
36
least developed
countries included

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 2024 the Board considered the *Nuclear Technology Review 2024*.

In the area of safety and security, the Board discussed the *Nuclear Safety Review 2024* and the *Nuclear Security Review 2024*.

As regards verification, the Board considered the *Safeguards Implementation Report for 2023*. 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 also considered the Director General's reports on naval nuclear propulsion: Australia and naval nuclear propulsion: Brazil, respectively. The Board kept under its consideration 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 and considered the Director General's respective reports thereon. The Board also kept under its consideration the issue of the NPT Safeguards Agreement with the Islamic Republic of Iran and considered the Director General's reports thereon.

The Board considered the Director General's reports on nuclear safety, security and safeguards in Ukraine.

The Board discussed the *Technical Cooperation Report for 2023* and approved funding for the Agency's technical cooperation programme for 2025.

The Board considered IAEA safeguards in relation to AUKUS and the restoration of the sovereign equality of Member States in the IAEA.

In June 2024, the Board recommended for approval by the General Conference *The Agency's Draft Budget Update for 2025*.

62 reports considered

129 hours of meetings

1704 statements delivered

COMPOSITION OF THE BOARD OF GOVERNORS 2024–2025

CHAIR (2025)

HE Ms Matilda Aku ALOMATU OSEI-AGYEMAN

Governor from Ghana

CHAIR (until Dec 2024)

HE Mr Philbert Abaka JOHNSON

Governor from Ghana

VICE-CHAIRS

HE Mr Andranik HOVHANNISYAN

Governor from Armenia

HE Ms Caroline VERMEULEN

Governor from Belgium

35 Board members

- Algeria
- Argentina
- Armenia
- Australia
- Bangladesh
- Belgium
- Brazil
- Burkina Faso
- Canada
- China
- Colombia
- Ecuador
- Egypt
- France
- Georgia
- Germany
- Ghana
- India
- Indonesia
- Italy
- Japan
- Korea, Republic of
- Luxembourg
- Morocco
- Netherlands, Kingdom of the
- Pakistan
- Paraguay
- Russian Federation
- South Africa
- Spain
- Thailand
- Ukraine
- United Kingdom of Great Britain and Northern Ireland
- United States of America
- Venezuela, Bolivarian Republic of

THE GENERAL CONFERENCE

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

In its sixty-eighth regular session in September 2024, the General Conference approved the Cook Islands and Somalia for membership of the Agency, and adopted resolutions on the Agency's financial statements for 2023; on the Agency's Regular Budget appropriations for 2025; 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; on the application of IAEA safeguards in the Middle East; and on nuclear safety, security and safeguards in Ukraine. The Conference also adopted decisions on the progress made towards the entry into force of the amendment to Article XIV.A of the Statute, approved in 1999, and on the report on the promotion of the efficiency and effectiveness of the IAEA decision-making process.

744 participants

SCIENTIFIC FORUM:
Atoms4Food – Better Agriculture for Better Life

43 speakers

144
general debate statements delivered

2963
participants registered

2671
Member State representatives

108
from international organizations

177
from NGOs

PRESIDENT OF THE GENERAL CONFERENCE

HE Mr HAM Sang Wook

Ambassador and Resident Representative of the Republic of Korea

97
side events

13 179
livestream participants

2932
downloads of the GC68 mobile app

ABBREVIATIONS

ALPS	Advanced Liquid Processing System
AP	additional protocol
ASEAN	Association of Southeast Asian Nations
CLP4NET	Cyber Learning Platform for Network Education and Training
COP	Conference of the Parties to the United Nations Framework Convention on Climate Change
CPF	country programme framework
CRP	coordinated research project
CSA	comprehensive safeguards agreement
CT	computed tomography
DSRS-TeC	Disused Sealed Radioactive Sources Technical Centres peer review service
EPR	emergency preparedness and response
FAO	Food and Agriculture Organization of the United Nations
FINAS	Fuel Incident Notification and Analysis System
GW(e)	gigawatt (electrical)
HEU	high enriched uranium
ICTP	Abdus Salam International Centre for Theoretical Physics
imPACT	integrated missions of PACT
INFCIRC	Information Circular
INIR	Integrated Nuclear Infrastructure Review
INIR-RR	Integrated Nuclear Infrastructure Review for Research Reactors
INPRO	International Project on Innovative Nuclear Reactors and Fuel Cycles
IPPAS	International Physical Protection Advisory Service
IRRS	Integrated Regulatory Review Service
IRRUR	Integrated Research Reactor Utilization Review
IRS	Incident Reporting System
IRSRR	Incident Reporting System for Research Reactors
IUPCR	Integrated Uranium Production Cycle Review
LEU	low enriched uranium
MNSR	miniature neutron source reactor
NCCP	national cancer control programme
NDT	non-destructive testing
NEXSHARE	Network for Experiment and Code Validation Sharing
NNL	National Nuclear Laboratory (United Kingdom)
NORM	naturally occurring radioactive material
NPP	nuclear power plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons

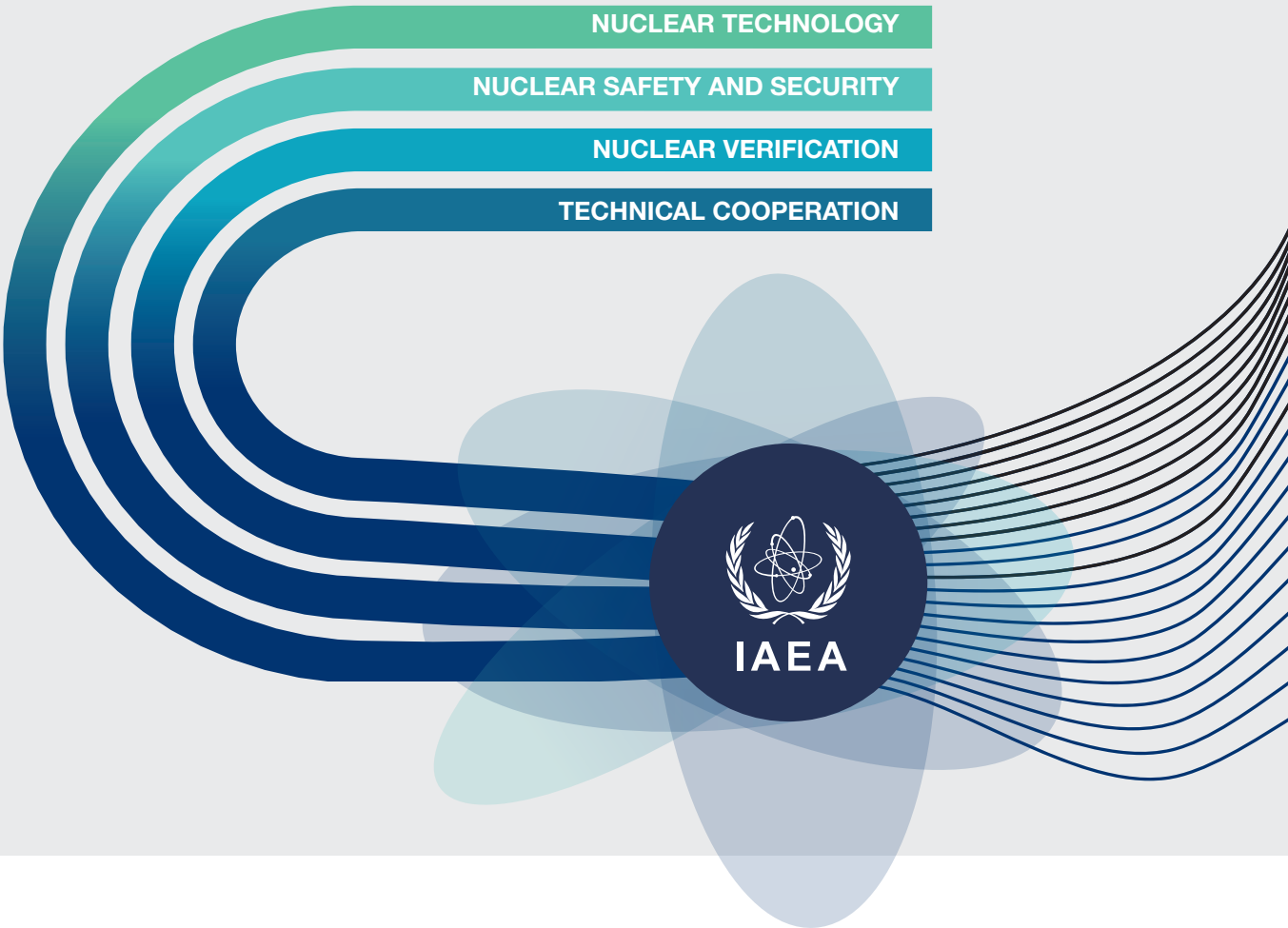
NUTEC Plastics	NUclear TEChnology for Controlling Plastic Pollution
OECD	Organisation for Economic Co-operation and Development
OMARR	Operation and Maintenance Assessment for Research Reactors
OPEC	Organization of the Petroleum Exporting Countries
OSART	Operational Safety Review Team
PET-CT	positron emission tomography–computed tomography
PACT	Programme of Action for Cancer Therapy
PRIS	Power Reactor Information System
QUANUM	Quality Assurance in Nuclear Medicine
QUATRO	Quality Assurance Team for Radiation Oncology
RANET	Response and Assistance Network
RBM	results based management
RISS	Advisory Mission on Regulatory Infrastructure for Radiation Safety and Nuclear Security
SALTO	Safety Aspects of Long Term Operation
SEDO	Safety Evaluation of Fuel Cycle Facilities During Operation
SLOWPOKE	Safe Low Power Critical Experiment
SMR	small modular reactor
SMR Platform	IAEA Platform on Small Modular Reactors and their Applications
SOP	standard operating procedure
SPECT-CT	single photon emission computed tomography–computed tomography
SQP	small quantities protocol
TC	technical cooperation
TCF	Technical Cooperation Fund
TLD	thermoluminescence dosimetry
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Programme
WHO	World Health Organization
ZODIAC	Zoonotic Disease Integrated Action

IN FOCUS 2024

ATOMS FOR PEACE AND DEVELOPMENT

In 2024, the Agency continued to address the needs of Member States in tackling global challenges using nuclear techniques, while maintaining vigilant oversight of nuclear material and facilities in 190 States in accordance with their safeguards agreements with the Agency. The Agency continued its work to highlight the role of nuclear energy, including at the Nuclear Energy Summit 2024 and COP29, and launched a research mission to Antarctica to track plastic pollution using nuclear techniques. Efforts also focused on improving access to nuclear technology and applications in the areas of health, food and agriculture and environmental protection; promoting the participation of women in the nuclear field, with the achievement of gender parity among Agency staff in the Professional and higher categories; conducting safeguards in a war zone; and promoting nuclear safety and security around the world — including by helping to prevent a nuclear accident at nuclear facilities in Ukraine.

'In Focus 2024' provides an overview of some of these key programmatic activities that were implemented with enhanced interdepartmental coordination and in close cooperation with Member States and other interested partners, with a view to making greater impact in addressing global issues. It also includes a section entitled 'Optimizing Organizational Effectiveness', which summarizes efforts to optimize the use of resources and leverage technology to enable efficient and effective programme delivery.



Rays of Hope

The Rays of Hope initiative, launched in 2022, supports Member States' efforts to increase access to safe and secure radiotherapy and diagnostic imaging services, with the goal of reducing cancer deaths worldwide.

More than 90 Member States have requested assistance through Rays of Hope and the Agency has responded by providing vital equipment. In 2024, linear accelerators were provided to Kenya, Malawi and the Niger, and SPECT-CT machines to Benin and Senegal. In addition, mammography units were delivered to six Member States in Latin America, expanding their screening and diagnostic capabilities to tackle breast cancer. Several countries, including Benin, Chad, the Democratic Republic of the Congo, the Dominican Republic, Malawi and Panama, are working on developing infrastructure related to nuclear medicine, radiotherapy and oncological services and the Agency has supported the training of 80 radiation medicine professionals around the world since the start of the initiative.

In 2024, the Agency more than doubled its growing network of Rays of Hope anchor centres, established as knowledge and capacity building hubs to advance cancer care access in their respective regions. Together with the Agency, these centres provide targeted support to other facilities in the region in education, training, innovation, research and quality assurance. Anchor centres in Argentina and Türkiye organized workshops to develop regional roadmaps to strengthen paediatric radiotherapy services and the centre in Japan held a training course for nuclear medicine physicians on theranostics techniques.

To support the anchor centres, the Agency organized a lecture on research programmes and an online workshop on contouring highlighting several of its innovative training tools. Expert missions were also conducted to identify key areas where the Agency could further support the centres. Furthermore, over 120 specialists from the world's leading professional societies for radiation medicine are channelling their expertise and support to anchor centres through dedicated technical working groups.

Industry and international financial institutions continued to be crucial partners. Private sector companies such as Standard Imaging, PTW Dosimetry and IBA Dosimetry signed Practical Arrangements in support of Rays of Hope, including in-kind contributions to anchor centres, and Practical Arrangements were also signed with the OPEC Fund for International Development that included Rays of Hope within their scope.

To date, the Agency has recognized 11 Rays of Hope anchor centres:

- Bab El Oued Teaching Hospital and Pierre and Marie Curie Centre, Algeria;
- National Atomic Energy Commission, Argentina;
- Japanese Network of Cooperation in Radiation Medicine for Rays of Hope, Japan;
- King Hussein Cancer Center, Jordan;
- Korea Institute of Radiological and Medical Sciences, Republic of Korea;
- National Oncology Institute, Morocco;
- Nuclear Medicine, Oncology and Radiotherapy Institute, Pakistan;
- Institute of Oncology Ljubljana, Slovenia;
- Nuclear Medicine Research Infrastructure Facility, South Africa;
- Mahidol University Faculty of Medicine Ramathibodi Hospital, Thailand;
- Ege University Faculty of Medicine, Türkiye.

The Director General underscoring the importance of regional cooperation and capacity building during a side event at the 68th regular session of the Agency's General Conference entitled 'Realizing Hope for All: Rays of Hope Anchor Centres — One Year On'.

ZODIAC

In 2024, the Zoonotic Disease Integrated Action (ZODIAC) initiative continued to enhance Member States' capacity to rapidly detect and respond to outbreaks. By the end of that year, a total of 151 Member States had designated ZODIAC National Coordinators and 129 Member States had ZODIAC National Laboratories (ZNLs).

A coordinated research project was initiated on enhancing laboratory preparedness in the detection, surveillance and control of emerging and re-emerging zoonotic diseases in the Asia and Pacific region. Activities under this project focused on the development of tests that (i) can be used on multiple species to detect viruses such as SARS-CoV-2 and lyssaviruses; (ii) can identify endemic zoonoses presenting similar symptoms, such as those causing abortion in livestock; and (iii) can detect viruses within a family, such as poxviruses.

Together with partners, the Agency has developed a cloud-based server platform for the ZODIAC Respiratory Disease Phenotype Observatory to enhance imaging data, processes and analysis for the improved detection and characterization of infectious respiratory diseases. The Observatory's image repository platform, which uses AI and machine learning algorithms to analyse large datasets, was successfully tested and will start receiving curated imaging data.

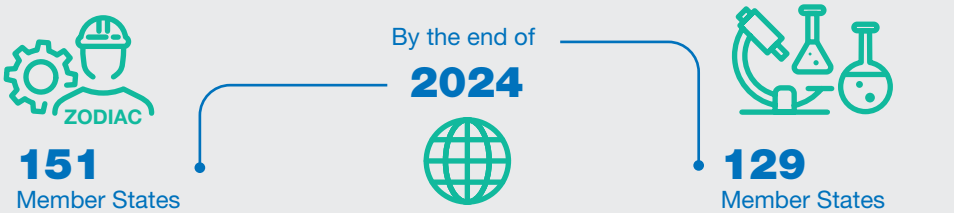
Standard operating procedures for serology molecular diagnostics and the production of secondary standard reference materials were disseminated to ZNLs, and related hands-on training was provided by the Agency as and when required.

A real-time decision-making support platform is under development to digitalize animal health monitoring plans and to facilitate sample collection, testing and traceability reporting. In addition, a regional meeting on ZODIAC implementation in Africa was hosted by Morocco, bringing together 34 ZNLs to review achievements under the initiative and identify synergies with One Health initiatives.

The Agency continued to raise awareness in different forums — including events at the 8th World One Health Congress and the FAO Global Conference on Animal Health Innovation, Reference Centres and Vaccines — about how ZODIAC enhances Member States' laboratory capacity in pandemic preparedness.

As a result of ZODIAC, Latin American zoonotic disease laboratories are much better equipped today than they were five years ago. There is still a need for greater human health and animal health collaboration and the strengthening of biosafety and biosecurity.

Ana Maria Nicola
FAO consultant and member of the ZODIAC Ad-Hoc Scientific Panel



NUTEC Plastics

NUclear TEChnology for Controlling Plastic Pollution (NUTEC Plastics) advances efforts to reduce and monitor plastic pollution globally. The initiative has two components: plastic waste upcycling and marine plastics monitoring.

For the upcycling component, pilot plants in Argentina, Indonesia, Malaysia and the Philippines have developed improved and competitive feedstock, construction materials and promising renewable fuels from plastic waste. These pilots, based on public-private partnerships, have demonstrated the outstanding potential of radiation technology in an industrial environment, attracting interest from the private sector and other countries. China has also joined NUTEC Plastics as a pilot country to develop innovative radiation-assisted upcycling technology. Research and development is under way to use ionizing radiation to transform biomass into biodegradable or easy-to-recycle bio-based plastics, reducing reliance on petroleum-based plastics and reducing greenhouse gas emissions.

Under the marine monitoring component, the NUTEC Plastics Global Marine Monitoring Network, designed to monitor and assess the impact of marine plastics on coastal and marine ecosystems, was launched. In 2024, the Agency conducted its first scientific research mission to Antarctica, with preliminary analysis revealing microplastics in all samples. The results will be shared in early 2025 with the Scientific Committee on Antarctic Research, an interdisciplinary body that provides scientific advisory services to the Antarctic Treaty Consultative Meetings. To date, 104 laboratories have joined the initiative, enabling new data on microplastic pollution to become available regularly.

- In 2024, the number of Member States participating in the upcycling and marine monitoring components of NUTEC Plastics increased from 38 to 41 and from 77 to 100, respectively.
- During the 4th and 5th sessions of the Intergovernmental Negotiating Committee (INC) to develop an international legally binding instrument on plastic pollution, including in the marine environment, NUTEC Plastics raised awareness about the benefits of using nuclear techniques for marine plastics monitoring and about key considerations for negotiators in the INC process to prevent further damage to ocean health from microplastics pollution.

Agency experts on a mission in Antarctica to collect samples for analysis under NUTEC Plastics.

Learn more

Atoms4Food

A joint initiative of the Food and Agriculture Organization of the United Nations (FAO) and the Agency, Atoms4Food aims to provide Member States with tailor-made and integrated solutions by harnessing nuclear science and technologies along with other advanced technologies through seven Atoms4Food services.

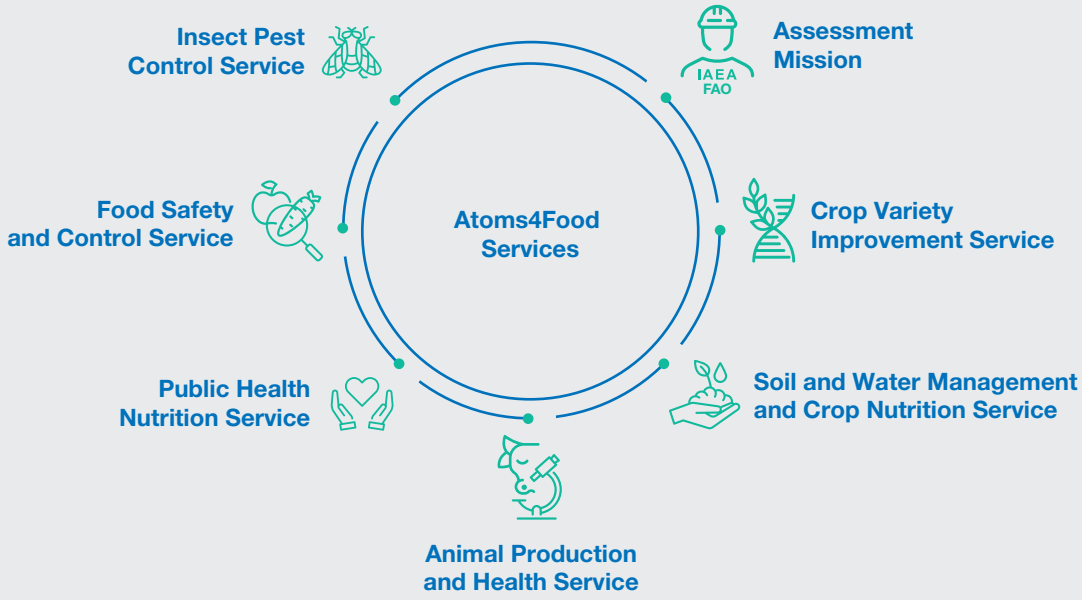
The initiative aims to improve food security for all by making agri-food system transformation more efficient, inclusive, resilient and sustainable. In 2024, Atoms4Food continued to boost interest among Member States and donors in the application of nuclear techniques in food and agriculture.

In 2024, the Agency developed a comprehensive plan for implementation of the Atoms4Food initiative to optimize the use of nuclear applications for sustainable agri-food system transformation. To set the baselines and analyse specific needs and strategic priorities in Member States, the Atoms4Food Assessment Mission will map countries' food security and nutrition needs and their comparative advantage in using nuclear, isotopic and associated techniques, as a basis for tailored interventions. A questionnaire has been developed to identify Member States' priority needs and requirements under Atoms4Food, including in relation to national policies, research and development capacities, technology and infrastructure, and human and financial resources.

As of December 2024, Argentina, Benin, Burkina Faso, Eritrea, Eswatini, Ghana, Kenya, Mauritania, the Niger, the Philippines, Sierra Leone and the United Republic of Tanzania had officially requested support under Atoms4Food. Strong commitment to food safety was demonstrated by Benin and Burkina Faso through national kick-off meetings conducted at the ministerial level.

I am confident that better production, better nutrition, better environment and better life, leaving no one behind, are also the goals of Atoms4Food to help us accelerate our future achievements towards the Sustainable Development Goals and beyond.

Qu Dongyu
FAO Director-General



Renovation of the Nuclear Applications Laboratories

In Seibersdorf, Austria, the Agency runs eight nuclear applications laboratories focusing on food and agriculture, human health, environmental monitoring and assessment, and nuclear instrumentation and accelerator applications, along with two safeguards analytical laboratories. In 2014, work commenced to comprehensively renovate the nuclear applications laboratories, established in 1962.

A total of 38 Member States, one international organization, one private sector donor and two individuals have provided over €29 million in extrabudgetary contributions to the final phase of the Renovation of the Nuclear Applications Laboratories (ReNuAL) initiative, known as ReNuAL2, enabling the Agency to conclude contracts for all major construction. By the end of 2024, the newly refurbished Dosimetry Laboratory was operational, major construction of the new laboratories building was completed and construction on the new greenhouses was on track to be finalized in early 2025. All new facilities constructed under ReNuAL2 are expected to begin operations in 2025.

In advance of the completion of construction on the final elements of ReNuAL, namely fit-for-purpose 21st century laboratories and greenhouses, the Agency has strengthened its coordination capabilities to ensure that its laboratories have adequate support in delivering enhanced services to Member States.

During a visit by the Director General and the President of the OPEC Fund for International Development, Abdulhamid Alkhalifa, to the newly refurbished Dosimetry Laboratory, Agency staff showcase nuclear-derived techniques for improving cancer therapy.

The Agency made improvements in the following areas:

- **Partnership building:** An internal workshop was conducted to equip the laboratories with tools to establish and sustain stronger partnerships. In 2024, the laboratories pursued collaborations with over a dozen potential partners, including private sector entities.
- **Safety:** The continuous application of safety requirements was ensured by helping the laboratories adapt their authorizations according to the changes stemming from ReNuAL and providing training in accordance with Agency safety regulatory requirements.
- **Outreach and visibility:** Awareness of laboratory activities was enhanced externally and internally by increasing the number of organized visits and launching a series of scientific seminars in order to showcase the laboratories' diverse research and development activities.
- **Administrative efficiencies:** Equipment management and laboratory sustainability were improved, enabling better planning and budgeting. Emphasis was placed on supporting cross-laboratory collaboration, streamlining shared administrative processes and strengthening the nuclear applications capacity building programme.

Nuclear Power Around the World

For a fourth successive year, the Agency revised upwards its annual projections for the potential growth of nuclear power in the coming decades.

In its new outlook for global nuclear capacity for electricity generation, the Agency increased its low case projection to 514 GW(e) by 2050, representing a significant increase of 56 GW(e) compared to the 2023 projection. Likewise, the high case projection increased to 950 GW(e) by 2050, up from 890 GW(e) in 2023 and representing a 235 GW(e) increase compared to 2020. For these projections to be realized, there would need to be large scale implementation of long term operation across the existing fleet and more than 640 GW(e) of new build in the coming 26 years. Global annual investments would also need to rise from the current average of around US $50 billion to some US $125 billion to meet the high case projection.

About 50 Member States have an interest in adding nuclear power to their energy mix, and 37 countries are in various phases of initiating or implementing their national nuclear power programmes. The Agency continued its assistance to newcomer countries in 2024, conducting a Phase 2 Integrated Nuclear Infrastructure Review (INIR) mission to Poland in April and a Phase 1 INIR follow-up mission to the Philippines in December.

Public support is crucial for nuclear power programmes. To this end, the Agency established a Stakeholder Engagement Advisory Service for Nuclear Power Programmes in June 2024 and conducted a pre-mission to Malaysia in October 2024. The Joint ICTP–IAEA Nuclear Stakeholder Engagement School, hosted by the Abdus Salam International Centre for Theoretical Physics (ICTP), was piloted in November 2024.

The Huaneng Shidaowan high temperature gas cooled reactor (HTGR) nuclear power plant in China. (Photograph courtesy of China Huaneng Group)

Today I can assure you that nuclear is coming back, and coming back strongly.

Fatih Birol
Executive Director
of the International Energy Agency

377.0
GW(e)
global operating nuclear power capacity in 2024

417
operating nuclear power reactors in 31 countries

6.8
GW(e)
new capacity connected to grid in 2024

64.5
GW(e)
under construction with 62 reactors in 15 countries

IAEA Platform on Small Modular Reactors and their Applications

Demand for Agency support in the area of small modular reactors (SMRs) has been increasing owing to their reduced capital costs, flexibility in terms of siting and operation, scalability and diverse products.

With the participation of all relevant Agency Departments and Offices, the IAEA Platform on Small Modular Reactors and their Applications (SMR Platform) coordinates the Agency's efforts to strengthen support to Member States and other stakeholders interested in the early deployment of SMRs. This support covers not only technology development and demonstration, but also legal frameworks and efforts to ensure safety, security and safeguards.

In 2024, the Platform organized workshops on business models for nuclear power projects, in Jordan, and on general aspects of SMR deployment, in Mongolia. A virtual webinar was held for Myanmar to discuss SMR technologies and stakeholder engagement. The Platform was also involved in a regional workshop on SMRs for near-term deployment, in Indonesia, and a workshop on suitability studies for SMRs, in Thailand.

Through the Platform, work is under way to update the IAEA Nuclear Energy Series publication *Technology Roadmap for Small Modular Reactor Deployment*. Furthermore, a comprehensive curriculum is being finalized for the SMR School, which will be launched in 2025 with a view to raising awareness about key aspects of SMR development and deployment among government officials and policymakers in interested Member States.

We greatly appreciate the IAEA SMR Platform implementation team for navigating us through the wide spectrum of IAEA activities on SMRs. Cooperation in organizing a webinar on SMRs (…) in March 2024, followed by a special workshop in Ulaanbaatar on general aspects of SMRs in November 2024, was very meaningful in our preparation to conduct a pre-feasibility study on SMR deployment in Mongolia.

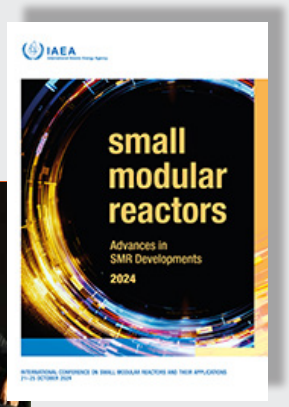
Chadraabal Mavag
Head of the Nuclear Technology Department Executive Office, Nuclear Energy Commission of Mongolia

International Conference on Small Modular Reactors and their Applications

Jointly organized by the Department of Nuclear Energy and the Department of Nuclear Safety and Security, the SMR Conference featured 44 technical sessions, 5 topical plenaries, 5 side events and 6 poster sessions, providing an international forum to take stock of progress and discuss opportunities, challenges and enabling conditions for the accelerated safe and secure development and deployment of SMRs. An Industry Night was held for public and private SMR developers to present their designs and discuss innovative deployment strategies.

over 1200 participants from 97 Member States and 18 international organizations

1100 virtual participants



In addition, the publication Small Modular Reactors: Advances in SMR Developments 2024 was issued.

Vienna, October 2024

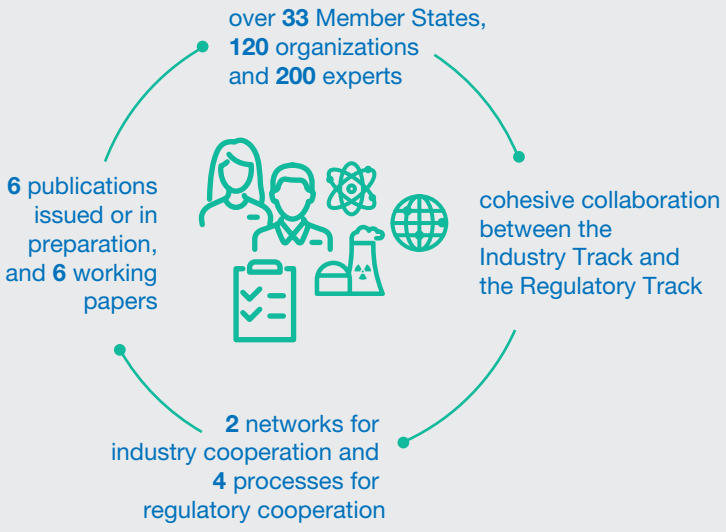
Nuclear Harmonization and Standardization Initiative

The Nuclear Harmonization and Standardization Initiative (NHSI), launched in 2022, is aimed at facilitating the effective global deployment of safe and secure advanced nuclear reactors, including SMRs.

In October 2024, participants gathered for the third NHSI Plenary, marking significant progress under both the Industry Track and the Regulatory Track and charting the course for Phase II. The Industry Track's four Topical Groups focused on: harmonization of high-level user requirements; common approaches on codes and standards; experimental testing and validation through the newly established NEXSHARE collaborative data sharing network; and accelerating infrastructure implementation for small modular reactors. Five white papers were published, focusing on the work of the groups and covering serially manufactured products, non-nuclear codes and standards, and long-lead items.

The Regulatory Track's three Working Groups produced (i) a framework for regulatory cooperation in design reviews, including a framework for sharing information among regulatory bodies, (ii) a multinational pre-licensing joint review process through which regulators can jointly evaluate specific technical areas of a proposed reactor design, (iii) a process for leveraging reviews already completed by regulatory bodies in other Member States and (iv) a collaborative review process that allows regulators to work together in parallel during ongoing national regulatory reviews. This work is captured in three technical documents, to be published in 2025.

During 2024, the Initiative laid the groundwork for Phase II (2025–end 2026), which will focus on the implementation of Phase I outcomes and cover new areas, including nuclear security considerations.



We share the IAEA's vision (…) for the Industry Track and for facilitating regulatory framework harmonization to reduce unnecessary design changes, so we appreciate that. All of the proposals for Phase II are on the right track, all of those areas will be valuable.

Marcus Nichol
Executive Director of New Nuclear, Nuclear Energy Institute, United States of America

Cooperation and collaboration between industry and regulators is key. The UK's Office of Nuclear Regulation strongly supports Phase II. There's a real need for this work to be done.

Paul Fyfe
Senior Director (Regulation) and Director of Safeguards, Office for Nuclear Regulation, United Kingdom

Fusion Energy

Recent developments in fusion energy have intensified interest among policymakers, scientists, investors and the public. In November 2024, government ministers and senior officials from numerous countries gathered in Rome for the inaugural ministerial meeting of the World Fusion Energy Group (WFEG), showcasing global advancements in developing fusion as a clean, safe and limitless energy source.

During the WFEG meeting, co-organized by the Agency and Italy, participants emphasized that international collaboration, including in building supply chains and developing a specialized workforce, is essential in order to transition from research to commercialization. The Group focused on three core topics: the status of fusion energy, global collaboration and public-private partnerships, and exploring new business opportunities. This event highlighted how recent breakthroughs have generated momentum in the fusion sector, improving the near term feasibility of fusion power plant deployment.

In 2024, the Agency signed a memorandum of understanding with the ITER Organization and established Practical Arrangements with the Fusion Industry Association. Both agreements aim to enhance collaboration in fusion energy, focusing on outreach, public engagement, knowledge-sharing, training and other key areas.

The IAEA remains steadfast in its support of fusion energy development, championing initiatives that bring us closer to realizing the dream of limitless, clean energy. Together, let us embrace the promise of fusion energy, forging a path towards a brighter, more sustainable future for all.

Rafael Mariano Grossi
IAEA Director General

Two publications were issued at the WFEG meeting. The IAEA World Fusion Outlook 2024 offers an overview of the fusion field, detailing emerging plant concepts, development timelines, policy frameworks and investment trends. Fusion Key Elements outlines a strategic approach to the commercialization of fusion energy, focusing on research, development and demonstration; industrialization; safety, security and non-proliferation; global collaboration; stakeholders; and public engagement.

Rome, November 2024

WFEG ministerial meeting at the Italian Ministry of Foreign Affairs and International Cooperation.

Atoms4NetZero

The Agency's Atoms4NetZero initiative aims to provide policymakers and decision makers with net zero energy scenario modelling that takes into account the full potential of nuclear power to contribute to net zero emissions. The first Global Stocktake, agreed at COP28, recognized the need to accelerate the deployment of low-emissions technologies such as nuclear power.

In July 2024, the Agency held a workshop on modelling the contribution of nuclear power to net zero transitions and in August 2024, a joint IAEA–Argonne National Laboratory training course brought together experts in the use of energy planning tools, including the Agency's Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE). In addition, a country case study to model Estonia's net zero transition using MESSAGE was developed in collaboration with the University of Tartu.

At the 68th regular session of the General Conference, the Agency organized a side event entitled 'Powering the Future through Atoms4NetZero', involving modelling teams from Argentina, Estonia, Ghana, Indonesia, Kenya, Nigeria and Tunisia that use Agency tools and methodologies. Countries that have been trained in the use of MESSAGE are also independently developing net zero scenario analyses, such as the work on carbon neutrality presented by the Republic of Korea at the fourth meeting of the Technical Working Group on Nuclear Power in Low-Carbon Energy Systems in December 2024.

In September 2024, the Agency signed Practical Arrangements with the China National Nuclear Corporation, which include cooperation under the Atoms4NetZero initiative. And at COP29 in November 2024, the Agency signed a memorandum of understanding with the Ministry of Energy of Azerbaijan on cooperation in the area of energy planning in the context of the Paris Agreement, according to which a joint analysis will be conducted under Atoms4NetZero on the role of nuclear energy, including small modular reactors, in Azerbaijan's clean energy transition.

The Director General and the Minister of Energy of Azerbaijan, Parviz Shahbazov, sign a memorandum of understanding at COP29 in Baku, November 2024.

Collaboration under the Atoms4NetZero initiative, which focuses on analysing the potential of nuclear energy, including small modular reactors, in the clean energy transition, will give a fresh impetus to Azerbaijan's energy sector.

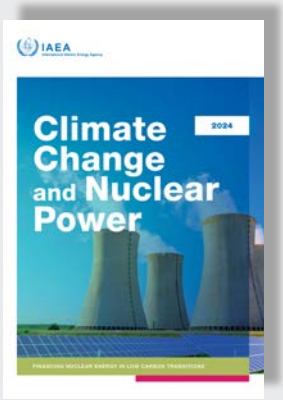
Parviz Shahbazov
Minister of Energy
of Azerbaijan

COP29 and Nuclear Energy Summit 2024

Led by the Director General, the Agency boosted the role of nuclear technology at the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29) in Baku. This followed the first ever Nuclear Energy Summit in Brussels, where over 30 high-level government officials expressed support for the role of nuclear power in enabling clean energy transitions and increasing energy security.

The global momentum behind nuclear power established at the 28th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change in 2023 continued to build at the inaugural Nuclear Energy Summit, held in Brussels in March 2024 and co-organized by the Agency and the Government of Belgium. Heads of State and Government from more than 20 countries and other high-level officials emphasized the importance of using nuclear power to achieve energy security, meet climate goals and drive sustainable development. Increased financing, workforce development and more proactive support to nuclear newcomer countries were identified as being key to long term success.

The Agency's engagement at COP29 helped to maintain the visibility of the indispensable role of nuclear energy and technologies in addressing climate change mitigation and adaptation. The Agency organized or participated in more than 40 nuclear-related events in the Atoms4Climate pavilion and partner pavilions, including one High-Level Party Event organized jointly by the Agency and the COP29 presidency during the World Leaders Climate Action Summit. Several memoranda of understanding and Practical Arrangements were signed by the Agency's Director General with heads of the World Meteorological Organization, the International Renewable Energy Agency, the European Bank for Reconstruction and Development and LinkedIn to build and strengthen synergies and partnerships. By the end of COP29, an additional six countries had endorsed the declaration calling for the tripling of nuclear capacity by 2050, bringing the total number of endorsing countries to 31.



The 2024 edition of **Climate Change and Nuclear Power** was issued at COP29.

Brussels, March 2024

The Director General speaking at the opening of the Nuclear Energy Summit, March 2024.

Nuclear Safety, Security and Safeguards in Ukraine

In 2024, the Agency continued to closely monitor and report on the nuclear safety, security and safeguards situation in Ukraine while also providing technical support and assistance to help prevent a nuclear accident.

The Agency expanded its programme of assistance to Ukraine, taking a more proactive stance to help ensure the stability of critical energy infrastructure for the safe operation of the NPPs.

The Agency maintained the uninterrupted presence of its staff at nuclear sites in Ukraine (Zaporizhzhya, Khmelnytskyy, Rivne and South Ukraine nuclear power plants (NPPs) and the Chornobyl NPP site) and continued to use the Seven Pillars developed in 2022 to tailor an independent and impartial assessment of nuclear safety and security in Ukraine. At Zaporizhzhya NPP, Agency staff continued to monitor and report on the observance of the Five Principles established in 2023 for protecting the plant. In December 2024, for the first time since the armed conflict started, a drone hit and severely damaged an official Agency vehicle on the road to Zaporizhzhya NPP.

The Agency continued to provide other technical support and assistance to help ensure the safe and secure operation of nuclear facilities and activities involving radioactive sources in Ukraine by delivering nuclear safety- and security-related equipment, providing medical assistance for Ukrainian operating personnel, assisting with the radiation safety and nuclear security of radioactive sources, and helping to mitigate the consequences associated with the destruction of the Kakhovka Dam.

The Agency continued to implement safeguards for Ukraine, including in-field verification activities, in accordance with Ukraine's comprehensive safeguards agreement and additional protocol. On the basis of its evaluation of all safeguards relevant information available, the Agency did not find any indication giving rise to a proliferation concern.

Agency staff during a visit to the Dniprovska 750 kV substation, October 2024. (Photograph courtesy of Ukrenergo)

Nuclear safety, security and safeguards in Ukraine

Two years of Agency presence at Zaporizhzhya NPP (publication)

Highlights in 2024:

- Six public reports;
- 64 Director General updates and press releases;
- 86 Agency staff rotation missions, resulting in 179 person-months spent in Ukraine supporting nuclear safety and security;
- Eight additional in-person missions supporting nuclear safety and security, two of them led by the Director General;
- 72 deliveries of nuclear safety- and security-related equipment amounting to €13.3 million;*
- 27 deliveries of medical equipment and supplies amounting to €1.26 million;
- Five remote and in-person nuclear safety training events delivered for Ukrainian NPP staff;
- 18 remote training sessions and 1 three-day workshop in the area of mental health;
- 35 Ukrainian nuclear facilities under safeguards;
- 133 safeguards inspections conducted, 6 complementary accesses provided;
- Total of 14.6 person-months performing safeguards activities in Ukraine.

* Includes in-kind contributions and equipment provided through partnerships.

Fukushima ALPS-Treated Water Discharge

Since 2021, at the request of the Government of Japan, the Agency has been independently reviewing the safety of discharging advanced liquid processing system (ALPS) treated water from the Fukushima Daiichi Nuclear Power Station into the sea. The Agency has committed to assessing and monitoring activities before, during and after the discharge, ensuring consistency with international safety standards.

In 2024, the Agency maintained its pivotal role in overseeing the discharge process, which began in August 2023. Since the beginning of the discharge, 10 batches totalling 78 300 cubic metres of ALPS-treated water have been discharged, with independent Agency analyses confirming tritium levels well below the regulatory and operational limits.

The Agency's dedicated Task Force, comprising independent and internationally recognized experts from around the world and Agency experts, has conducted three missions since the commencement of the discharge, including reviews in April and December 2024 to assess its technical, regulatory and operational aspects. The Agency also performed interlaboratory comparisons and on-site measurements in 2024 to verify environmental radionuclide concentrations and radionuclide concentrations in ALPS-treated water and to monitor the radiation exposure of workers, which confirmed consistency with international safety standards.

In response to requests from Japan and concerns expressed by Member States, the Agency introduced additional measures to promote transparency, expand international participation and build trust in the region during the ongoing release of ALPS-treated water. These additional measures allow for hands-on independent sampling and monitoring to ensure that the discharges of ALPS-treated water remain within defined limits and are conducted within agreed parameters set by the Agency in its role as an independent, impartial and technical organization.

Since 2023, the Agency has maintained a continuous presence at the Fukushima site through its dedicated office and its laboratory. This on-site Agency laboratory in Fukushima is being upgraded with new equipment in order to analyse a broader range of radionuclides and achieve greater sensitivity in water and environmental sample testing, and the Agency continues to assess that Japan's ALPS-treated water discharge remains safe, transparent and scientifically validated.

Highlights in 2024:

- Two Task Force missions;
- Continuous on-site presence of Agency staff at the Fukushima Daiichi Nuclear Power Station;
- Independent monitoring to directly observe the technical safety aspects of the systems and activities;
- Enhanced on-site Agency laboratory capacity.

Agency Task Force walkdown at the ALPS facilities to assess the technical, regulatory and operational aspects of the discharge.

Amendment and Rescission of Small Quantities Protocols

During 2024, significant progress was made in addressing what the Board of Governors has described as a "shortcoming in the Agency's ability to provide safeguards assurances" — a protocol to the comprehensive safeguards agreement (CSA) referred to as the 'small quantities protocol' (SQP).

Available since 1971 to States that concluded a CSA with the Agency, the text of the SQP was standardized in 1974. Designed for States with limited or no nuclear material or activities, it holds in abeyance the implementation of most of the safeguards procedures in Part II of the CSA, and in particular those related to reporting and inspections. While the SQP simplifies the implementation of safeguards under the CSA in the States concerned, it also results in a number of important limitations for the Agency.

To address these limitations, the Board of Governors decided in 2005 to revise the standard text of the original SQP and modify the criteria for having such a protocol. It also decided that the revised text would be used as the basis for any newly-concluded SQP to a CSA, and that States which already had an SQP based on the original text would be asked to amend it to reflect the revised text. Furthermore, if a State no longer met the criteria for having an SQP, it would be asked to rescind the protocol altogether.

While the implementation of most of the safeguards procedures in Part II of the CSA are still held in abeyance under the revised SQP, it allows for the application of key provisions related to the State's submission of an initial report on all nuclear material subject to safeguards, and the Agency's conduct of inspections in the State to verify that nuclear material.

The Safeguards Implementation Report for 2023 highlighted that, for States with an SQP based on the original standard text, the Agency's ability to draw a credible and soundly based annual safeguards conclusion was significantly affected. Furthermore, it stated that, given the significant lapse in time since the decision of the Board of Governors in 2005, the Agency would no longer be able to continue to draw a safeguards conclusion for such States.

In 2024, seven countries amended or rescinded their original SQPs, bringing the number of operative SQPs that had yet to be amended or rescinded to 15. These actions have significantly strengthened the Agency's ability to implement safeguards in the countries concerned. For States that still have an SQP based on the original standard text, the Agency remains ready to provide assistance with its amendment or rescission.

I have stated on many occasions that the small quantities protocol based on the original standard text was inadequate for the Agency's safeguards system, and called upon States with such protocols to amend or rescind these as soon as possible. I am delighted with the progress made in 2024, and hope that the few remaining States will take appropriate action in 2025 to address this important issue.

Rafael Mariano Grossi
IAEA Director General

Artificial Intelligence

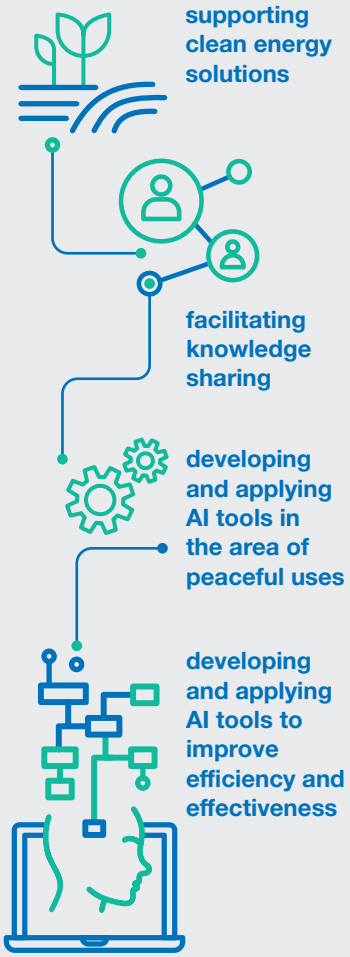
The use of artificial intelligence (AI) within the Agency is increasing, mirroring global trends. The Agency is both deploying and developing AI tools and methodologies to improve programmatic efforts, management processes and administrative functions. It has also been closely engaging with counterparts to better understand the extent and manner of AI integration in the nuclear sector, and to support the sharing of information and good practices among Member States.

Notable activities of the Agency in the area of AI in 2024:

- Technical meeting on safety and operational considerations in the use of advanced technologies at research reactors, including digital control systems, robotics and AI;
- Training workshop to prepare clinically qualified medical physicists for the use of AI in relation to medical uses of radiation;
- Launch of a coordinated research project, under the ZODIAC initiative, focused on developing or adapting AI techniques to process large X-ray and CT scan image datasets to better detect infectious disease patterns;
- Technical meeting on AI analysis to accelerate the technological development of evolutionary and innovative reactor designs;
- Issuance of General Guidelines for Agency Personnel on the Use of Generative Artificial Intelligence (GenAI), which provide clear guidance on the 'dos and don'ts' regarding the use of GenAI, consistent with the Agency's administrative and legal framework;
- In the area of safeguards, focus was placed on developing AI applications that can improve the efficiency of information analysis and surveillance review;
- During the 68th regular session of the General Conference, the Agency hosted AI-focused side events, including the Nuclear Operators' Forum: Pioneering the Deployment of AI Applications in Nuclear Power Plants. At this event, the Director General indicated his intention to organize an international symposium in 2025 to discuss clean energy solutions, exploring opportunities for using nuclear energy to power data centres to support AI's expansion, and the use of AI to drive innovation and efficiencies in the nuclear industry.

The Agency continues to focus on AI in the following areas:

- Development and application of AI tools to support routine business activities, and to improve the efficiency and effectiveness of its services and programmatic work;
- Development and application of AI tools in its activities related to the peaceful uses of nuclear material and technology and supporting Member States in their use;
- Keeping abreast of AI development and use in the nuclear field and facilitating knowledge sharing.



Together for More Women in Nuclear

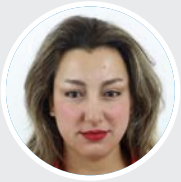
The Agency works to address the under-representation of women in the nuclear field through the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP) and the Lise Meitner Programme (LMP). By enabling more women to enter and pursue careers in the nuclear field, these programmes help to build the future nuclear workforce.

Established in 2020, the MSCFP provides scholarships for relevant master's degrees and opportunities to complete internships, participate in technical events and join the MSCFP/LMP student and alumni LinkedIn group. By the end of 2024, there were 760 MSCFP fellows from 129 Member States, of whom 320 had completed their master's studies with support from the programme. Of these graduates, 167 progressed to internships facilitated by the Agency while others pursued doctoral studies or employment.

Launched in 2023, the LMP provides women working in the nuclear sector in the early and middle stages of their careers with career development opportunities through a visiting professional programme. Participants gain valuable technical experience in different facilities, focused on their area of expertise, and enhance their leadership skills. They also become part of the MSCFP/LMP LinkedIn group and benefit from participation in technical events organized by the Agency and its partners. The third LMP cohort was hosted in 2024 by the Korea Nuclear International Cooperation Foundation.

In March 2024, the Agency held an event entitled 'For More Women in Nuclear: IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes', which featured career talks and discussions with nuclear experts and recipients of the two programmes. More than 400 MSCFP and LMP participants attended the event.

The MSCFP and the LMP are funded by extrabudgetary financial and in-kind contributions. As of December 2024, the MSCFP had received pledges amounting to €15.2 million and in-kind contributions for 110 students. Donors include Member States, the European Union, private sector partners and academic institutions.



The MSCFP internship in the IAEA's Division of Nuclear Security provides me with opportunities to advance in the nuclear security field through participation in the Division's activities and by working with renowned experts. I am fortunate to be part of the Marie Skłodowska-Curie Fellowship Programme and would like to encourage women interested in the nuclear field to apply for this programme.

Chaimaa El Mazourhi
Morocco, MSCFP intern in the Agency's Division of Nuclear Security

Learn more

The Agency event 'For More Women in Nuclear: IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes', March 2024.

Optimizing Organizational Effectiveness

Meeting greater demand for the Agency's services means increasing the output and agility of the administrative processes that underpin efficient and effective programme delivery to Member States. In this context, efforts have focused on leveraging technology to optimize processes, building staff capacities in areas such as artificial intelligence (AI) and enhancing procurement capabilities. Increasing multilingual communication and outreach also remained important.

Ongoing efforts to increase staff engagement by fostering a supportive working environment were focused on career development, ethical conduct and the physical and mental well-being of all personnel.

A milestone was reached as the representation of women and men in professional and senior management roles reached 50/50% – a goal set by the Director General when he took office in 2019 and the representation of women in the Secretariat was 30%.

We are committed to maximizing value and impact for Member States in support of the Agency's increasingly relevant global mandate. By streamlining processes and leveraging the latest technology to enhance our effectiveness, we are making sure that our management practices and internal procedures are efficient, agile and adaptable to accommodate new requests. We also prioritize maintaining a supportive environment for our staff, enabling them to perform at their best.

Margaret Doane
Deputy Director General
and Head of the Department of Management

workforce development
staff well-being
women in the Secretariat

results based management
innovation
agility

partnerships
resource mobilization

outreach
communication
multilingualism

Managing for results

The Agency continued its efforts to strengthen its results based management (RBM) to improve the clarity and consistency of programme designs across the organization. To this end, the interdepartmental RBM Coordination Group helps to coordinate, implement and ensure the quality RBM application throughout the programme cycle. In 2024, the Agency prepared the draft Programme and Budget for 2026–2027, which is informed by lessons learned from previous biennia and from various reviews and assessments, as well as internal and external evaluation. The Agency continued its efforts to improve its risk management system and processes throughout the programme cycle and to support accountability and decision making. In addition, it consistently mainstreamed cross-cutting issues throughout all phases of the RBM cycle.

Performance indicators were further refined to measure programme performance. For example, performance indicator metrics including baselines, targets and means of verification were reviewed to gauge programme performance and report to Member States in a meaningful manner. In addition, a dedicated internal mid-year review exercise, using performance indicators to track actual results against planned targets, was leveraged to strengthen performance monitoring. To assess the impact of its activities in Member States, the Agency continued to draw analysis from the knowledge tests and participant follow-up surveys for better and more timely measurement of capacity-building results.

The Agency continues to collaborate with the wider UN system and other international actors, including through the UN Strategic Planning Network (UNSPN) and the OECD Development Assistance Committee Results Community to contribute to and continuously learn from best practices in applying RBM for better results.

Maintaining an enabling environment

Strengthening staff competencies

By the end of 2024, almost 90% of managers had completed the Leadership Development Programme.

The mentoring initiative, sponsored by the Deputy Director General and Head of the Department of Management, supported 169 mentor-mentee pairs.

A new career development initiative, Career Development Conversations, was launched to assist staff in crafting individual career plans.

Increasing staff engagement

By the end of 2024, some 2000 staff members had taken part in engagement surveys covering topics such as performance, communication and well-being. The results helped to establish baselines to measure further progress in these areas.

The Ethics function delivered training and outreach aimed at fostering a 'speak-up culture' and ensuring that personnel understand and demonstrate the Agency's core values and standards of conduct.

Supporting staff well-being

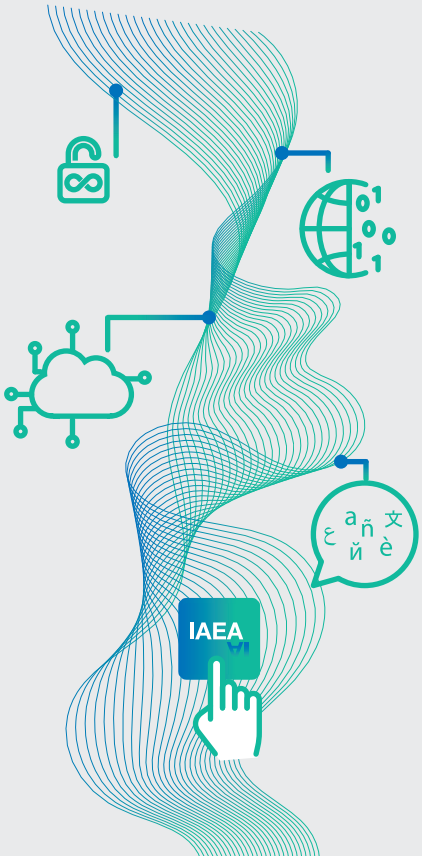
Staff physical and mental well-being was supported through preventative care, including 4000 vaccinations and 1500 counselling sessions. In addition, a nursing room was opened at the Seibersdorf site.

To make further progress towards the inclusion of persons with disabilities, an independent accessibility assessment was conducted of the Agency's premises at the Vienna International Centre and at the laboratories in Seibersdorf.

Innovation and agility

The increased use of advanced IT services and tools enhances both efficiency and effectiveness across the Agency by streamlining processes and enabling the data-driven management of operations. In 2024, the Department of Management:

- Enhanced IT solutions and platforms to support the technical Departments, for example by leveraging AI tools such as large language models for translation and robotics process automation in finance. Online portals were launched to facilitate the implementation of key programmes and information sharing.
- Supported faster innovation by increasing the number of staff trained in IT tools and technologies by 48%, and trained over 500 staff on data analytics skills to enhance productivity and efficiency.
- Maintained a clear focus on information security to respond to the increasing reliance on IT and the growing complexity of IT threats. The Agency also made further strides in securing IT infrastructure that monitors, detects and responds to IT and information security risks and maintained ISO/IEC 27001 certification for its information security system, which demands high standards of performance.
- Implemented a new fast-track emergency procurement procedure that significantly enhances the Agency's ability to rapidly procure and deliver life-saving equipment. This enabled swift support in critical situations in Ukraine, as well as in other emergency responses, including in Cuba, Grenada, Honduras, the Syrian Arab Republic and Türkiye.

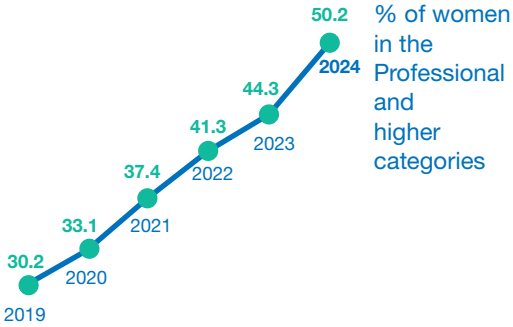


Women in the Secretariat

By the end of 2024, the percentage of women in the Professional and higher categories had reached 50%, and in senior management positions (D level or higher) it was 48%, with the highest standards of efficiency, technical competence and integrity being upheld.

51.8% Senior management
48.2%

49.8% Professional and higher categories
50.2%



% of women in the Professional and higher categories

Partnership and resource mobilization

The Agency continued providing support to Member States, including through flagship initiatives focusing on key areas of the applications of nuclear science and technology. Emphasis is placed on areas such as cancer care, food safety and security, disease prevention, ocean protection and women in nuclear, through Rays of Hope, Atoms4Food, ZODIAC, NUTEC Plastics, the IAEA Marie Skłodowska-Curie Fellowship Programme and the Lise Meitner Programme, and on support to Ukraine.

The Agency is continuously expanding its strategic collaboration with other UN system and international organizations. For example, cooperation with the United Nations Environment Management Group proved pivotal in increasing outreach and visibility and facilitating the implementation of programme activities related to marine pollution, specifically those addressing marine microplastic pollution and ocean acidification. Close collaboration with the World Health Organization (WHO) led to a joint publication on the sustainable management of radiotherapy facilities and equipment. This partnership was important in ensuring that there were no overlaps between Member State needs addressed by the Agency and those addressed by WHO. The partnership between the Food and Agriculture Organization of the United Nations (FAO) and the Agency was expanded beyond the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture through a joint initiative, Atoms4Food, which aims to support Member State efforts to tackle growing hunger and boost food security.

In 2024, €195 million in extrabudgetary contributions were mobilized. Of this, around €5 million were mobilized through non-traditional partners — a significant increase compared to 2023. The Agency will continue to seek opportunities to mobilize new streams of public and private finance and expand partnerships, including with non-traditional donors, in order to boost its ability to support Member States. The mobilization of knowledge and innovation from partners will remain a key focus of the Agency's work, where appropriate.

Reaching a global audience

The expansion of **multilingualism** and outreach remained a priority, with efforts to diversify the range of output formats for publications and other materials and to increase the use of e-publishing and the electronic dissemination of conference materials.

104 publications issued in English

3.3 million online views of Agency publications

▶ **156** publication translations issued

11.3 million words translated

22 000 participants at Agency meetings in Vienna

over **5000** online participants

1.2 million visits to iaea.org per month

2.5 million impressions per month on social media channels

226 multimedia items:

- ▶ videos
- ▶ press conferences
- ▶ livestreamed events

107 Director General interviews

NUCLEAR POWER, FUEL CYCLE AND NUCLEAR SCIENCE

Proryv Project. Copyright: Rosatom

Nuclear energy remains indispensable for tackling climate change, ensuring energy security and supporting development. Small modular reactors have the potential to make up to one-quarter of nuclear power capabilities by 2050, paving the way for a more sustainable future.

Mikhail Chudakov
Deputy Director General
and Head of the Department of Nuclear Energy

Nuclear Power, Fuel Cycle and Nuclear Science

Learning and Training

1412 online training and education courses hosted on CLP4NET

45 training events

Collaboration and Peer Review

15
active Collaborating Centres

23
active coordinated research projects

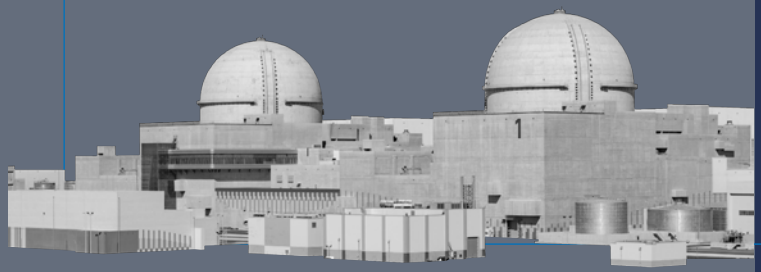
11
peer review missions

87
technical meetings

IAEA Schools

282
participants in IAEA schools

- **134** Nuclear Energy Management School
- **95** Nuclear Knowledge Management School
- **27** Regional Research Reactor School
- **26** Nuclear Stakeholder Engagement School



Tools and Databases

36
databases

14
simulators

4
toolkits for operating a nuclear power programme

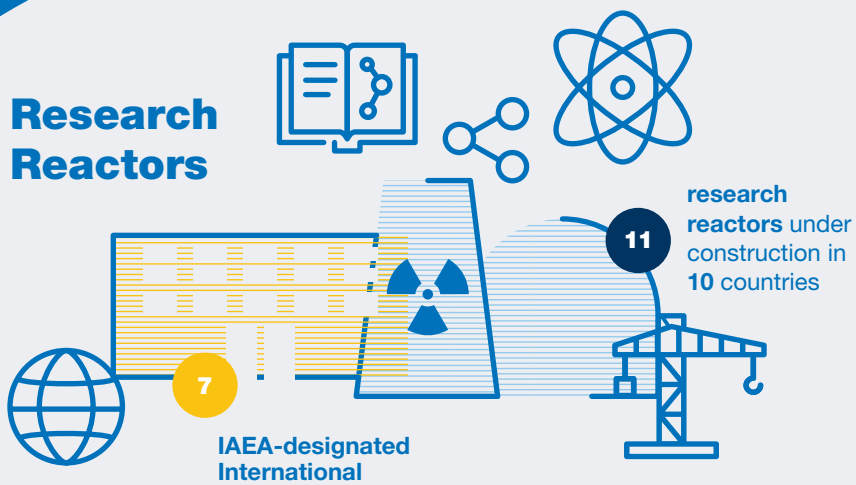
12
modelling tools for integrated energy planning for sustainable development

1
modelling tool for estimating nuclear fuel cycle material and service requirements

Key Areas

- Nuclear Power
- Nuclear Fuel Cycle and Waste Management
- Capacity Building and Nuclear Knowledge for Sustainable Energy Development
- Nuclear Science

Research Reactors



research reactors under construction in **10** countries

IAEA-designated International Centres based on Research Reactors in **7** countries

NUCLEAR POWER

OBJECTIVE

To support Member States with existing nuclear power plants (NPPs) to enhance operating performance and safe, secure, efficient and reliable long term operation, with a harmonized approach to human, technological and organizational aspects.

To support Member States embarking on new nuclear power programmes in planning and building their national nuclear infrastructures through coordinated assessment and assistance activities.

To support Member States in modelling, analysing and assessing future nuclear energy systems for sustainable development of nuclear energy and to provide them with collaborative frameworks and support for technology development and deployment of advanced nuclear reactors, small modular reactors, non-electric applications, fusion energy technology development and deployment, and integrated energy systems.

Indonesia is advancing its nuclear energy planning by developing the NPP Roadmap using the INPRO ROADMAPS methodology with support from IAEA experts. Recognizing nuclear energy as a vital strategy for achieving our decarbonization targets, we are committed to establishing our first nuclear power plant within the next decade.

Eniya Listiani Dewi
Director General of New Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources of Indonesia

Reactor pressure vessel installation at Hinkley Point C NPP, United Kingdom.
(Photograph courtesy of EDF, copyright 2025)

2

INIR missions

Phase 2, Poland
Phase 1 follow-up, Philippines

136 000

new Power Reactor Information System (PRIS) users

864 000 page views

1

new e-book

e-version of the IAEA's Milestones approach

1

new network

NEXSHARE

KEY OUTPUTS

Nuclear Power Programmes

Launching nuclear power programmes

Nuclear power is being considered for various reasons, including in relation to environmental concerns and socioeconomic development. The number of Member States considering, planning or implementing a new nuclear power programme reached 32 in 2024, and over 20 other Member States expressed interest in nuclear power during the year. The Agency developed new approaches and tools to respond to the growing demand for its services in support of nuclear power infrastructure development and continued to provide support to Member States in raising awareness of the commitments required for the decision making process, as well as in building roadmaps and developing the required infrastructure in line with the Milestones approach.

Operating nuclear power plants and expanding nuclear power programmes

Ensuring safe and efficient operation is crucial for sustaining operating NPPs, and the Agency continues to support Member States in applying innovative technologies and addressing technical and supply chain issues. To this end, the Agency held the following events in 2024:

- Technical meeting on the deployment of AI solutions for the nuclear power industry, held in Rockville, United States of America and gathering experts from diverse organizations who shared experience on the near term deployment of AI at NPPs and advised the Agency on activities that would assist Member States in this regard;
- Technical meeting on the on-site technical adaptation of NPPs to environmental changes, which looked at lessons learned from addressing the risks and mitigating the impacts of climate change and environmental variability in relation to electricity production by NPPs;
- Technical meeting on developing a sustainable nuclear supply chain for near deployment reactors, which discussed challenges and solutions for operator, supplier, regulatory, standards development and inspection organizations. ◆

Technical meeting on the deployment of AI solutions for the nuclear power industry, Rockville, United States of America, March 2024.

Nuclear Reactor Technology Development

Nuclear power technology is evolving, with a focus on developing advanced energy systems and broadening their applications. The Advanced Reactors Information System (ARIS) database is a resource for Member States considering their first NPP or expanding their nuclear energy programme, and contains data on evolutionary reactors currently in use, advanced designs nearing deployment and innovative concepts, including small modular reactors (SMRs) and microreactors. The ARIS database was significantly upgraded in 2024 and now features over 125 reactor designs, including 68 SMRs, a more interactive and user-friendly interface, tools for comparing multiple reactor designs and dynamic graphic visualizations of plant data.

Advanced Reactor Information System

Technology development for advanced water cooled reactors

Through the first Collaborating Centre on Artificial Intelligence for Nuclear Power, established in partnership with the Center for Science of Information at Purdue University, United States of America, the Agency can better support innovation in the design and operation of the world's commercial NPPs, 95% of which are water cooled reactors. This new Collaborating Centre advances the use of AI in nuclear power through programmatic activities, knowledge sharing, training and educational courses to empower professionals worldwide. In addition, a technical meeting held in 2024 with over 50 participants from 24 Member States explored how AI-driven tools such as simulation, data analytics and virtual prototyping can accelerate the development of advanced reactor designs, marking a significant step forward in nuclear innovation.

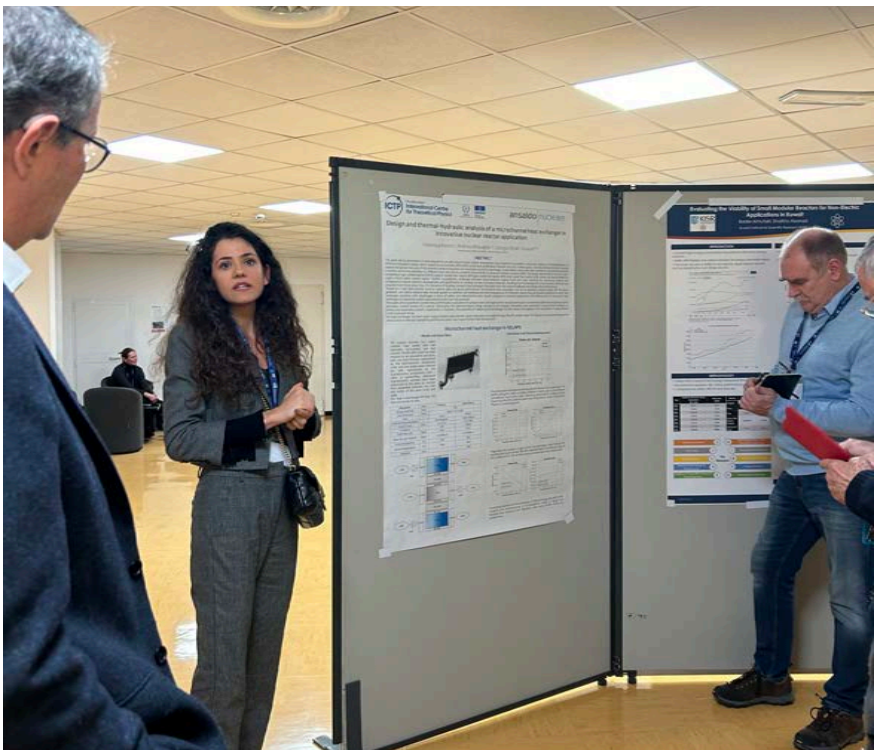
Small and medium sized or modular reactors, including high temperature reactors

Global interest in small and medium sized or modular reactors has been increasing owing to their ability to meet the need for flexible power generation for a wider range of users and applications and replace ageing fossil fuel-fired power plants. In this regard, a white paper on developing generic user recommendations and considerations (GURC) for SMRs was developed under the Nuclear Harmonization and Standardization Initiative's Industry Track. A final publication is to follow that will comprise 20 policies and 121 considerations for harmonized top-tier requirements for GURC.

The high temperature reactor code package (HCP), used for the design and simulation of several safety-related aspects of high temperature reactor cores, is disseminated through the Agency-facilitated Open-source Nuclear Codes for Reactor Analysis platform and training courses for users in Member States are delivered through relevant technical cooperation projects.

Fast reactors

In 2024, the Agency published *Sodium Coolant Handbook: Thermal Hydraulic Correlations*, the result of a coordinated research project (CRP) on sodium properties and safe operation of experimental facilities in support of the development and deployment of sodium cooled



Poster session (discussion) at the 4th Joint ICTP-IAEA Workshop on Physics and Technology of Innovative Nuclear Energy Systems, November 2024, Trieste, Italy.

fast reactors, and completed a CRP on the neutronics benchmark analysis of start-up tests conducted at the China Experimental Fast Reactor.

Non-electric applications of nuclear power

Since electricity accounts for only around one fifth of global energy consumption, there is also a recognized need to use nuclear energy to help decarbonize a wide range of non-electric applications. Aside from the proven use of nuclear heat for district heating and desalination, the first commercial projects to provide high quality process steam to petrochemical industrial sites were announced in 2024. The Agency organized a special session on nuclear desalination in collaboration with the International Desalination and Reuse Association (IDRA) at the IDRA World Congress 2024 in Abu Dhabi to showcase the potential role of nuclear. In addition, cogeneration projects around the world and the benefits and challenges of cogeneration were discussed at a technical meeting. To support the future expansion of hydrogen production, the Agency completed a CRP and issued a related publication on assessing technical and economic aspects of nuclear hydrogen production for near term deployment.

Fusion energy technology development and deployment

To help Member States prepare for fusion energy technology deployment, various new activities were launched. Meetings were held, among other things, to identify gaps and shortcomings relating to fusion codes and standards and to discuss technical issues associated with the development and nuclear qualification of tritium breeder blankets and associated neutronics. In addition, the publication *Considerations of Technology Readiness Levels for Fusion Technology Components* was issued. ◆

Enhancing Global Nuclear Energy Sustainability through Innovation

Nuclear energy requires comprehensive evaluation for strategic long term planning to ensure that it aligns with the Sustainable Development Goals. In 2024, the Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) developed a set of decision support tools for developing nuclear energy scenarios and conducting studies for the formulation of national strategies for sustainable nuclear energy systems and the achievement of net zero emission goals. To support and enhance Member State capacities, INPRO piloted its Advisory Service in China, Indonesia and Viet Nam, launched a collaborative project to develop the necessary competencies through educational programmes and INPRO Schools, conducted Dialogue Forums on the successful development and sustainable deployment of SMRs, and led collaborative projects to address technological and institutional innovations such as the back end of the fuel cycle, multi-recycling of fuel, fusion energy, nuclear hydrogen, and developing tools for the net zero transition. Mongolia and Rwanda joined INPRO, bringing its membership to 46. ◆

Technical tour organized within the framework of the 22nd INPRO Dialogue Forum on Successful Development and Sustainable Deployment of SMRs, Republic of Korea, May 2024.

NUCLEAR FUEL CYCLE AND WASTE MANAGEMENT

OBJECTIVE

To support Member States in establishing and improving effective, safe, secure and sustainable frameworks, and implementing solutions for nuclear programmes and nuclear applications in the fields of fuel cycle, research reactors, radioactive waste management, decommissioning and environmental remediation.

To support Member States in strengthening their capabilities and human resources in the domains of fuel cycle, radioactive waste management, decommissioning and environmental remediation, and research reactors, including collaborative arrangements and shared facilities.

To be a platform to facilitate and strengthen international cooperation, coordination and information sharing among Member States.

Integrating radioactive waste management from the earliest planning and design stages of any new nuclear development is fundamental — be it SMRs or innovative fuel types. We must also demonstrate our commitment to addressing past legacies and dealing with the waste in a responsible manner. This proactive approach ensures sustainability, efficiency and the safe advancement of cutting-edge nuclear technologies.

James McKinney
Chief Strategist for Integrated Waste Management, Nuclear Decommissioning Authority, United Kingdom

ONKALO spent fuel disposal facility in Finland, which is undergoing trial operations. (Photograph courtesy of Posiva)

5

peer review missions conducted

1 DSRS-TeC
1 INIR-RR
1 IUPCR
2 OMARR

2

Collaborating Centre agreements signed

NNL, UK
Polimi, Italy

211

nuclear reactors permanently retired from service, **of which 23** fully decommissioned

520

research reactors decommissioned or undergoing decommissioning in **37 countries**

60 000

tonnes of uranium produced globally (GlobalData estimate)

KEY OUTPUTS

Front End

With the commitment by over 30 countries to triple their nuclear capacities by 2050 and the possible deployment of small modular reactors (SMRs) worldwide, the timely, sustainable and sufficient production of uranium and nuclear fuel has become an important topic. Substantial geoscientific research efforts will be needed to develop an understanding and reliable estimate of uranium resources. Participants in a technical meeting on assessing and quantifying prognosticated and speculative uranium resources, held in 2024 in Rio de Janeiro, Brazil, evaluated new data and techniques for systematically assessing and quantifying such resources. The Agency has also provided assistance in developing national infrastructure for uranium production through Integrated Uranium Production Cycle Review (IUPCR) missions, such as that conducted in Uganda in May 2024.

Fostering the development of innovative fuels for advanced reactors, including SMRs, by sharing information on their design, manufacturing, performance and qualification was the topic of several technical meetings and consultancy meetings held and coordinated research projects (CRPs) launched or closed by the Agency in 2024.

The IAEA Low Enriched Uranium (LEU) Bank in Kazakhstan, which provides an assurance of supply mechanism of last resort, continued safe operations at the Ulba Metallurgical Plant, with the second campaign of recertification of LEU-filled 30B cylinders carried out in June 2024. An LEU reserve in Angarsk, Russian Federation, established following an agreement of February 2011 between the Government of the Russian Federation and the Agency, remained operational. ◆

Back End

Managing the spent nuclear fuel arising from nuclear power plants until its disposal is an important step of the back end of the nuclear fuel cycle.

Management of spent fuel from nuclear power reactors

With increased Member State interest in SMR deployment, a CRP was launched in 2024 to identify challenges, opportunities, gaps and issues for the back end of SMR fuel cycles. Meanwhile, a CRP to assess the performance of spent fuel storage systems for extended durations moved into its second phase.

Radioactive waste management

In June 2024, the First Research Coordination Meeting on Deep Borehole Disposal (DBD) Options discussed research, development and demonstration plans to enhance the current global knowledge basis for the DBD concept. This represented a significant milestone on the path towards adding DBD to the suite of established disposal options. To further support capacity building in Member States, comprehensive training course modules were developed, covering essential topics such as disposal roadmaps, site investigations and repository design.

The Spent Fuel and Radioactive Waste Information System (SRIS) remains a cornerstone of the Agency's efforts to support Member States in managing related data. In 2024, the SRIS was enhanced through the development of standardized data templates, which streamline data submissions and reduce the reporting burden. Complementing the SRIS, the Spent Fuel and Radioactive Waste Inventory Tool (SWIFT) allows Member States to manage their national radioactive waste and spent fuel inventories. ◆

Recovery of devices containing ^{226}Ra sources from a subsurface storage facility in Mongolia.

Managing legacy waste remains the key focus of radioactive waste management. The 2024 publication *Addressing Challenges in Managing Radioactive Waste from Past Activities* provides information and examples in this respect.

Management of disused sealed radioactive sources

Radioactive sources are used worldwide in medicine, industry and research. Once they fall out of use, the safety and security risks increase if the sources are improperly managed. In view of the challenge presented by long-lived radionuclides, in particular legacy radium-226 (^{226}Ra), the Global Radium-226 Management Initiative leverages this isotope's potential as a feedstock for actinium-225, used in cancer treatment. The Initiative gained momentum in 2024 and currently includes over 90 Member States, covering all regions. A related technical meeting attended by 56 Member States provided an opportunity for enhanced connectivity and produced tangible results for further actions in view of ^{226}Ra recycling. Six successful transfers have been recorded since the inception of the Initiative in 2021, with many more in the pipeline. ◆

Decommissioning and Environmental Remediation

Decommissioning

Decommissioning is the last phase of a nuclear facility's life cycle and needs to be considered in its design and operation. It includes planning and costing, physical and radiological characterization, decontamination, dismantling, demolition and the final cleanup of the site.

In 2024, the Agency conducted a series of technical meetings and workshops to share knowledge on the decommissioning of various nuclear facilities. These addressed the decommissioning supply chain, technological innovations, knowledge organization systems, nuclear site repurposing and stakeholder engagement. A meeting held in Vienna in collaboration with the European Commission's Joint Research Centre further advanced the application of a jointly developed taxonomy to decommissioning projects.

A new CRP was launched in 2024 on the deployment of innovative digital technologies for efficient decommissioning. In addition, the second phase of the Agency's Global

Status of Decommissioning project was initiated with the aim of gathering essential data for the analysis of key decommissioning trends, including the use of AI, robotics and digital twins.

Environmental remediation

In 2024, the Agency enhanced its support to Member States in managing naturally occurring radioactive material, a persistent nuclear safety challenge. It provided technical training to 19 Member States on site characterization to facilitate remediation planning and the design of remedial solutions. Additionally, to address environmental challenges effectively and sustainably, a CRP to develop low-cost, deployable remediation technologies was launched.

Research Reactors

The Agency assists Member States with the planning, operation, utilization and fuel cycle of research reactors, used for research, material testing, radioisotope production, education and training. It also provides assistance in capacity building and infrastructure development.

New research reactor projects, infrastructure development and capacity building

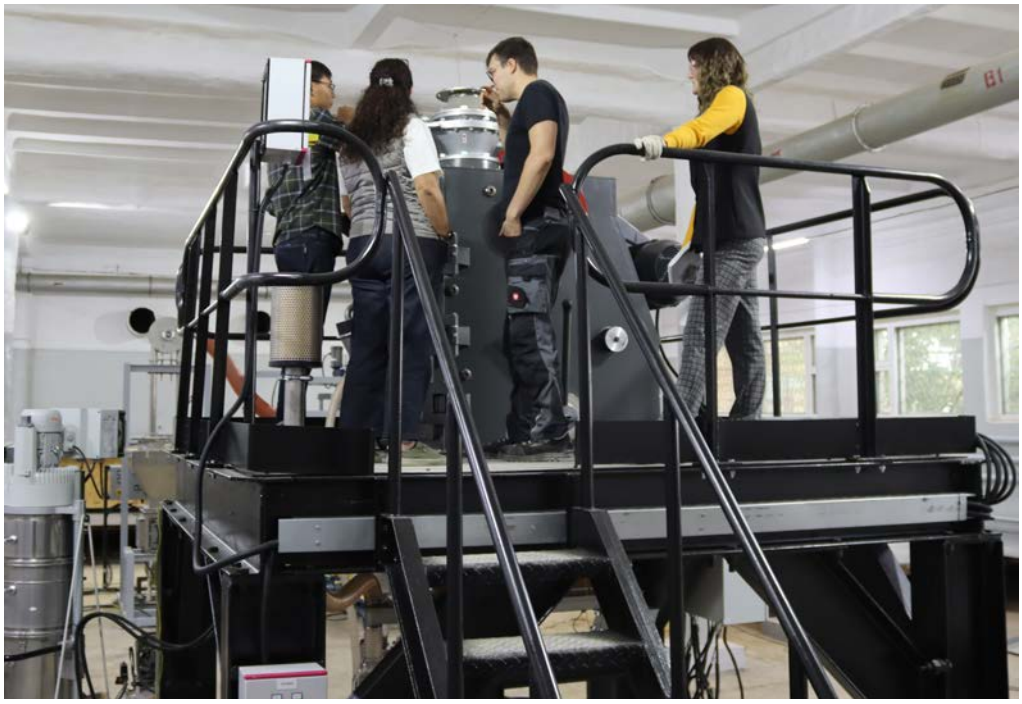
Two Research Reactor Schools, conducted in France and the Russian Federation, trained young professionals from 17 Member States in a broad range of topics related to physics, safe operation and applications. To assist Member States in developing and implementing new research reactor projects, the Agency organized workshops on the preparation of feasibility studies for such projects and on technical requirements in the bidding process for a new research reactor, and conducted a follow-up Integrated Nuclear Infrastructure Review for Research Reactors mission to Thailand.

Research reactor fuel cycle

In support of Member State efforts to minimize and eventually eliminate the use of high enriched uranium (HEU) from research reactors and radioisotope production facilities, the Agency organized technical meetings on experience in the removal of HEU from research reactors, on HEU/LEU conversion, operation and utilization of MNSR and SLOWPOKE research reactors, and on treatment and conditioning options for research-related spent fissile materials, allowing participants to share experience and further develop related publications. Direct assistance in preparing for the disposition of irradiated HEU fuel from two research reactors in Kazakhstan was provided through expert support and a series of coordination meetings.

Research reactor operation and maintenance

In 2024, the Agency continued assisting Member States to improve the operational performance of their research reactors and address ageing issues through Operation and Maintenance Assessment for Research Reactors missions, conducted in Brazil and Chile, and missions supporting in-service inspections of research reactors, conducted in Chile and Egypt. It also published *Guidelines for Ageing Management, Modernization and Refurbishment Programmes for Research Reactors* and *Optimization of Research Reactor Availability and Reliability: Recommended Practices* and launched a CRP on the development of time limited ageing analyses for research reactors. Participants from 51 Member States benefited from training events and technical meetings on related topics. ◆



Assembling equipment for the down-blending of irradiated HEU fuel in Kazakhstan. (Photograph courtesy of Kazakhstan's National Nuclear Centre)

CAPACITY BUILDING AND NUCLEAR KNOWLEDGE FOR SUSTAINABLE ENERGY DEVELOPMENT

OBJECTIVE

To support Member States in strengthening their energy planning capacities in formulating science-based energy strategies and programmes, and to improve the understanding of Member States and the international community of the role of nuclear energy in mitigating climate change, facilitating the net zero transition and achieving the SDGs.

To support Member States in strengthening their organizational capacities in nuclear knowledge management and human resources development and to foster and expand international networking in these areas.

To acquire and preserve nuclear science and technology information and data from Member States and international partners and to provide Member States with effective and efficient access to authoritative information and other resources collected in the International Nuclear Information System (INIS) and the IAEA Library.

"

Acquiring, retaining, managing and transferring technical knowledge are major challenges both in countries with established programmes and in those termed as newcomer countries by the IAEA.

Elsie Pule
Director of Special Projects,
Rosatom Central and Southern Africa Pty Ltd

4
Knowledge Management Assist visits

5
Nuclear Energy Management Schools

4
Nuclear Knowledge Management Schools

4
International Nuclear Management Academy visits

KEY OUTPUTS

Energy Modelling, Data and Capacity Building

Energy modelling and planning is key to informing policymakers on ways to curb greenhouse gas emissions from the energy sector, the main source of such emissions. The Agency, though its work on capacity building in energy planning, is providing Member States with energy modelling tools and training and supporting them in their efforts to model energy transition pathways that meet their climate objectives. In this context, the Agency published the *IAEA Toolkit for Sustainable Energy Planning* as part of its contribution to the G20 Brasil Energy Transitions Working Group. The inclusion of nuclear power in the first Global Stocktake, concluded at COP28, and the increasingly ambitious projections for nuclear capacity growth by 2050, reflect the growing interest in nuclear power to complement other low carbon sources and achieve related objectives. Several workshops and training events in 2024 focused specifically on modelling the role of nuclear power in net zero transitions, addressing one of the goals of the Agency's **Atoms4NetZero initiative** launched at COP27. Discussion points included the modelling of low carbon heat supply from nuclear power plants and the modelling of flexibility and storage requirements in electricity systems with high shares of variable renewables. The Agency also initiated the development of specific guidelines for taking into account all the attributes of nuclear power in integrated energy system models. ◆

Energy, Economic and Environmental (3E) Analysis

With the pledge by 31 countries to triple nuclear capacity by 2050 confirmed at COP29, and the Agency's own nuclear capacity high case scenario projecting an increase of 2.5 times the current capacity by the middle of the century, it is clear that investment in nuclear power will need to rise significantly in the coming decades. At the Clean Energy Ministerial held in Brazil in October 2024 ahead of COP29 — labelled the 'finance COP' — the Agency released a publication entitled *Climate Change and Nuclear Power 2024: Financing Nuclear Energy in Low Carbon Transitions*. This publication assesses the level of financing needed to meet the Agency's high case projection — typically an increase in annual investment from around US $50 billion to US $125 billion (or US $150 billion in the case of tripling nuclear capacity). The analysis confirms the important role of governments in providing financing and different types of guarantees, but also highlights the need to attract financing from the private sector to meet the bulk of the investment needs. It underlines the benefits of including nuclear power in sustainable taxonomies and recognizes it as a clean low carbon technology. Green bonds, sustainable bonds and other instruments can now complement other sources of financing and are key to attracting interest from private banks and financial institutions. The publication also analyses the important role that multilateral development banks could play in providing access to financing to emerging markets and developing economies. ◆

Group project work at a Nuclear Knowledge Management School in College Station, Texas, United States of America, December 2024.

Nuclear Knowledge Management

The nuclear industry, given its unique nature and the dynamic global landscape, is poised for increasing opportunities. In 2024, to assist Member States in capturing, maintaining, preserving and transferring knowledge:

- Four Knowledge Management Assist Visits were conducted for nuclear organizations in Brazil, for national education providers in the Philippines, at Polish State-owned company Polskie Elektrownie Jądrowe, and at the King Abdullah City for Atomic and Renewable Energy in Saudi Arabia;
- Three International Nuclear Management Academy missions facilitated by the Agency supported the establishment of master's degree programmes focusing on technology management for the nuclear and radiological sectors at Yerevan State University in Armenia, Sofia University in Bulgaria and Harbin Engineering University in China;
- A technical meeting was held on new training and learning methods to ensure competent and qualified nuclear facility personnel. This will help Member States to integrate good practices related to technology development and new training and learning techniques and tools in accordance with the systematic approach to training (SAT) methodology;
- The annual Technical Meeting on Educational Networks in October 2024 provided a forum for university and regional network representatives to share best practices in education outreach.

Human resource development and management

The Agency supports Member States that are operating, expanding or developing new nuclear power programmes in acquiring and maintaining competent staff for all nuclear organizations — including government agencies and owner/operators — and in engaging with stakeholders.

In 2024, three national workshops for the development of national strategies and planning for human resource development in nuclear programmes were organized in El Salvador, Kenya and Poland. Additionally, two interregional training courses on human resource management for new and expanding nuclear power programmes were implemented in the Russian Federation and the United States of America. ◆

Nuclear Information

Member States and the Agency continue to receive information support through the IAEA Lise Meitner Library and the International Nuclear Information System (INIS). To improve the management of, and increase access to, valuable resources, a new integrated library management system was implemented in 2024. In addition, the Nuclear Artificial Intelligence for Document Indexing and Analysis (NADIA) tool, which was developed in house and uses natural language processing and machine learning technology to categorize and index knowledge products within INIS, was deployed, increasing the accuracy and speed with which knowledge products are processed. A training workshop on the principles of information management and the use of a new and more efficient INIS system was conducted in October 2024. ◆

INIS training seminar held in Vienna, October 2024.

1.2 million
users accessed the INIS repository globally

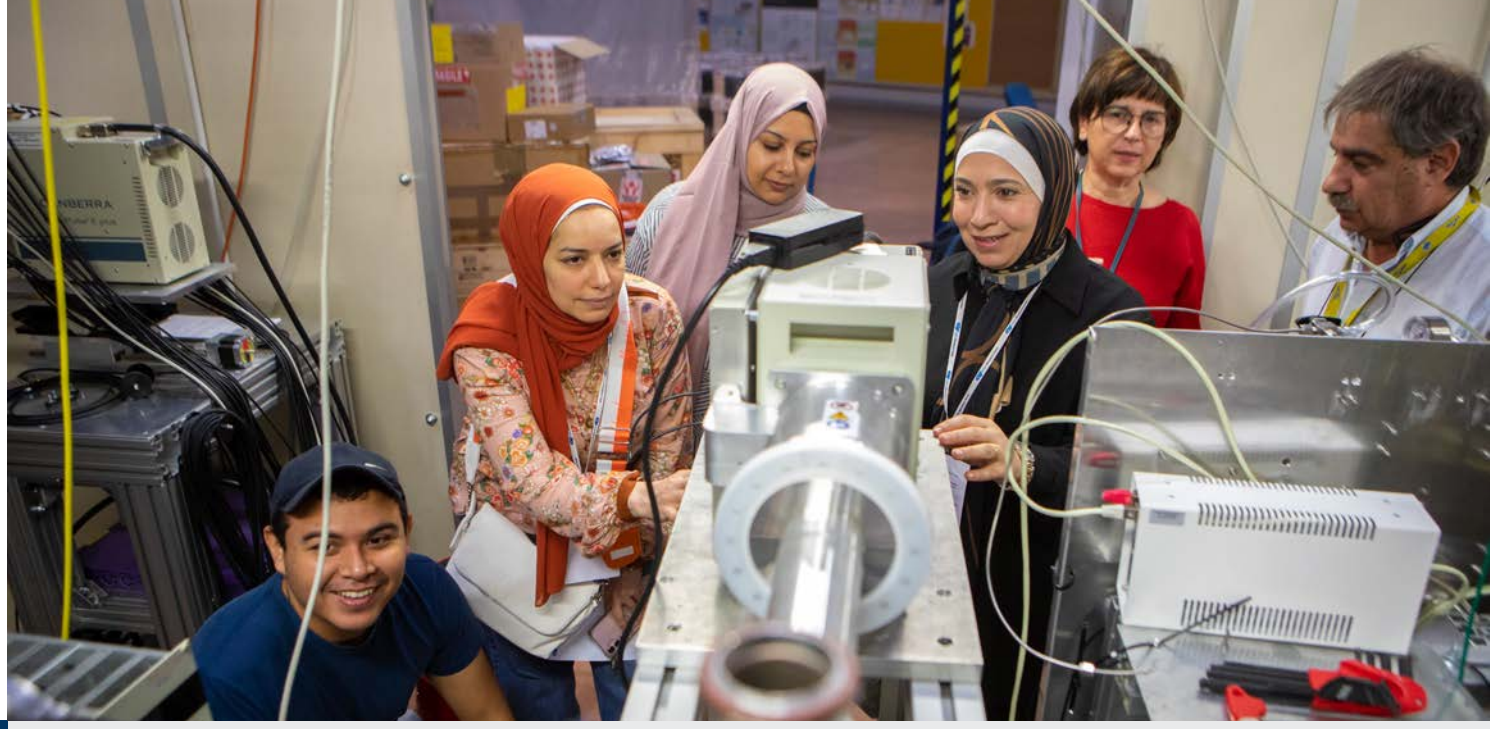
2 million
unique INIS searches

24 million
full text downloads

2.5 million
viewed pages

107 000
new records curated, including **15 000** full-text documents

Celebrating World Book and Copyright Day at the Vienna International Centre, April 2024.



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 socioeconomic development.

To support Member States in enhancing sustainable operation and effective utilization of particle accelerators and neutron sources, as well as effective utilization of research reactors, increasing opportunities for access to these facilities and their diverse applications, and in developing relevant qualified professionals.

"

We are revising our strategic plans to incorporate the feedback provided by the Integrated Research Reactor Utilization Review (IRRUR) mission and are actively pursuing expanded utilization of the McMaster Nuclear Reactor (MNR) to sustain and enhance a world-class facility for neutron-based science that drives McMaster's continued excellence in nuclear research, innovation and training.

Karin Stephenson

Director of Nuclear Research and Education Support, MNR, McMaster University, Canada

Agency workshop trainees preparing an experiment at the joint Agency–Elettra Sincrotrone Trieste beam line, Italy, October 2024. (Photograph courtesy of Elettra Sincrotrone Trieste)

16
coordinated research projects in progress

1
IRRUR mission to Canada

4
accelerator support missions to Ghana, Italy and Tunisia

4
cooperation agreements signed with ITER Organization, Fusion Industry Association, French CEA and Elettra

200
people received hands-on training in nuclear science and applications

15 TB
of material downloaded from the Nuclear Data Services database

KEY OUTPUTS

Atomic and Nuclear Data

The Agency provides fundamental nuclear data for power and non-power applications, as well as atomic data for fusion energy research. In 2024, it released a number of user interfaces, notably a new version of Data Explorer and an application programming interface (API) for Livechart for nuclear structure and decay data. The seventh international workshop on compound-nuclear reactions and related topics discussed developments in nuclear reaction models for nuclear applications, and the Decennial IAEA Technical Meeting on Atomic, Molecular and Plasma–Material Interaction Data for Fusion Science and Technology, held in Helsinki, focused on the fusion data needs of processes relevant for fusion plasmas and plasma-wall interactions. ◆

Research and Applications with Accelerators and Neutron Sources

The Agency supports Member States with regard to research, applications, infrastructure development and capacity building using particle accelerators and neutron sources.

Periodic training courses and workshops provided hands-on training in scientific experiments and practical applications at research reactors, accelerator-based neutron sources, and laser, ion beam and synchrotron light facilities. Research groups from some 20 Member States carried out experiments at jointly operated instruments at the Ruđer Bošković Institute, Croatia, and Elettra Synchrotron Trieste, Italy, covering areas such as materials research, energy, cultural heritage, environmental pollution, nutrition and medical applications. ◆

Integrated Research Reactor Utilization Review (IRRUR) mission assessing the research reactor at McMaster University in Canada. (Photograph courtesy of McMaster University)

The Agency continued its endeavours in the area of 'Atoms for Heritage' by organizing technical meetings, workshops and schools, allowing numerous participants to enhance their knowledge regarding advances in nuclear analytical techniques for the characterization, preservation and dating of heritage samples and objects, including applications in combatting illicit trafficking of art and archaeological artefacts.

Two Agency publications issued in 2024 — *Laboratory Intercomparison Exercises Performed in 2010–2022 for Neutron Activation Analysis Laboratories* and *Neutron Activation Analysis Using Short Half-life Radionuclides* — are intended for neutron activation analysis laboratory practitioners and end users interested in quality control and quality assurance and the use of this analytical technique for more diverse applications. ◆

Nuclear Instrumentation

The safe and effective use of nuclear techniques requires reliable measurement, diagnostics and control instrumentation. Advanced nuclear instrumentation is used for many sophisticated applications, such as precision imaging systems for medical diagnostics, remote sensors for environmental safety and the probing and manufacturing of cutting-edge materials and items.

More than 400 person-weeks of hands-on training took place at the Agency's Nuclear Science and Instrumentation Laboratory (NSIL) and at partner organizations, covering gamma spectroscopy, X-ray fluorescence, neutron science, muon tomography, radiotracer applications, mobile radiological mapping and nuclear security. Nine interns were hosted and trained by the laboratory for at least three months.

A joint ICTP–IAEA workshop held in Doha allowed trainees to familiarize themselves with fully programmable systems-on-chip and their applications to scientific instrumentation and reconfigurable computing through tutorials and hands-on activities on open-source methods, software design tools and hardware platforms.

At the request of Jordan, Malaysia, Slovakia and Spain, the NSIL shared the safety assessment report of the Agency's Neutron Science Facility to facilitate the establishment and safe operation of similar facilities in interested Member States. Lastly, the analytical capabilities of some 98 laboratories in 57 Member States were improved through proficiency tests. ◆

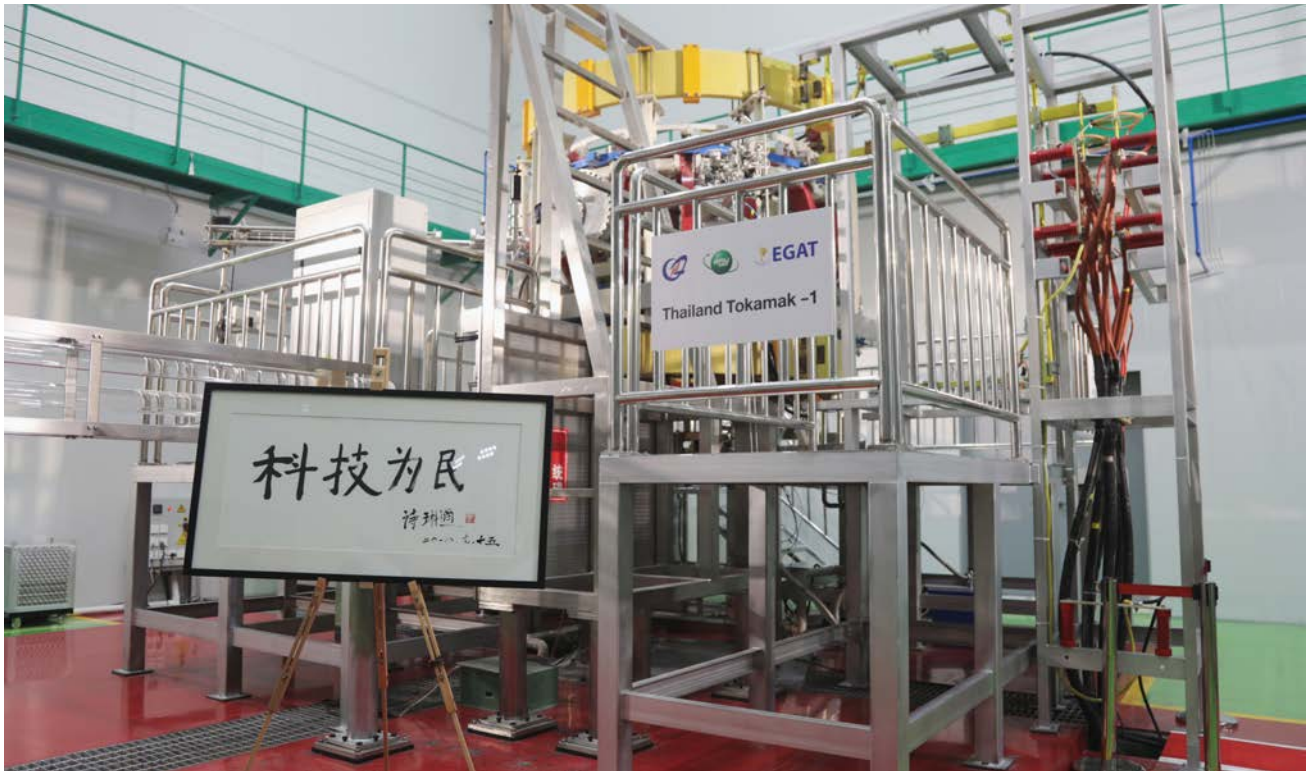
Fusion Science and Plasma Physics

In 2024, the Agency continued its support to Member States by accelerating fusion energy research, technology development and capacity building to make fusion energy generation a reality.

The following schools were held:

- The Joint ICTP–IAEA Fusion Energy School, featuring lectures by experts from academia and the private sector and aimed at developing a wider understanding of fusion energy and allowing participants to connect with leading researchers. Participants were introduced to skills in computational and experimental plasma physics, which will help them to conduct cutting-edge research and technology in the future;

The Agency signed Practical Arrangements with the French Alternative Energies and Atomic Energy Commission (CEA) in the area of neutrons for nuclear sciences and applications (Neutrons4NA), aiming to bring together different stakeholders interested in developing relevant technologies and open user access to nuclear sciences and applications using neutrons.



The experiments at the Thailand Tokamak 1 (TT-1) facility, jointly constructed by the Hefei Institutes of Physical Science of the Chinese Academy of Sciences and the Thailand Institute of Nuclear Technology (TINT), are part of the programme of the annual ASEAN School on the topic of plasma and fusion energy, organized in cooperation with the Agency. (Photograph courtesy of TINT)

- The 13th ITER International School, organized in cooperation with and supported by the Agency, which helped to prepare young scientists and engineers for work in the field of fusion energy and in research applications associated with the ITER Project; and
- The 9th ASEAN School on the topic of plasma and fusion energy, organized in cooperation with and supported by the Agency, which helped to raise awareness of fusion energy and plasma research in Southeast Asian countries and promoted interaction between young talent and leading researchers from around the world.

Technical meetings were held on:

- Long-pulse operation of fusion devices — this meeting reviewed, discussed and addressed scientific and engineering issues related to steady-state and long-pulse operation of fusion devices, which are essential for ITER and future fusion reactors;
- Plasma disruptions and their mitigation — this meeting helped participating organizations to coordinate experimental, theoretical and modelling work in the field of plasma disruptions with a special emphasis on developing a solid basis for possible mitigation strategies in ITER and next generation fusion devices; and
- Control systems, data acquisition, data management and remote participation in fusion research — this meeting provided an international forum to discuss new developments in related areas.

The following publications were issued:

- *Plasma Physics and Technology Aspects of the Deuterium–Tritium (D-T) Fuel Cycle for Fusion Energy* — this publication provides an overview of plasma physics and technology aspects of the D–T fuel cycle in magnetic fusion devices, from ITER to demonstration fusion power plants;
- *Experiences for Consideration in Fusion Power Plant Design Safety and Safety Assessment* — this publication compiles international experience and safety practices related to experimental fusion machines. It provides valuable insights into safety considerations for prototype, demonstration and prospective commercial fusion power plants and will also serve as a foundation to determine whether fusion-specific design safety and safety assessment standards may be necessary. ◆

IAEA PUBLICATIONS IN 2024

Nuclear Power, Fuel Cycle and Nuclear Science

48 publications issued in 2024

- Nuclear Fuel Cycle and Waste Technology **18**
- Nuclear Power **17**
- Planning, Information and Knowledge Management **8**
- Nuclear Science **5**

more than **500 000** online views of publications in 2024

most popular

Nuclear Power Reactors in the World

15 609 online views

Multilingualism

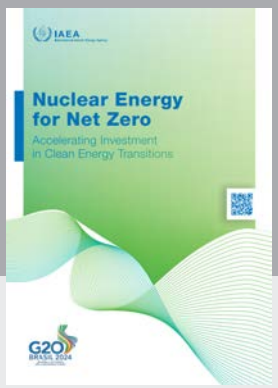
publications translated in 2024

- **2** Arabic
- **5** French
- **4** Russian
- **2** Spanish

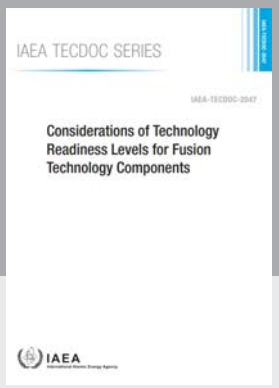
iaea.org/publications

Milestones in the Development of a National Infrastructure for Nuclear Power (Rev. 2)
This publication defines the three milestones in developing the infrastructure necessary for introducing nuclear power and provides guidance on related activities, also outlining specific infrastructure considerations for small modular reactors.

Roadmap for Developing a Geological Disposal Programme
Implementation of a geological disposal programme for radioactive waste is a major undertaking. This publication provides a roadmap for developing such a programme to deal with spent nuclear fuel declared as waste, high level waste and intermediate level waste.



Nuclear Energy for Net Zero: Accelerating Investment in Clean Energy Transitions
Produced for the G-20, this publication provides an overview of nuclear energy's contribution to global climate change mitigation pathways towards net zero and highlights the related investment requirements, providing decision makers with key information and data.



Considerations of Technology Readiness Levels for Fusion Technology Components
This publication addresses the growing need for the use of technology readiness levels in fusion programmes. It is intended for technologists, researchers, university professors and students, regulatory experts, nuclear engineers and fusion plant planners.

IAEA CONFERENCES IN 2024

Nuclear Power, Fuel Cycle and Nuclear Science

International Conference on Research Reactors: Achievements, Experience and the Way to a Sustainable Future
November 2024, Vienna
Over 400 in-person participants from 82 Member States
and 2 organizations, plus 1191 online participants

Jointly organized by the Department of Nuclear Energy, the Department of Nuclear Sciences and Applications and the Department of Nuclear Safety and Security, this event covered various topics relating to research reactors, including uses and applications, operation and maintenance, new research reactor programmes, safety, security, fuel management and common management considerations. It featured five side events, including a joint event with Women in Nuclear Global that looked at challenges and opportunities for women at research reactors.

International Conference on Nuclear Knowledge Management and Human Resources Development
July 2024, Vienna
763 in-person participants from 107 Member States
and 9 international organizations, plus 875 online participants

This event centred on the roles and critical interplay of people, technology, alliances and sustainability in nuclear knowledge management and human resources development. It facilitated the exchange of experience and good practices, highlighting innovative approaches to empower individuals, enhance technological capabilities, strengthen international cooperation and advance sustainable nuclear energy development.

International Conference on the Management of Spent Fuel from Nuclear Power Plants: Meeting the Moment
June 2024, Vienna
293 in-person participants from 58 Member States
and 6 organizations, plus 1205 online participants

Jointly organized by the Department of Nuclear Energy and the Department of Nuclear Safety and Security, this event enabled researchers, operators and regulators to discuss national spent nuclear fuel management strategies and how the management of spent fuel will support the role that nuclear energy could play in a changing energy mix.

NUCLEAR TECHNIQUES FOR DEVELOPMENT AND ENVIRONMENTAL PROTECTION

In 2024, nuclear sciences and applications delivered tangible solutions to global challenges. We expanded the network of national veterinary laboratories with advanced diagnostic tools and training to improve animal health. To optimize cancer patient care and outcomes, we continued supporting enhanced access to radiotherapy and theranostics. Our research confirmed microplastics in Antarctica, advanced bio-based plastics, and improved marine plastic monitoring. We trained Member States in using advanced isotopic modelling for sustainable water management, while developing nuclear-driven food security solutions adapted to changing climate conditions. Leveraging all available means, including Rays of Hope, Atoms4Food, NUTEC Plastics, ZODIAC and GloWAL, we continued to drive innovation in nuclear sciences and applications for a healthier, more sustainable future.

Najat Mokhtar
Deputy Director General
and Head of the Department
of Nuclear Sciences and Applications

Nuclear Techniques for Development and Environmental Protection

Research, Collaboration and Advocacy

95
active coordinated research projects

200
technical, consultancy and research coordination meetings

1156
active research contracts

54
active collaborating centres

26
collaborating networks

54
conferences, forums, symposiums side events

Online Resources

26
databases

Ocean Acidification International Coordination Centre (OA-ICC) news stream

- **32 463** unique visitors from **199** countries
- **827** posts
- **51 133** views

Learning and Training

44 webinars

14 Online courses and e-learning material

121 training courses and workshops

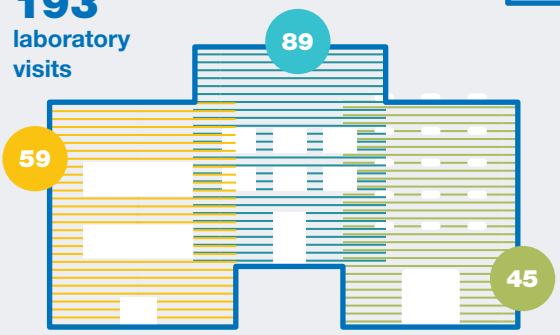
Key Areas

- Food and Agriculture
- Human Health
- Water Resources
- Marine Environment
- Radiochemistry and Radiation Technology

12 international laboratories

3 · 8 · 1

193 laboratory visits



160+ countries received support from the laboratories

virtual tours of the laboratories

FOOD AND AGRICULTURE

OBJECTIVE

To increase the sustainability and resilience of agri-food systems and related livelihoods in Member States by reducing the impact of climate change on food and agriculture, including through detecting outbreaks of animal and zoonotic diseases, plant pests, food safety risks and environmental pollutants.

"

One Health (…) should not be tackled using a multidisciplinary approach only, but rather a transdisciplinary approach that transcends the boundaries of disciplinary thinking and enables us to set priorities that can be translated into policy and thus the need to invest in it.

Wanda Markotter

Professor and Director of the Centre for Viral Zoonoses, University of Pretoria, South Africa

4177

animals genetically characterized using multi-species SNP genotyping arrays

15

stable isotope databases created by 16 Member States under a CRP on food export

9

months to eradicate an Mediterranean fruit fly outbreak in the Dominican Republic

10

protocols published for screening and identifying drought tolerant rice and sorghum mutants

18

SOPs, protocols and production guidelines developed on soil and water management

KEY OUTPUTS

Promoting Camelids using Genomic Characterization and Improvement

Camelids are reared for milk, meat and sport, supporting many pastoral communities in Africa and Asia. They are built for drought and thrive in arid and semi-arid areas that are unsuitable for most crop and livestock production. In prior years, the Agency, through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, sequenced and assembled the genome of *Camelus dromedarius* using radiation hybrid mapping and next generation sequencing. In 2024, a total of 180 000 single nucleotide polymorphisms (SNPs) were extracted into a multi-species SNP genotyping array that is used to characterize, conserve the biodiversity of and improve various camelid species. To date, the SNP array has enabled the genetic characterization of 1142 animals from 21 dromedary, 5 Bactrian and 14 New World camelid populations, each with at least 45 000 SNPs for analysis. Member States from South America, Africa and Asia also received training in laboratory procedures and bioinformatics to enhance their capacity to perform analyses, including the identification of genomic regions affected by selection, and to develop genomic tools for camelid breeding and improvement.

The United Nations declared 2024 as the International Year of Camelids to highlight their significant contribution to livelihoods around the world. As part of the awareness raising efforts, the Agency, through the Joint FAO/IAEA Centre and in partnership with the FAO and Peru, organized an event in June 2024 to address the global interest in camelids and promote a collaborative platform for stakeholders. The event highlighted related research and development work, supported the conservation of camelid biodiversity and recognized camelids' potential in relation to sustainable agriculture, ecotourism and poverty reduction. The FAO–Agency **Atoms4Food initiative** fully supports these and other opportunities linked to animal production. ◆

Underpinning Food Safety and Quality through Strong Food Control Systems

Food control systems are under increasing pressure due to various factors, including the disruptive effects of pandemics, food-borne diseases, climate change and conflicts affecting food supply chains — a challenge that is being addressed through **Atoms4Food**. Nuclear techniques are often used to complement non-nuclear methods in order to provide solutions to food safety and control challenges.

In May 2024, the Agency held the International Symposium on Food Safety and Control to highlight the role of nuclear techniques in food control systems and to provide a forum for collaboration. The event brought together a plethora of stakeholders to discuss measures to protect the integrity of the food supply chain and improve its resilience against disruptions caused by pandemics, conflict or other catastrophic events. In addition, contemporary and novel applications of nuclear and complementary techniques were presented and future perspectives and opportunities considered. The discussions aligned with the One Health approach, which, in the context of food safety, promotes collaboration to identify, understand and mitigate risks at every stage of the food chain. ◆

Combating Fusarium Wilt in Bananas through Genetic Innovations

Plant improvement through mutation breeding is a core area of **Atoms4Food**. The Agency, through the Joint FAO/IAEA Centre, carried out mutation-assisted improvement in Mchare cooking bananas, a popular banana type in the East African Highlands that is vital to the economy and food security of the Tanzanian Northern Highlands, Kenya and islands of East Africa. Enhancing the Mchare — one of the parental lines of Cavendish banana — is crucial for developing resistance against Fusarium wilt and ensuring sustainable banana production.

In collaboration with the International Institute of Tropical Agriculture, the Agency concluded an 18-month field trial in the United Republic of Tanzania's Bukoba area, known to be a hotspot for the pathogen *Fusarium oxysporum f.sp. cubense* tropical race 1. Conducted in an area with a high prevalence of Fusarium wilt, the trial yielded promising results. A significant proportion of Mchare mutants survived compared to the control, which was severely affected by the disease. Parental improvement through mutation breeding using radiation represented a significant milestone in developing a sustainable and durable solution to combat the threat of Fusarium wilt, helping to safeguard banana production.

A parallel trial in the United Republic of Tanzania's Arusha region revealed superior agronomic traits, including improvements in stature, height, bunch and finger shape and size, and leaf size and arrangement. These traits offer greater genetic diversity and shortened breeding cycles, which are vital to banana breeding programmes. ◆

Addressing Antimicrobial Resistance through Nuclear Techniques

Antimicrobial resistance (AMR) poses a significant global health threat, complicating infection treatment in humans and animals, escalating health care costs and increasing mortality rates — a challenge that is recognized by the **Atoms4Food initiative**. The second UN General Assembly High-Level Meeting on AMR in 2024 highlighted the urgency of addressing AMR, which causes over 1 million deaths annually — a figure projected to increase significantly. Climate change in particular is expected to exacerbate the problem by altering soil ecosystems, fostering the growth of resistant microbes.

To support global AMR efforts, the Agency launched a coordinated research project (CRP) in 2021 to address AMR by using nuclear and isotopic techniques to assist in tracing the fate, dynamics and persistence of antimicrobials and AMR in agricultural systems. This key information enables the development of strategies to mitigate their spread in the environment. Specifically, in 2024, a stable carbon-13-labelled antibiotic, sulfamethoxazole (SMX), was synthesized and used in experimental studies to evaluate the movement and dynamics of AMR in soil and plants. This unique labelled antibiotic was disseminated to eight Member States to study AMR in a range of agro-ecosystems. To date, the CRP has developed a set of protocols, including in relation to the extraction and analysis of SMX and DNA from soil, water and plant samples. The results of the CRP will enhance understanding of how to reduce the risk of AMR and support the development of strategies to safeguard ecosystems and promote sustainable agricultural practices.

To study AMR from a multidisciplinary perspective, three laboratories of the Joint FAO/IAEA Centre are collaborating to develop new analytical techniques, contributing to the One-Health approach. ◆

United Republic of Tanzania

A perfectly healthy rhizome of a Mchare banana mutant evaluated in hotspot field conditions (left) and an agronomically superior dwarf Mchare mutant (right). Short to medium-height plants are preferred in banana production because they are less prone to wind damage.

Jackson trap baited with trimedlure, a powerful synthetic lure, being used for the detection of the Mediterranean fruit fly in the Dominican Republic.

End 2023

the Dominican Republic's Ministry of Agriculture detects the Mediterranean fruit fly near Punta Cana

Feb & Sep 2024

Technical Advisory Committees visit the area to provide guidance on eradication strategies

IAEA
FAO
OIRSA

27 Sep 2024

the eradication of the pest is officially declared with no quarantine restrictions imposed by importing countries

Dominican Republic

Dominican Republic Successfully Eradicates the Mediterranean Fruit Fly

With Agency support and technical expertise on insect pest control, provided through the Joint FAO/IAEA Centre, the Dominican Republic was able to successfully contain a new incursion of the Mediterranean fruit fly, a highly destructive pest threatening agricultural production worldwide. This is the second time the country has successfully eliminated this invasive insect using the sterile insect technique (SIT).

In late 2023, the Dominican Republic's Ministry of Agriculture detected the Mediterranean fruit fly near Punta Cana, triggering the activation of an emergency response protocol to contain the outbreak. Thanks to the Ministry's surveillance network, the pest was detected early and declared transient, with the affected area confined to less than 50 square kilometres — a significant improvement compared to the 2015 outbreak that affected over 2000 square kilometres.

In February and September 2024, two Technical Advisory Committees composed of Agency, FAO and International Regional Organization for Plant and Animal Health (OIRSA) experts visited the area to provide guidance on eradication strategies. Based on the field assessments, along with laboratory analyses and collected data, a series of technical recommendations to mitigate the impact of a potential future outbreak was issued, highlighting the importance of early detection and rapid response. The National Plant Protection Organization implemented a contingency plan that included weekly releases of 3 million sterile flies for 26 weeks; field surveillance and control measures such as insecticide bait sprays and bait stations; and continuous technical support from international experts.

The eradication of the pest was officially declared on 27 September 2024, with no quarantine restrictions imposed by importing countries. Insect pest control through the SIT underpins the **Atoms4Food initiative**. ◆

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.

The Lancet Oncology's latest Commission, supported by the IAEA, took a fresh look at global initiatives being done to strengthen radiotherapy and access to theranostics for cancer care. The Commission emphasized the value of collaboration, radionuclide supply chains and shortfalls in workforce. Given the rising incidence in cancer, there is an urgent need to meet these challenges. The eight-point action plan in the report set out a roadmap to drive accessibility, equity and resilience in cancer care in our ever-changing global landscape.

David Collingridge
Editor-in-Chief of *The Lancet Oncology*

1145

radiotherapy beams across **355 hospitals** in **84 countries** measured by the IAEA/WHO TLD postal dose audit service

4

audits conducted on medical quality assurance
2 QUANUM
2 QUATRO

4

scientific and technical newsletters sent to over 3000 readers

7

Agency publications produced and over 60 scientific publications featured in peer-reviewed journals

KEY OUTPUTS

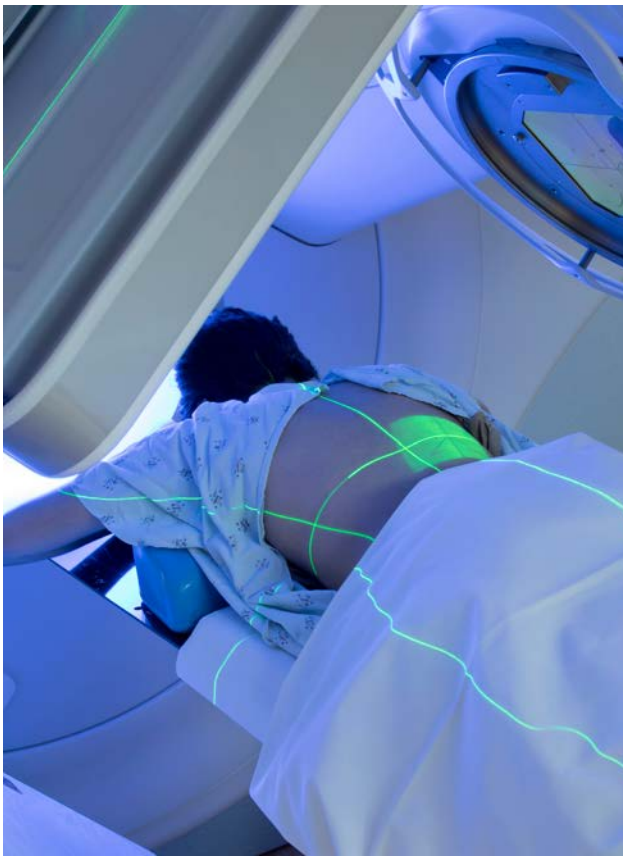
Leading an International Collaboration

While nearly half of all cancer patients require radiotherapy at some point, access remains limited for millions worldwide. In 2024, the Agency made a notable contribution to cancer care by leading a **Lancet Oncology Commission** — an important global public good that provides data and recommendations to support better policy and change practice.

Together with experts from 44 institutions and centres across 23 countries and with the support of eight professional societies, the Agency identified strategies to optimize patient care and outcomes by proposing actions that can enhance access to radiotherapy and theranostics, which involves using radiopharmaceuticals to diagnose and treat cancer patients. Through its **Rays of Hope initiative**, the Agency is actively working to implement such strategies in low and middle income countries (LMICs), expanding access to lifesaving cancer care where it is needed most. For instance, efficiently utilizing existing resources through resource-sparing approaches can significantly extend radiotherapy access, and it was calculated that such measures would have benefited an additional 2.2 million prostate and breast cancer patients in 2024. One of these approaches is hypofractionation, which involves using fewer but higher doses of radiation per daily treatment session over a shorter time frame. On the basis of 2024 data, it was calculated that substituting 50% of conventional radiotherapy with hypofractionation could yield cost savings of US $2.76 billion.

The Agency and its collaborators also found, based on a case study of lung cancer in Mongolia, that despite the upfront equipment costs, investment in advanced treatments such as stereotactic body radiation therapy can yield long term savings, even in LMICs.

In addition, the Agency and its collaborators assessed challenges and needs in theranostics. Through health economics modelling of a theranostics treatment for prostate cancer, it showed a total social impact of US $725 million over a seven-year period. For health care providers and policymakers, the Commission report by the Agency and its collaborators will serve as an evidence base to take informed decisions that accelerate cancer care access. ◆



Translating Today's Technologies into Tomorrow's Tools

During the Agency's fifth International Conference on Hybrid Imaging (IPET 2024), nuclear medicine physicians, radiologists, radiation oncologists, clinical oncologists, medical physicists, technologists, radiographers, radiopharmacists, radiochemists and other health specialists examined streamlined and emerging hybrid imaging techniques for cancer management. The Czech Republic's Deputy Prime Minister and Minister of Health, Vlastimil Válek, spotlighted how governments can actively upscale access at the national level and was joined by representatives of the Agency, professional organizations, **Rays of Hope** anchor centres, industry leaders and a patient advocate for a high-level panel, emphasizing the importance of collaboration in advancing medical imaging. During the Conference's 17 clinical sessions, seven poster review segments and 11 side events, participants were able to deepen their understanding of complex cases and applications, which will help to enhance the quality of the care patients receive.

The Agency subsequently organized a five-part webinar series on theranostics, addressing specific aspects of this growing field. The series and its accompanying lectures help to strengthen global practice among specialists around the world.

Under a coordinated research project (CRP), the Agency developed *Dosimetry for Radiopharmaceutical Therapy*, a publication that addresses educational gaps in medical physicist training while offering tools and methodologies for implementing a dosimetry-guided and patient-specific approach to this therapy.

Ongoing research involving 54 centres from 11 countries resulted in a novel dosimetry audit methodology for brachytherapy. This method will serve as the basis for a new audit service at the Agency's Dosimetry Laboratory, helping to ensure the safety and effectiveness of this treatment for common cancers.

Under a CRP, the Agency completed the optimization of the use of a nuclear technique to better understand environmental enteric dysfunction — an acquired disease of the small intestine implicated in stunting, a measure of chronic malnutrition. For children worldwide, particularly those living in unsanitary conditions, the carbon-13 sucrose breath test serves as a novel, non-invasive tool that can help assess nutrient absorption — one of the domains of this disease. ◆

Advancing Cancer Care

Since effective cancer care requires a multifaceted approach, the Agency and the World Health Organization (WHO) published *Guidance on Setting Up a Comprehensive Cancer Centre* to enhance cancer control capacities. Drawing on the expertise of professionals around the world, this resource outlines fundamental principles of multidisciplinary cancer care while describing essential infrastructure, human resources and equipment through five country examples.

In 2024, through the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories, the Agency provided calibration services, issuing 123 certificates with 466 calibration coefficients for 26 Member States. To further support countries in accurately measuring radiation doses, the Agency issued an updated version of the code of practice *Absorbed Dose Determination in External Beam Radiotherapy*, which helps to ensure that cancer patients can receive care in a consistent and verifiable manner, wherever they are. To facilitate the implementation of its codes of practice, the Agency organized several regional training events in different languages.

The Agency also continued to expand the educational resources available through its Human Health Campus.

- **A new e-learning course on clinical radiobiology offers interactive training to bridge global knowledge gaps on a key prerequisite for treating cancer with radiation. Within a week of its official release, over 820 health professionals had accessed the course.**
- **And to strengthen countries' capacities in addressing a common cancer among women, the Agency released the only comprehensive and free modular training course of its kind for breast cancer diagnosis. This offers an accessible training solution for specialists across the globe, particularly in settings where resources are often limited.** ◆

Delivering Data-Driven Insights Informing Global Policy Discussions

For the second year in a row, the Agency's Directory of Radiotherapy Centres enabled the World Intellectual Property Organization (WIPO) to measure the worldwide availability of cancer therapy equipment and include radiotherapy in its assessment of global innovation. The WIPO Global Innovation Index 2024 showed a 2.7% increase in global radiotherapy equipment from 2022 to 2023.

Together with the Food and Agriculture Organization of the United Nations and WHO, the Agency reviewed current scientific understanding and calculations of human energy requirements — a key measure underpinning global nutrition indicators that was last evaluated in 2001. Having already been used to generate scientific publications redefining understanding of human energy metabolism, the Agency's Doubly Labelled Water Database is helping to revise global recommendations for energy requirements by providing much-needed data through its almost 12 000 measurements of daily total energy expenditure spanning 40 countries.

On World Obesity Day in March 2024, the Agency launched a new database on body composition to help countries devise better health policies to combat growing obesity challenges. The database brings together data from almost 2600 study participants, collected using the deuterium dilution stable isotope technique. ◆

Partnering with Purpose for Improved Impact

Building on its long-standing cooperation with partners, the Agency welcomed the M.D. Anderson Cancer Center (MDACC) of the University of Texas as a Collaborating Centre — the first such centre in North America for cancer care. Through this collaboration, MDACC has provided experts to support the Agency's technical activities, organized a series on research programmes, including in support of **Rays of Hope** anchor centres, and hosted several training events. In May 2024, the Agency and MDACC organized a regional course for over 40 imaging specialists from the Caribbean, strengthening access to breast imaging diagnostics for the region's 3.8 million women.

The Agency also renewed its collaboration with professional societies such as the European Association of Nuclear Medicine and joined forces with organizations such as the International Centers for Precision Oncology Foundation. In doing so, it continued to support the professional development of medical practitioners worldwide, particularly those in LMICs, including through complimentary access to educational materials and virtual access to major medical conferences. Under Practical Arrangements with the world's leading radiation medicine societies, over 120 specialists continue to provide expertise to **Rays of Hope** anchor centres through dedicated technical working groups. ◆

An Agency radiologist highlights mammography availability across the globe, before introducing the Agency's related e-learning course.

The Director General and Senior Vice President of the M.D. Anderson Cancer Center, Chris McKee, at the signing ceremony designating MDACC as an Agency Collaborating Centre, January 2024.

WATER RESOURCES

OBJECTIVE

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

Isotope hydrology and its full integration into the water sector could be that shining light we need to join all the different scientific perspectives.

Farai Tunhuma

Global Senior Advisor for water supply, sanitation and hygiene, United Nations Children's Fund

Group training on field sampling with radon to evaluate recent recharge to surface water systems, El Salvador. (Photograph courtesy of El Salvador's Ministry of the Environment and Natural Resources)

449

active Global Network of Isotopes in Precipitation monitoring sites in 101 Member States at the end of 2024

289

participants in the 2024 water isotopes interlaboratory comparison exercise

107

participants in the first water quality interlaboratory exercise conducted jointly with UNEP

139

counterparts trained in isotope hydrology methods

KEY OUTPUTS

Global Water Analysis Laboratory Network

The First Coordination Meeting of the Global Water Analysis Laboratory (GloWAL) Network took place in June 2024, identifying scientific and technological innovation directions and compiling key training and development needs. In 2024, the completion of the first GloWAL Network baseline survey, involving 90 laboratories from 65 countries, highlighted key areas of technical need. The results will serve to develop key performance indicators to measure the Network's progress. In 2025, the Network will start accepting applications from Member State laboratories to join and deliver targeted training courses. ◆

Evaluating River Sustainability

The Agency developed an innovative method to assess the sources of inflows to river systems using isotope hydrology. The method analysed water samples from 136 perennial rivers and 45 large catchments worldwide. A dynamic water retention indicator was defined to assist decision makers in understanding the impact of climate change and land-use changes on river catchments. This indicator is a step forward to ensure that rivers continue providing essential services to both the countries they pass through and the ecosystem. The findings were published in the prestigious journal *Nature*. ◆

Advanced Training on Isotope-Enabled Modelling

In 2024, the advanced version of the isotope-enabled water balance modelling training course was implemented for the first time, including sessions delivered by the developer of the modelling software to strengthen participants' understanding of the modelling framework and allow customization of the modelling setup. The objective of this train-the-trainers style course is to grow regional capacity to incorporate isotopes into water balance modelling, which is an essential step in developing a sustainable water management plan. Water balance modelling enables Member States to monitor water sustainability by comparing the amount of water coming into a catchment with the amount going out. This approach evaluates the amount of water within the catchment that can be used sustainably. ◆

An Agency expert testing the design of automated sampling systems for extreme rainfall events.

MARINE ENVIRONMENT

OBJECTIVE

To support Member States in understanding, addressing and mitigating their most pressing marine challenges using nuclear and isotopic techniques, while enhancing their expertise and capability to develop tailored science-based strategies for the sustainable management of marine ecosystems and resources.

"

The Marine Radioactivity Information System empowers national-level assessments across IAEA Member States and lays a robust foundation for future global evaluations. By preserving and streamlining historical data, it enables the next generation of scientists to make better use of global data and drive innovation and efficiency in ongoing and future research.

Mat Johansen
Senior Researcher at the Australian Nuclear Science and Technology Organisation

4200

plastic chemicals entering the ocean of potential concern to human and ocean health

946 237

measurements available in the Marine Radioactivity Information System

Jan 2024

Agency mission to Antarctica launched under NUTEC Plastics

18

Antarctic sampling sites

141

samples collected by Agency scientists in Antarctica

KEY OUTPUTS

Research and Response for Contaminants of Emerging Concern

Marine pollution remains one of the greatest threats to marine and coastal ecosystem health. Legislating and regulating marine pollution faces several challenges, notably the rapid introduction of new and unregulated contaminants into marine environments, often as byproducts of plastic production.

Per- and polyfluoralkyl substances (PFAS), also referred to as 'forever chemicals', flame retardants and plasticizers are among the most problematic substances in the marine environment due to environmental persistence, bioaccumulation and widespread contamination of ecosystems and water supplies. They are also often linked to adverse health effects, including endocrine disruption, reproductive toxicity and carcinogenicity. Of more than 16 000 chemicals that are or have been potentially used for plastics production, about 25% are of concern; however, it is possible that the other 75% have simply not been adequately studied, as identification, classification and consequential regulation are time-intensive processes.

Research

The Agency's research and development on marine pollutants increasingly focuses on these contaminants of emerging concern, particularly those associated with plastic pollution, an issue that underpins the **NUTEC Plastics initiative**. In 2024, the Agency developed a two-part approach to better understand this global challenge. The first part is aimed at gaining a broader understanding of unidentified PFAS by repurposing a total oxidizable precursor (TOP) assay to assess total amounts of PFAS in marine organisms and seafood samples. The second part is aimed at improving understanding of known contaminants by developing new analytical methods using isotope dilution techniques to specifically target over 50 PFAS that are known to be toxic or of concern. The latter approach has been applied in laboratory and field experiments to investigate impacts of natural weathering on the sorption of PFAS on polystyrene microplastics, a process that could exacerbate environmental and health risks associated with both pollutants.

Further Agency research on contaminants of concern involves gadolinium, a rare earth element extensively used as a contrast agent in medical imaging. In 2024, the Agency pioneered innovative methods to quantify specific gadolinium pharmaceuticals in natural waters, and these are now being applied to map global distribution and assess environmental impacts. Such efforts advance global understanding of the sources of these pollutants, their impacts on marine ecosystems and seafood, and their roles in biogeochemical cycles.

Response

Major polluting events can have extremely detrimental impacts on ecosystems. The Agency continues to provide emergency response support to Member States facing catastrophic environmental pollution. In 2024, following an oil spill off the coast of Tobago, the Agency provided support to Trinidad and Tobago's Institute of Marine Affairs to strengthen the country's laboratory capabilities. It also undertook a series of initiatives to assist Member States in producing high-quality marine pollution data, including by harmonizing methodologies through workshops and the development of guidelines (for example, for mercury and blue carbon assessments), releasing a certified reference material (IAEA-159A) for the analysis of persistent organic pollutants listed

under the related Stockholm Convention, and conducting a worldwide interlaboratory comparison exercise on trace and rare earth elements in marine sediment. In addition, the Agency's global network of analytical laboratories dedicated to mercury data collection was highlighted at the 16th International Conference on Mercury as a Global Pollutant as a tool to generate knowledge and scientific data that will contribute to a better understanding of the processes affecting ocean health.

In 2024, the Agency was involved in the development of one of ten UN Ocean Decade Vision 2030 white papers, each focusing on a specific Ocean Decade Challenge. The paper on Challenge 1 — to understand and beat marine pollution — provides a roadmap to identify pollution sources and assess their impacts on human health and ocean ecosystems. The Agency's work to enhance the quality, coverage and availability of data on the state of the ocean is essential for the informed governance of the marine environment and the socioeconomic activities it supports. ◆

Harnessing the Power of Ocean Data

The ocean is a repository for radionuclides — radioactive elements — that originate from both natural sources and human activities. All radionuclides contribute to background levels of radioactivity in the ocean and many can play a role as tracers for researching ocean processes, including changing ocean currents and sedimentation processes. Additionally, radionuclides from human activities must be monitored to ensure that the health of humans and the environment is not compromised. To track and understand radionuclides in marine ecosystems, the Agency hosts and maintains the **Marine Radioactivity Information System (MARIS)**. A global open-access data platform, MARIS is a vital tool for scientists, policymakers and the public that combines data collection, processing, analysis and visualization to provide

CHALLENGE 1
— Understand and Beat Marine Pollution

Key Recommendations

- **2025 — Establishment of a network to define priority pollutants and construct harmonized protocols for rigorous monitoring**
- **2026/27 — Delivery of training programmes focused on the implementation of harmonized protocols**
- **2026 — Definition of specifications and operational conditions of sentinel stations**
- **2028 — Completion of a thorough data gap analysis and strategies to fill the existing gaps in understanding the impacts of marine pollution**
- **2030 — Implementation of a network of long term sentinel stations and regional laboratory hubs dedicated to (i) generating high-quality data on a global scale; (ii) promoting capacity building and (iii) facilitating the transfer of technology**

Vanessa Hatje, Agency Research Scientist and Ocean Decade Vision 2030 Working Group 1 Co-Chair, delivers key recommendations from the Challenge 1 white paper at the Ocean Decade Conference in Barcelona, April 2024. (Photograph courtesy of UNESCO)

actionable insights on the levels and effects of radionuclides in the marine environment. It also serves as an essential starting point for further scientific studies, including long term monitoring and advancing predictive modelling for tracking the consequences of authorized and accidental releases from nuclear facilities.

At their core, environmental information systems like MARIS organize and analyse data related to the natural environment. They can handle vast amounts of data and convert raw numbers into meaningful insights. MARIS collects data on the levels of radionuclides in seawater, marine sediment and marine organisms, including seafood. This data is sourced from a global network of research institutions, governments and monitoring agencies, including through national and regional databases, technical reports and peer reviewed publications in scientific journals. All this data is integrated into a unified framework that allows users to monitor environmental levels, identify trends and make data-driven decisions.

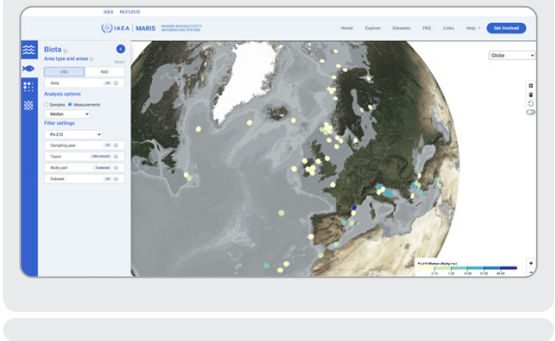
In 2024, the Agency significantly enhanced several key components of MARIS's data management functionality.

- A Python package that streamlines data ingestion and standardization processes was developed to enable automated handling of diverse MARIS data sources.
- Compliance with best practice FAIR (findability, accessibility, interoperability, and reuse) Data Principles was ensured through implementation of the Network Common Data Form (NetCDF). This facilitates unified and efficient storage of all data and metadata in self-contained files, aligning MARIS with environmental science data standards, allowing for improved discoverability of MARIS data and strengthening MARIS's position as an attractive option for sharing the results of current research on marine radioactivity worldwide.
- Another major leap forward was achieved on data visualization. An upgrade to the MARIS website allows for visualization of levels of radioactivity in seawater, sediment and marine biota, as well as sampling locations. This was complemented by the successful deployment of interactive visualization capabilities through Observable, a third-party platform for developing and hosting powerful data products.

These initiatives have established new frameworks for data sharing and analysis, including modularized application programming interface (API) integration and comprehensive training materials. Initial exploration of AI applications, particularly in knowledge discovery using large language models, has laid the groundwork for future innovations in marine radioactivity analysis using MARIS.

In 2024, the Agency published a curated dataset in MARIS detailing radionuclide activity concentrations in marine biota consumed as seafood. Developed under a coordinated research project, this dataset forms the radiological basis for a comprehensive global assessment of doses from seafood consumption. From over 330 000 measurements of radionuclides in marine organisms, a meticulous process distilled the data to just over 21 000 high-quality records for 16 key radionuclides in seafood, including fish, shellfish and seaweed. Freely accessible on the MARIS homepage, this dataset is an invaluable resource for advancing radiological research and safeguarding seafood safety worldwide.

These advancements in 2024 solidified MARIS as a central hub for scientific collaboration and innovation in the field. ◆

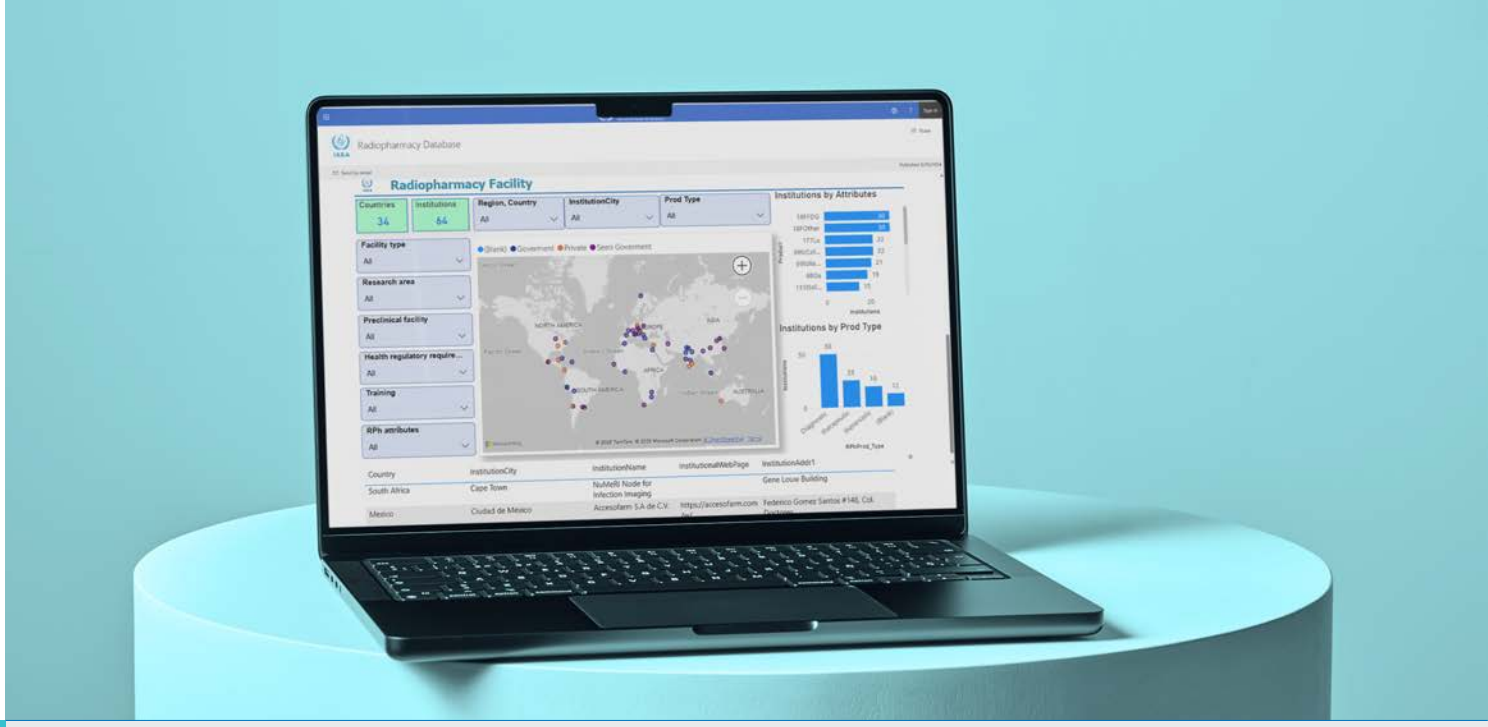


2024
launch of a curated dataset in MARIS
detailing radionuclide activity concentrations in marine biota consumed as seafood

from over
330 000
measurements of radionuclides in marine organisms

21 000
high-quality records were created for 16 key radionuclides in seafood, forming the basis for a

global
assessment of radiation doses from seafood



RADIOCHEMISTRY 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, cultural heritage, food safety, health care and environmental applications, among other uses.

To support Member States in offering suitable tools to ensure the generation of high-quality, suitable data/impact assessments to guide science-based policy decisions.

Radiation technology for converting greenhouse gases into harmless forms presents significant opportunities for environmental sustainability and materials innovation. While there have been several successful applications, many new directions remain to be explored.

Andrzej Chmielewski
Director General of the Institute of Nuclear Chemistry and Technology, Poland

517
participants from 100 Member States participated in a global proficiency test

26 Nov 2024
NDT Service Centre inaugurated to coordinate disaster management response

18
ongoing coordinated research projects

15
active Collaborating Centres

KEY OUTPUTS

Radioisotope and Radiopharmaceutical Production and Development

In 2024, the Agency launched a comprehensive radiopharmacy database that consolidates vital information on radiopharmaceuticals and associated research facilities. Featuring interactive maps for enhanced accessibility, it encourages Member States with production and research capabilities to participate in surveys, thereby fostering collaboration, identifying emerging trends, highlighting potential supply gaps in radiopharmaceutical production and strengthening connections among researchers and industry stakeholders. By connecting diverse players, the database facilitates innovative developments and enhances access to essential radiopharmaceuticals, thereby advancing health care and improving patient outcomes worldwide.

In 2024, the Agency made significant strides in promoting alpha-emitting radionuclides through the publication *Production and Quality Control of Actinium-225 Radiopharmaceuticals* and an article in *Nuclear Medicine and Biology* entitled 'Alpha Atlas: Mapping global production of α-emitting radionuclides for targeted alpha therapy'. Producers of these radionuclides will also be included in the radiopharmacy database. Another major achievement was the establishment, in collaboration with the World Health Organization, of the Technical Working Group on Radiopharmaceutical Medicines Regulations, which provides ongoing regulatory guidance to ensure safety standards while enhancing patient access to essential medications. The Group aims to help streamline regulations and create a sustainable foundation for the safe and effective use of radiopharmaceuticals across Member States. ◆

Launching the Non-Destructive Testing Service Centre at Seibersdorf

During the Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme in November 2024, the Agency launched the Non-Destructive Testing (NDT) Service Centre, which has state-of-the-art facilities for disaster emergency response. At the same time, guidelines on training syllabi in non-destructive testing for civil engineering (NDT-CE) were released, setting a benchmark for harmonizing training and equipping professionals with the knowledge and skills needed to excel in NDT and civil engineering applications. Training will focus on enhancing civil infrastructure recovery outcomes and promoting the resilience of civil structures in Member States. ◆

Mitigating Greenhouse Gases using Radiation

Gases such as carbon dioxide and methane contribute significantly to the greenhouse effect, driving unprecedented rises in global temperatures, which lead to severe weather changes, rising sea levels and substantial ecosystem disruptions. They also deteriorate air quality, posing serious health risks to humans and wildlife. The Agency has taken steps towards combating climate change by launching a coordinated research project on mitigating greenhouse gases using radiation, which aims to develop radiation-based solutions that efficiently convert greenhouse gases into simpler, less harmful compounds or create materials that facilitate their capture and secure storage. ◆

IAEA PUBLICATIONS IN 2024

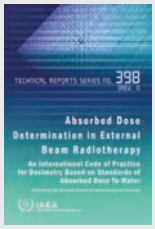
Nuclear Techniques for Development and Environmental Protection

19 publications issued in 2024

- Environment **7**
- Food and Agriculture **2**
- Human Health **3**
- Nuclear Science **7**

more than **400 000** online views of publications in 2024

most popular



Absorbed Dose Determination in External Beam Radiotherapy

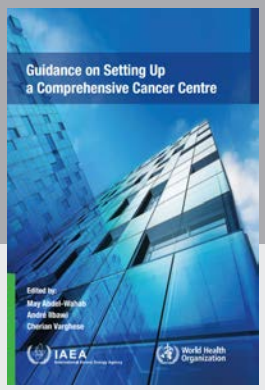
27 380 online views

Multilingualism

publications translated in 2024

2 Arabic **2** Chinese **2** French **3** Russian **2** Spanish

iaea.org/publications



Guidance On Setting Up a Comprehensive Cancer Centre
This joint IAEA-WHO publication supports the growth and development of existing cancer centres and the planning and establishment of new ones, contributing to the advancement of cancer care on a global scale.

Guidelines on Training Syllabi in Non-destructive Testing for Civil Engineering (NDT-CE)
Developed as a reference for trainers and certification bodies, this publication provides a framework for NDT training in civil engineering, with a focus on standardizing methods to ensure structural safety.

Crop Improvement with Induced Genetic Variation to Cope with Drought in Rice and Sorghum
This publication includes comprehensive screening protocols for improving drought tolerance in rice and sorghum crops using mutant lines, based on the results of a five-year coordinated research project.

Enhancement of Modelling Approaches for the Assessment of Radionuclide Transfer in the Marine Environment
This publication provides marine modelling guidance and intercomparison for the purpose of assessing the fate and transport of radionuclides released into the marine environment.

IAEA CONFERENCES IN 2024

Nuclear Techniques for Development and Environmental Protection

Fifth International Conference on Hybrid Imaging (IPET 2024)
October 2024, Vienna
Over **500** in-person participants from **103** Member States, plus **3000** online participants

With a view to strengthening nuclear medicine and radiology practices across the world, this event brought together global experts for an in-depth exploration of multimodality imaging techniques for managing cancer. Among other things, the Conference highlighted innovative applications of these techniques, featured a special session on ethics, leadership, education and patient advocacy and explored how AI can optimize patient workups.

Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme
November 2024, Vienna
Over **1500** in-person participants from **144** Member States

Jointly organized by the Department of Nuclear Sciences and Applications and the Department of Technical Cooperation, this event brought together ministers, senior officials and policymakers to address global challenges in health, food safety and security, water resources management and climate change. Participants reviewed progress, shared best practices and explored new opportunities for using nuclear science and technology to tackle pressing global issues.

International Symposium on Food Safety and Control
May 2024, Vienna
467 in-person participants from **115** Member States and **14** organizations, plus **1475** online participants

This event brought together experts and stakeholders in food safety and food control systems, providing a forum for information sharing on cutting-edge research and development in the application of nuclear technologies for food safety and control, networking between the public and private sectors and defining future research needs and directions.

First Coordination Meeting of the Global Water Analysis Laboratory Network
June 2024, Vienna
94 in-person participants from **54** Member States, plus representatives of **6** international organizations

This event established the terms of reference for the Global Water Analysis Laboratory Network (GloWAL Network) and developed the baseline survey and implementation strategy.

NUCLEAR SAFETY AND SECURITY

Nuclear safety and security are built across all levels: individual, organizational, national, regional and international. To protect people, society and the environment from harmful effects of ionizing radiation, we must be continuously and collectively driven to pursue the highest standards of nuclear safety and security.

Lydie Evrard
Deputy Director General
and Head of the Department
of Nuclear Safety and Security

Nuclear Safety and Security

Peer Review and Advisory Services

56
safety- and security-related peer review and advisory services

- **46** safety-related
- **10** security-related

in 35 countries

Incident and Trafficking Database

147
incidents reported to the Incident and Trafficking Database

International Instruments

96
Parties to the Convention on Nuclear Safety > 3 new Parties

90
Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management > 1 new Party

134
Parties to the Convention on Early Notification of a Nuclear Accident > 1 new Party

129
Parties to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency > 1 new Party

165
Parties to the Convention on the Physical Protection of Nuclear Material (CPPNM) > 1 new Party

137
Parties to the CPPNM Amendment > 2 new Parties

153
Member States committed to the Code of Conduct on the Safety and Security of Radioactive Sources and its Supplementary Guidance > a further 4 Member States expressed a political commitment

Learning and Training

207
safety- and security-related training activities

- with **7796** participants

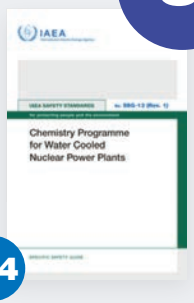
5
international schools on nuclear and radiological leadership for safety, including

- **2** train-the-trainers courses
- more than **100** participants from **36** Member States

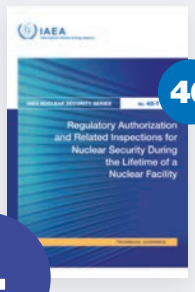
Key Areas

- Incident and Emergency Preparedness and Response
- Safety of Nuclear Installations
- Radiation and Transport Safety
- Radioactive Waste Management and Environmental Safety
- Nuclear Security

8
new Specific Safety Guides issued in 2024



134
IAEA Safety Standards Series publications issued in total



46
IAEA Nuclear Security Series publications issued in total

4
new Technical Guidance publications issued in 2024

13
modules

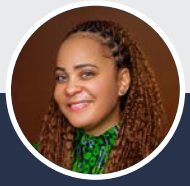
new
e-learning series for all General and Specific Safety Requirements

INCIDENT AND EMERGENCY PREPAREDNESS AND RESPONSE

OBJECTIVE

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



The IAEA's swift intervention underscores its commitment to nuclear safety and proactive prevention. Beyond addressing Liberia's immediate concerns, the Agency's support empowered our Environment Protection Agency staff to discover a caesium-137 source and strengthen national capacity. Building on this success, Liberia joined the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency during the 68th IAEA General Conference.

Karishma Pelham-Raad
Assistant Minister for International Organization Affairs, Department of International Cooperation and Economic Integration, Ministry of Foreign Affairs, Liberia

52

countries registered in the International Radiation Monitoring Information System (IRMIS)

3

countries joined in 2024 (Albania, Georgia and Morocco)

19

Convention Exercises conducted
2 ConvEx-1
17 ConvEx-2

43

registered Response and Assistance Network (RANET) countries

178

incidents reported
by Member States

KEY OUTPUTS

Testing Readiness for Emergency Response

In 2024, the Agency's Incident and Emergency Centre (IEC) advanced its mission to strengthen global nuclear and radiological EPR capabilities through training, international exercises, new collaborations and technical guidance.

The Twelfth Meeting of the Representatives of Competent Authorities identified under the Early Notification Convention and the Assistance Convention, held in June 2024, was pivotal in assessing emergency response challenges, with participants urging the Agency to strengthen emergency assistance and address technological advancements, including AI and small modular reactors.

In October 2024, Pakistan hosted the 2024 ConvEx-2c exercise, allowing the Secretariat and Member States to test national and international EPR protocols. The full-scope exercise simulated a severe nuclear incident, focusing on public protection, international assistance and real-time information exchange.

The Agency also assisted Liberia in responding to a radiological incident at a major medical facility, deploying rapid response capabilities through the Response and Assistance Network and underscoring the global importance of the Assistance Convention. ◆

National and International Emergency Preparedness

In 2024, IEC activities were focused on developing efficient frameworks, enhancing national and regional capacities and facilitating real-time data exchange to support emergency response.

Through new partnerships such as the Arab regional action plan for EPR, the Agency continued to promote international collaboration, bolstering Member States' readiness to respond effectively to any nuclear or radiological emergency.

To support Member State capacity building, the Agency published a revision of *Generic Procedures for Medical Response During a Nuclear or Radiological Emergency* and issued a new publication entitled *Classification, Assessment and Prognosis During Nuclear Power Plant Emergencies: Guidelines on Providing Information to the On-site and Off-site Protective Action Decision Makers*. It also organized two editions of the School of Radiation Emergency Management — which was updated to include a focus on emerging technologies and tools for radiation monitoring and emergency response — in Argentina and China.

A total of 28 EPR training events were conducted, including expert training on radiation monitoring, medical preparedness and emergency response arrangements. These events were designed to strengthen emergency management frameworks, improve communication protocols and ensure effective response strategies in the event of a nuclear or radiological emergency. ◆

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 availability and application of up-to-date safety standards.

To support Member States in establishing and enhancing their national safety infrastructure through the conduct of safety review services and facilitation of adherence to, and 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 human resource development, education and training, and knowledge management and knowledge networks by means of international cooperation, including exchange of information and operating experience, and coordination of research and development activities.

"

The IAEA undertook a Technical Safety Review of the Rolls–Royce SMR design against the IAEA safety standards earlier in the year. Good practices and recommendations were identified for how we capture our safety-related information, which is useful as we continue to develop our safety case. No shortfalls were identified for the plant itself, which is a real positive. Many nuclear regulators regularly use the IAEA safety standards as the basis for their domestic regulations, so the assessment performed together with the positive outcome is reducing risk ahead of future licensing efforts in numerous countries.

Helena Perry
Regulatory Affairs and Safety Director, Rolls–Royce

100%

of issues raised during OSART and SALTO missions adressed

2400

beneficiaries of safety-related training events

84

operating experiences shared via the FINAS, IRS and IRSRR reporting systems

25

case studies from 20 Member States shared under the Generic RoadMap project

28 000

notifications recorded by the External Events Notification System

KEY OUTPUTS

Assisting in Strengthening National Safety Infrastructures and Regulatory Frameworks

In 2024, the Agency continued to promote and support the establishment of comprehensive safety infrastructures and regulatory frameworks to ensure the safety of nuclear installations throughout their lifetimes.

The third extraordinary meeting of the Convention on Nuclear Safety (CNS), held in September 2024, aimed to improve the efficiency and effectiveness of the review process. This was followed by the Organizational Meeting for the Tenth Review Meeting of the Contracting Parties to the CNS, planned for 2026. The Agency continued to support the growing number of Contracting Parties to the CNS (96 as of December 2024) by organizing educational workshops to provide assistance and information on the CNS peer review process and obligations.

In April 2024, the Agency conducted a training course on the Integrated Regulatory Review Service (IRRS) to provide information and guidance to senior staff from regulatory bodies who will participate in future IRRS missions.

For embarking countries, the Agency continued to provide support through the Generic RoadMap project in the development of infrastructure for the safety of a first nuclear reactor. Furthermore, it organized a technical meeting in October 2024 on the challenges faced by newcomer countries in the establishment of effective regulatory frameworks and infrastructures for safety.

The International Meeting on the Code of Conduct on the Safety of Research Reactors was held in Vienna in August 2024. The Agency also provided training on the preparation of feasibility studies for new research reactor projects, on technical requirements in the bidding process for a new research reactor, and on the training of future team reviewers of Integrated Safety Assessment of Research Reactors (INSARR) missions. These activities contributed to further enhancing the regulatory oversight and operational safety of research reactors.

Workshops were held on operational radiation protection, on ageing management for nuclear fuel cycle facilities and on the safety of fuel manufacturing for advanced reactors. The Agency also held workshops to promote the Safety Evaluation of Fuel Cycle Facilities During Operation (SEDO) mission and on regulatory supervision of nuclear fuel cycle facilities.

A technical meeting on safety and operational considerations in the use of advanced technology in research reactors provided a forum for Member States to discuss capacity building and identify improvements needed in relation to the safety infrastructure and regulatory framework for the development, deployment and use of advanced technologies for research reactors, including artificial intelligence. ◆

Promoting Safety Assessment of Nuclear Installations Including Advanced and Innovative Reactors

The Agency continued supporting Member States in ensuring the safe and secure use of advanced nuclear technologies, including small modular reactors (SMRs), fusion energy, floating nuclear power plants (NPPs) and the peaceful uses of nuclear power for propulsion of ships, and the use of artificial intelligence in the design and operation of nuclear installations.

The Agency conducted three Technical Safety Review (TSR) missions on SMR designs in the Republic of Korea, the

United Kingdom and the United States of America and held interregional training courses on safety aspects of SMRs and other advanced reactor technologies in Vienna and in Tsuruga, Japan, with a total participation of 40 Member States.

The Agency also conducted an advisory mission in Rwanda on safety analysis and design safety features of the Rwandan critical assembly project, a low power research reactor that incorporates both liquid metal fuel and coolant in its design. Furthermore, it held a technical meeting on probabilistic safety assessment for non-reactor nuclear facilities. ◆

Analysing Climate Change Challenges to the Safety of Nuclear Installations

In 2024, the Agency continued to support Member States in evaluating the impact of climate change on the safety of nuclear installations.

The Agency facilitated the exchange of operating experience through a coordinated research project on climate change challenges to the safety of nuclear installations. The project was launched in June 2024 at the first research coordination meeting, where two case studies were presented: a coastal site and a river site.

The Agency is also developing a safety report on the effect of climate change on assessment of meteorological and hydrological hazards for nuclear installations. In October 2024, it held the first meeting of the Scientific Programme Committee for the 2025 International Conference on Resilience of Nuclear Installations against External Events from a Safety Perspective — Focus on Climate Change. ◆

Improving Nuclear Power Plant Safety Worldwide

The Agency continued to enhance the safety of operating NPPs by providing Operational Safety Review Team (OSART) missions, and to support safe long term operation and ageing management through Safety Aspects of Long Term Operation (SALTO) missions.

In 2024, the Agency conducted 16 OSART consultative support workshops to support Member States planning to host an OSART mission, including embarking countries. In addition, it undertook two Independent Safety Culture Assessment (ISCA) missions.

The Agency also continued to support Member States in enhancing the safety of their long term operation and ageing management. Since the establishment of the SALTO mission in 2007, the Agency has conducted 59 such missions and 24 follow-up missions.

In 2024, Phase 7 of the International Generic Ageing Lessons Learned programme was launched, with the participation of some 200 experts from 33 Member States. The programme's Steering Committee approved a record number of tasks for collecting proven practices in ageing management, and significant progress was made during the nine meetings held over the year. ◆

Experts involved in an IRRS mission to the Republic of Korea in discussion with the staff of a nuclear facility, November 2024. (Photograph courtesy of the Korea Institute of Nuclear Safety)

Supporting International Exchange of Operating Experience for Nuclear Installations

The Agency encourages Member States to report nuclear installation events to promote learning from operational experience, which is key for advancing safety and benefits the entire nuclear community.

The Agency held a technical meeting for the national coordinators of the Joint IAEA–OECD/NEA Fuel Incident Notification and Analysis System (FINAS) to exchange operating experience and lessons learned on incidents submitted to FINAS, to discuss the implementation of corrective actions arising from these and other incidents and to discuss actions to improve the system's effectiveness. It also disseminated operating experience arising from incidents reported to the Incident Reporting System for Research Reactors (IRSRR).

A Peer Review of Operational Safety Performance Experience (PROSPER) mission was conducted in Argentina and training courses and meetings were also held to exchange lessons learned from key events across Member States. ◆

Civil Liability for Nuclear Damage

The Agency assists Member States in pursuing the establishment of a global nuclear liability regime by supporting them in adhering to and implementing the multilateral treaties on civil liability for nuclear damage adopted under its auspices, and supports efforts towards the establishment of coherent national and international nuclear liability mechanisms, crucial to ensuring prompt, meaningful, equitable and non-discriminatory compensation for nuclear incidents.

The International Expert Group on Nuclear Liability (INLEX) held its 24th regular meeting in May 2024, followed by a workshop for diplomats on civil liability for nuclear damage. In June 2024, the Agency acted as Secretariat of the Fourth Meeting of the Contracting Parties and Signatories to the Convention on Supplementary Compensation for Nuclear Damage (CSC), held in Vienna. A subregional workshop on the CSC for Association of Southeast Asian Nations (ASEAN) Member States was held in July 2024 in Manila. During the 68th regular session of the General Conference, a side event was held on the CSC focusing on Member States' insights on joining a global nuclear liability regime. Members of INLEX continue supporting the Secretariat's legislative assistance activities for Member States covering nuclear liability and dedicated outreach activities on the CSC. ◆

SEDO mission team visiting the Nuclear Fuel Plant in Pitești, Romania, November 2024. (Photograph courtesy of the Nuclear Fuel Plant)

Team of Agency exerts conducting a review mission on the site survey report for an NPP in Sri Lanka, May–June 2024. (Photograph courtesy of the University of Peradeniya)

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 its 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.

"

The 2024 Education and Training Appraisal (EduTA) provided Brazil with a detailed review of its education and training infrastructure and how this aligns with IAEA safety standards and international best practice. The EduTA report will be invaluable as we continue to strengthen our national regulatory framework and develop competencies in radiation, transport and waste safety training.

Danielle Monegalha Rodrigues

Head of the Department of Education and Training, Institute of Radioprotection and Dosimetry, National Nuclear Energy Commission (CNEN), Brazil

55 911
total number of registrations on e-learning courses on radiation and transport safety

8800
new learners registered in 2024

No.1
course with most registrations: Safety and Quality in Radiotherapy

2016
launch of an e-learning course on radiation protection of patients

14 700
course completions

KEY OUTPUTS

Activities Related to Radon and Other Types of Existing Exposure Situations

In 2024, the Agency published a new Safety Guide on protecting workers from radon exposure and continued developing a safety report on the trade of non-food commodities/consumer goods.

The Agency also hosted a technical meeting to discuss national experiences in managing radiation protection in high background radiation areas, contributing to the preparation of a Safety Guide on existing exposure situations. ◆

High-Quality Radiation Monitoring Services Activities

In 2024, the Agency's Radiation Safety Technical Services Laboratory continued to provide high-quality radiation monitoring services, with an external audit confirming the laboratory's compliance with the ISO/IEC 17025:2017 standard.

In October 2024, the Agency hosted a technical meeting to discuss the implications of new operational quantities in personnel dosimetry proposed by the International Commission on Radiation Units and Measurements in its Report 95, aiming to raise awareness among international radiation protection stakeholders of the potential technical and regulatory impacts of these new quantities.

In November 2024, a report on a two-year interlaboratory comparison programme, conducted at Japan's request, was published to verify the accuracy of monitoring for radiation exposure of workers handling ALPS-treated water, provided by Tokyo Electric Power Company at the Fukushima Daiichi Nuclear Power Station. ◆

Supporting the Application of Agency Safety Standards

In 2024, there was an increase in requests for Occupational Radiation Protection Appraisal Service (ORPAS) review missions to promote a harmonized approach to occupational radiation protection. To meet these requests, the ORPAS self-assessment tool was upgraded.

One ORPAS mission was conducted in Thailand in March 2024 and several such missions are planned for 2025.

The Agency's work in occupational radiation protection focused on the exchange among Member States of operational experience in controlling, monitoring and recording occupational exposure, providing valuable lessons on radiation safety at work. The activities of the Information System on Occupational Exposure in Medicine, Industry and Research-Industrial Radiography (ISEMIR-IR) were reviewed for the planning of the fourth ISEMIR-IR global survey.

In March 2024, the Agency addressed challenges in patient radiation protection in the context of new imaging technologies by organizing a related technical meeting. It also continued to organize joint workshops, including the Joint IAEA–Argonne National Laboratory Workshop on Radiation Protection Optimization in Fluoroscopy-Guided Interventional Procedures in the United States of America in April 2024 and the Joint IAEA–ICTP Workshop on Radiation Protection in Image-Guided Radiotherapy in Italy in October 2024.

At the 16th International Congress of the International Radiation Protection Association, the Agency presented advancements in the Safety in Radiation Oncology (SAFRON) system, findings on common safety barrier failures, and

the importance of considering a patient's dose history in recurrent imaging procedures.

During the year, the Agency developed an e-learning course on radiation protection in nuclear medicine, promoting safety culture principles. With over 33 000 registrations for online learning about patient radiation protection, the related Agency portal receives more than 1.5 million views per year.

To mark the 20th year of the Education and Training Appraisal in radiation protection and safety (EduTA), the questionnaire used to collect information on the education and training regulatory frameworks and capabilities of Member States that receive assistance through Agency's technical cooperation programme was revised based on the lessons learned from the 33 EduTA missions carried out. The revised questionnaire was applied in Brazil and Greece.

Regulators from the Arab Network of Nuclear Regulators were trained to align their regulatory frameworks with Agency safety standards in relation to the competence of those responsible for safety at nuclear facilities. The Agency also supported over 50 Member States in enhancing the competence of young professionals through the organization of Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources in Algeria, Argentina, Brazil, Kenya and Malaysia. Lastly, with the support of the Agency, the number of trainers of radiation protection officers increased in more than 40 Member States in 2024. ◆

Integrated Regulatory Review Service Mission to Review the Agency's Regulatory Framework

In October 2024, the first-ever integrated regulatory review of the Agency's internal radiation safety regulatory framework was completed.

During the ten-day mission, the Integrated Regulatory Review Service (IRRS) team — comprising ten senior regulatory experts from ten Member States, two Agency staff members and one observer from Austria — covered all core regulatory areas of radiation safety, waste safety, emergency preparedness and response, transport and the interface with nuclear security. The IRRS team concluded that the Agency's regulatory programme is well established, with effective oversight of radiation, transport and waste safety. The team provided recommendations and suggestions to the Agency's internal regulator to further enhance the effectiveness of the regulatory framework and its functions in line with Agency safety standards, while also welcoming the regulator's strong commitment to the continuous improvement of its regulatory systems. The internal regulator provides safety oversight of activities that involve radiation uses at the Agency's laboratories in Vienna, Seibersdorf and Monaco and oversees its involvement in activities conducted, organized or contracted within Member States. ◆

Experts and participants in the EduTA mission conducted in Brazil, July 2024.

An Agency radiation monitoring technician takes a large area surface sample from a waste bin in the Nuclear Material Laboratory at Seibersdorf.

RIDP regional training course for new regulators, Rabat, May 2024. (Photograph courtesy of the Moroccan Nuclear and Radiation Safety and Security Agency)

Code of Conduct on the Safety and Security of Radioactive Sources and its Supplementary Guidance

The Agency and Member States continued their efforts to strengthen the safety and security of radioactive sources, including in import and export.

In 2024, the Agency held the Open-Ended Meeting of Technical and Legal Experts for Sharing Information on States' Implementation of the Guidance on the Import and Export of Radioactive Sources, providing an opportunity to celebrate the 20th anniversary of the approval of the Guidance by the Board of Governors. The Meeting recommended that the Agency continue to encourage States to express political support for the Guidance, nominate Points of Contact for the purpose of facilitating the export and/or import of radioactive sources, respond to or revise their responses to the Importing and Exporting States Questionnaire, and utilize regional networks to better enhance these efforts. The meeting further recommended that States engage competent authorities, industry, end users and other relevant national stakeholders in a coordinated effort to implement the Guidance. On the basis of these recommendations, the Agency continued to enhance tools and assistance related to the effective and sustainable implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and the Supplementary Guidance documents. By the end of 2024, 153 States had expressed political commitment to the Code of Conduct, 139 to the Supplementary Guidance on the Import and Export of Radioactive Sources, and 74 to the Supplementary Guidance on the Management of Disused Radioactive Sources. ◆

Regulatory Infrastructure Development Projects

Regulatory Infrastructure Development Projects (RIDPs) aim to support participating countries to establish a regulatory infrastructure for radiation safety and for security of radioactive material, consistent with the Agency's Safety Requirements and Nuclear Security Recommendations publications.

In 2024, the launch of a regional project in Asia and the Pacific brought the number of recipient countries to 100. RIDPs assist regulatory bodies and other competent authorities to establish solid regulatory frameworks for the safety and security oversight of facilities and activities using radiation sources. Through RIDPs, national authorities are supported in drafting national policies, strategies and regulations, producing inventories and maintaining national registers of radiation sources, and establishing resilient organizations and management systems for discharging regulatory responsibilities with effective independence. These authorities also work to build and strengthen radiation safety and nuclear security cultures, including by developing leadership skills and building the capacities of new and senior staff. The RIDP places a focus on high-priority applications, such as radiotherapy for cancer care. In 2024, the RIDP organized 11 events with 239 participants, including 40 new entrants to regulatory bodies, two advisory missions on regulatory infrastructure for radiation safety and nuclear security and diverse expert missions and technical visits. ◆

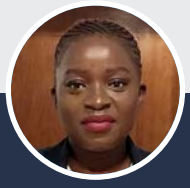
RADIOACTIVE WASTE MANAGEMENT AND ENVIRONMENTAL SAFETY

OBJECTIVE

To support Member States in improving the safety of radioactive waste and spent nuclear fuel management, including geological 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 nuclear fuel management, including geological repositories for high level waste, decommissioning, remediation and environmental releases, through peer reviews and advisory services; and to assist in their adherence to, and facilitate implementation of, the Joint Convention.

To support Member States in capacity building through education and training and by encouraging the exchange of information and experience.



"

The extension of the Coordination Group for Uranium Legacy Sites (CGULS) into the African region offers a new, solid network for African Member States facing remediation challenges at uranium-contaminated sites related to mining activities, benefitting from a decade of CGULS experience in Central Asia.

Linda K. Hamvula
Radiation Safety Officer, Radiation Protection Authority, Zambia

▲
CGULS Central Asia

36

e-learning modules on safety of decommissioning, remediation, management of NORM

31

Member States participated in the Regulatory Forum for Safety of Uranium Production and NORM (REGSUN)

130

early career professionals participated in training on radiological and environmental impact assessments

65

Member States participated in the Methods for Radiological and Environmental Impact Assessment (MEREIA) programme

KEY OUTPUTS

Expanding International Coordination in the Safety of Uranium Legacy Site Management

The Coordination Group for Uranium Legacy Sites (CGULS) promotes cooperation among Member States with uranium legacy sites, as well as the national and international organizations that support work to safely remediate the sites.

While the CGULS was originally focused on Central Asia, in 2024 it successfully expanded its scope to include African Member States, leading to cross-regional collaboration and knowledge sharing. The objectives of the CGULS in the African region were set during a technical meeting held in March 2024 in Zambia, paving the way for a region-specific approach to remediation that will draw on experience from Central Asia. Member States from both Central Asia and Africa convened in November 2024 at the CGULS Annual Meeting, sharing experience, discussing common issues and identifying region-specific challenges and actions. The discussions underscored the differences between the regions, particularly in terms of site diversity, complexity of exposure pathways and approaches to remediation. ◆

Managed Recycling and Final Disposal of Removed Soil and Waste Arising from Decontamination Activities in Fukushima Prefecture

In 2024, the Agency published the conclusions of three international expert meetings requested by the Ministry of the Environment of Japan (MOEJ) on the managed recycling and final disposal of removed soil and radioactive waste arising from the decontamination of land in Fukushima Prefecture.

The Agency convened a team of experts comprising its own staff and six international experts from Belgium, Germany, Japan, the United Kingdom and the United States of America, who considered the information shared by the MOEJ from technical, safety and social perspectives.

Approximately 13 million cubic metres of removed soil and 300 000 cubic metres of ash from incineration of organic material have been generated since 2011 during decontamination activities in Fukushima Prefecture and are stored at the Interim Storage Facility, which covers 16 square kilometres across the towns of Okuma and Futaba. This soil and waste is managed under a law that provides for final disposal outside Fukushima Prefecture by March 2045. Japan intends to use about 75% of the removed soil with low radioactivity concentration for managed recycling in civil engineering projects, with safety as the top priority. The removed soil that will not be used for managed recycling will be finally disposed of. From April 2025 onward, the MOEJ will consider appropriate structures and the required area for the final disposal facility (or facilities) for the removed soil that will not be used for managed recycling. ◆

NUCLEAR SECURITY

OBJECTIVE

To promote adherence to relevant legally and non-legally binding international instruments to enhance nuclear security globally.

To assist States in establishing, maintaining and sustaining national nuclear security regimes for nuclear and other radioactive materials, including during transport, and associated facilities used for peaceful purposes.

To play the central role of facilitating and enhancing international cooperation and increasing visibility and awareness through communication on nuclear security.

The agreement designating the National Centre for Nuclear and Radiological Security (NCNRS) as an IAEA Collaborating Centre for capacity building in nuclear security detection and response comes at a time when global cooperation in the radiological and nuclear sector is essential. The NCNRS has strengthened its capabilities and is equipped with the latest technologies, enabling its specialized and qualified technical personnel to support all activities agreed upon.

Zeyad Alsaaydeh
Chair of the NCNRS Board of Directors, Jordan

The Agency supported Azerbaijan, the host country of COP29, by providing local experts with hands-on training on required measures for nuclear security detection and response. (Photograph courtesy of the State Agency for Regulation of Nuclear and Radiological Activity, Azerbaijan)

20 years

of the Agency's programme to support major public events (MPEs)

48

Member States received support for

78

MPEs

In 2024

6 Member States received support for MPEs, including COP29

KEY OUTPUTS

Twenty Years of Supporting Member States in Nuclear Security Measures for Major Public Events

The year 2024 marked the 20-year anniversary of the Agency's programme of assistance for nuclear security at major public events (MPEs), a cornerstone of countries' efforts to secure large gatherings.

Since 2004, the Agency has supported 48 Member States through nuclear security measures for 78 MPEs. In 2024, it supported the planning or implementation of six MPEs, including large sporting events, a religious event and a major international conference. It also provided training, including a new train-the-trainer course, to build knowledge on nuclear security measures and emergency response arrangements for MPEs and the associated equipment. ◆

Enhancing Global Capacity Building for Nuclear Security

Inaugurated in October 2023, the Agency's Nuclear Security Training and Demonstration Centre (NSTDC) in Seibersdorf, Austria, completed its first full year of operation.

The NSTDC enhances nuclear security capacity building through the use of advanced technology and expertise and complements the training opportunities offered in Member States. In 2024, the Centre hosted 50 events with over 1000 participants and experts, and 50 visits with more than 1000 visitors. The NSTDC training programme includes 28 courses and workshops on a range of nuclear security topics. The Centre's operation is supported by 17 donors. ◆

Participants in a four-week hands-on training course on physical protection equipment installation, integration, operation and maintenance, conducted at the NSTDC in September and October 2024.

Shaping the Future of Nuclear Security

The fourth International Conference on Nuclear Security: Shaping the Future (ICONS 2024) was held in May 2024 and provided a global forum for ministers, policymakers, senior officials and nuclear security experts to discuss the future of nuclear security worldwide.

More than 2000 participants, including 49 ministers, deputy ministers and other high-ranking officials, gathered in Vienna to attend ICONS 2024 and discuss important issues related to nuclear security. Among other outcomes, the Conference underscored the critical role of international cooperation to strengthen nuclear security globally; stressed the critical role that nuclear security plays for all countries, even those without nuclear power programmes; emphasized the fundamental enabling role that nuclear security plays in the global pursuit of the 2030 Agenda for Sustainable Development; and raised awareness within the international nuclear security community regarding the threats and challenges that lie ahead so that countries can shape a future that is safe, secure and sustainable. ◆

Safety–Security Interface

Management of the interface between nuclear safety and nuclear security is aimed at avoiding undue interference between safety measures and security measures and to create or reinforce synergies between them.

In October 2024, the Agency launched a nuclear security working group under the Nuclear Harmonization and Standardization Initiative (NHSI). This group will address approaches to international collaboration to develop a common understanding of regulatory reviews for the security of small modular reactors.

The Agency continues to facilitate a coordination process to address the safety–security interface, including by responding to requests from Member States to implement Regulatory Infrastructure Development Projects (RIDPs), conducting peer review missions such as the Advisory Mission on Regulatory Infrastructure for Radiation Safety and Nuclear Security (RISS) and addressing the safe and secure management of disused sources. Member States also continue to encourage the Secretariat to develop guidance on how to effectively address the interface, while acknowledging the distinctions between nuclear safety and nuclear security. ◆

The Director General delivering his remarks at the closing session of the International Conference on Nuclear Security: Shaping the Future, held in Vienna in May 2024.

An IPPAS mission to Romania in December 2024 included a visit to Cernavodă nuclear power plant to assess nuclear security measures at the facility.

Identifying Nuclear Security Needs

The Agency offers a wide range of peer review and advisory services as part of its optimized approach to strengthening nuclear security, which is based on the assessment of national needs.

Agency missions, including the International Physical Protection Advisory Service (IPPAS), the International Nuclear Security Advisory Service (INSServ) and the RISS mission, provide States with invaluable information that is used in developing and enhancing their nuclear security programmes, including developing action plans within the Integrated Nuclear Security Sustainability Plans framework. In 2024, the Agency conducted six IPPAS, two INSServ and two RISS missions. ◆

Science and Technology for Nuclear Security

The Agency assists Member States in addressing current and emerging challenges in nuclear security by leveraging the latest technological developments.

The Agency supports research initiatives, including through coordinated research projects (CRPs). In 2024, a new CRP on the implications of uncrewed aerial, ground-based and maritime-based systems for nuclear security was launched as a cross-cutting project to cover the use of, and countermeasures to, uncrewed systems. Additionally, the Agency continues to develop tools for use by Member States to support efforts to detect radiation in order to efficiently and effectively assess potential nuclear security threats. In September 2024, it made available a new mobile application called the Personnel Alarm Assessment Tool (PAAT), which easily guides front line officers through an assessment process that provides a consistent and defensible science-based evaluation of persons who cause radiation alarms. By the end of the year, PAAT had nearly 540 users across 73 countries. ◆

Building Partnerships to Enhance Nuclear Security Collaboration

The Agency has established partnerships that support its work in nuclear security through technical expertise, theoretical and practical training and specific research and development activities.

The Agency works with Member States and international organizations through Collaborating Centres and Practical Arrangements to build nuclear security capacity around the world. Through research and development and training, the designated Collaborating Centres assist the Agency in building capacity regionally and internationally. In 2024, two new Collaborating Centre agreements were signed with Brazil and Jordan and an extension agreement was signed with the Russian Federation, bringing the total number of active Collaborating Centres for nuclear security to 11. Practical Arrangements also help the Agency to build capacity and secure cooperation in assorted nuclear security topics. In 2024, the Agency signed four new Practical Arrangements and extended one other, bringing the total number of Practical Arrangements for nuclear security to 13. ◆

11 **Collaborating Centres** in the area of nuclear security

1 **Extension agreement** signed with

Rosatom Technical Academy, Russian Federation

2 **New Collaborating Centre agreements** signed with

Nuclear and Energy Research Institute, Brazil – the first such Centre in Latin America

National Centre for Nuclear and Radiological Security, Jordan – the first such Centre in the Middle East

IAEA PUBLICATIONS IN 2024

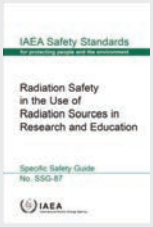
Nuclear Safety and Security

35 publications issued in 2024

- Emergency Preparedness and Response **2**
- Safety of Nuclear Installations **21**
- Radiation, Transport and Waste Safety **7**
- Nuclear Security **5**

more than **1 000 000** online views of publications in 2024

most popular



Radiation Safety in the Use of Radiation Sources in Research and Education

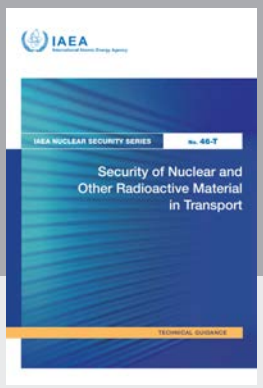
6973 online views

Multilingualism

publications translated in 2024

11 Arabic **68** Chinese **10** French **24** Russian **18** Spanish

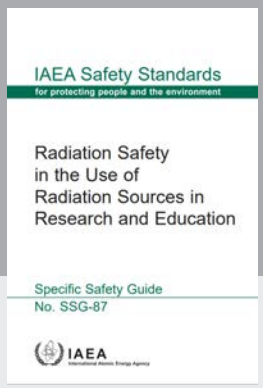
iaea.org/publications



Security of Nuclear and Other Radioactive Material in Transport
Aimed at nuclear security regulatory bodies and others involved in transport security, this publication offers practical and detailed guidance for States and their authorities on implementing and maintaining a nuclear security regime for transporting nuclear and radioactive material.

Borehole Disposal Facilities for Disused Sealed Radioactive Sources
With recommendations for the safe disposal in borehole disposal facilities of disused sealed radioactive sources, this publication aims to assist regulators and others in the commissioning, operation, closure, upgrading and regulation of such facilities.

Design Extension Conditions and the Concept of Practical Elimination in the Design of Nuclear Power Plants
This Safety Guide provides recommendations for designing new nuclear power plants with a focus on defence in depth and the practical elimination of event sequences that could cause significant radioactive releases.



Radiation Safety in the Use of Radiation Sources in Research and Education
With recommendations for the safe use of radiation sources in research and education, this Safety Guide covers the control of occupational and public exposure in both planned and emergency situations.

IAEA CONFERENCES IN 2024

Nuclear Safety and Security

International Conference on Enhancing the Operational Safety of Nuclear Power Plants
April 2024, Beijing
183 in-person participants from 40 Member States and 2 international organizations

This event reaffirmed the importance of ensuring the safe and reliable operation of existing NPPs as a priority to protect people and the environment. It also underscored safe and reliable NPP operation as the foundation for the safe long term development of the nuclear power industry and of new designs, including SMRs, which will contribute to realizing the goal of tripling nuclear power by 2050 and reaching net zero emissions.

International Conference on Nuclear Security: Shaping the Future (ICONS)
May 2024, Vienna
2066 in-person participants from 142 Member States and 16 international organizations

This event, the fourth in its series, provided a global forum for discussing the future of nuclear security. It highlighted the importance of international cooperation to strengthen nuclear security globally and the role of nuclear security in achieving the 2030 Agenda for Sustainable Development. The event also addressed the critical role of nuclear security for all countries and the challenges ahead.

International Conference on Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations (TSOs): Challenges and Opportunities in a Rapidly Changing World
December 2024, Vienna
358 in-person participants from 88 Member States and 7 international organizations

This event focused on the development and strengthening of technical and scientific capabilities to achieve enhanced nuclear and radiation safety and security of facilities and activities, including operational legacy situations and emerging challenges as well as the exchange and transfer of best practices with nuclear power embarking countries.

NUCLEAR VERIFICATION

In 2024, the IAEA drew safeguards conclusions for 175 States with safeguards agreements in force. Through its nuclear verification work, the IAEA fosters global confidence in the peaceful use of nuclear material and technology.

Massimo Aparo
Deputy Director General
and Head of the Department of Safeguards

Nuclear Verification

Safeguards Agreements

191
States* with safeguards agreements in force

of which **143** States had additional protocols in force

1388
nuclear facilities and locations outside facilities under safeguards

240 530
significant quantities of nuclear material under safeguards

*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.

Verification Activities

3155
verification activities undertaken

14 777
days of in-field verification

Conclusions**

75 States

all nuclear material remained in peaceful activities

92 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

** 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

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.

[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 (NPT) is based on the number of instruments of ratification, accession or succession that have been deposited.

1927
unattended safeguards data streams collected remotely from

167
facilities in 32 States

1359
cameras operating or ready to use at

231
facilities in 33 States

KEY OUTPUTS

Implementation of Safeguards in 2024

Over the course of 2024, the Agency carried out 3155 verification activities (3136 in 2023) that required 14 777 days in the field (14 302 in 2023). On the basis of these verification activities, the Agency was able to draw conclusions for 175 of the 190 States[3,4] with safeguards agreements in force with the Agency for which safeguards were applied in 2024.

Of the 137 States that had both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) in force, the Agency concluded that *all* nuclear material remained in peaceful activities for 75 States[4]; for 61 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 one other of these States, which had an operative small quantities protocol (SQP) based on the original standard text, the Agency was no longer able to draw a safeguards conclusion. Of the 45 States with a CSA but with no AP in force, for 31 States the Agency concluded only that *declared* nuclear material remained in peaceful activities. For the remaining 14 States, which had an operative SQP based on the original standard text, the Agency was no longer able to draw a safeguards conclusion.

Safeguards were also implemented with regard to nuclear material in selected facilities in the five nuclear-weapon States Parties 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 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.

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 2024, three 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.

Verification of a field-verifiable passive seal using the iPhone-based seal verifier application.

[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.

Conclusion of safeguards agreements and APs, and amendment or rescission of SQPs

The Agency continued to facilitate the conclusion of safeguards agreements and APs, and the amendment or rescission of SQPs through the implementation of the *Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols*, which was updated in September 2024. During 2024, a CSA with an SQP based on the revised text, and an AP entered into force for Timor Leste. An SQP was amended for Cyprus, Fiji, Mongolia, Oman and Sierra Leone and rescinded for the Plurinational State of Bolivia and Saudi Arabia.

The status of safeguards agreements and APs as of 31 December 2024 is shown in Table A6 in the Annex to this report. At the end of 2024, 99 States with CSAs in force had operative SQPs, with 84 of these SQPs based on the revised standard text. Thirteen States had rescinded their SQPs. ◆

The Director General with Prince Abdulaziz bin Salman Al Saud, Minister of Energy of Saudi Arabia, during a bilateral meeting at the 68th regular session of the Agency's General Conference at which Saudi Arabia announced that it would rescind its SQP by the end of 2024.

Naval Nuclear Propulsion

The use of nuclear material subject to safeguards under a CSA by a State in a nuclear activity such as naval nuclear propulsion is foreseen by the CSA. Australia and Brazil have informed the Agency of their plans related to the use of nuclear material — subject to safeguards under their respective CSAs — for naval nuclear propulsion. The use of nuclear material in such an activity requires arrangements under their respective safeguards agreements and the development of appropriate safeguards approaches. Hence, during 2024, the Secretariat continued to engage in consultations with the States concerned on these matters. The Director General submitted two reports to the Board of Governors on naval nuclear propulsion in 2024, one for Australia and the other for Brazil. ◆

Islamic Republic of Iran

Since February 2021, Iran has not been implementing any of its nuclear-related commitments under the Joint Comprehensive Plan of Action (JCPOA), including the AP. This has seriously affected the Agency's JCPOA-related verification and monitoring activities. During 2024, the Director General submitted to the Board of Governors, and in parallel to the UN Security Council, four quarterly reports and five updated reports entitled *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)*.

At the end of 2024, outstanding safeguards issues related to the presence of uranium particles of anthropogenic origin at two undeclared locations in Iran remained unresolved. Unless and until Iran clarifies these issues, the Agency will not be able to provide assurance about the exclusively peaceful nature of Iran's nuclear programme. The Director General submitted to the Board of Governors four quarterly reports entitled *NPT Safeguards Agreement with the Islamic Republic of Iran,* and one report entitled *Implementation of the Joint Statement of 4 March 2023*. ◆

Syrian Arab Republic

In August 2024, 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.[5] During 2024, Syria allowed the Agency to visit the three locations that were allegedly functionally related to the Dair Alzour site, and permitted the Agency to take environmental samples. The Director General will report to the Board of Governors the Agency's findings from these visits once the results from the environmental samples taken by the Agency have been analysed, assessed and discussed with Syria. ◆

Democratic People's Republic of Korea

In August 2024, 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 2024, no verification activities were implemented in the field, but the Agency continued to monitor developments in the nuclear programme of the DPRK and to evaluate all safeguards relevant information available to it. The Agency did not have access to the Yongbyon site or to other locations in the DPRK. Without such access, the Agency cannot confirm the operational status or 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, a clear violation of relevant UN Security Council resolutions, is deeply regrettable. ◆

The Director General with the Vice-President of Iran and Head of the Atomic Energy Organization of Iran, Mohammad Eslami, at a bilateral meeting during the 68th regular session of the Agency's General Conference, September 2024.

[5] The Board of Governors, in its resolution GOV/2011/41 of June 2011 (adopted by a vote), had, inter alia, found that Syria's undeclared construction of a nuclear reactor at Dair Alzour and failure to provide design information for the facility constituted non-compliance by Syria with its obligations under its NPT safeguards sgreement with the Agency in the context of Article XII.C of the Agency's Statute and called upon Syria to remedy urgently its non-compliance and resolve all outstanding questions so that the Agency could provide the necessary assurances as to the exclusively peaceful nature of Syria's nuclear programme.

Safeguards inspectors prepare to use the neXt generation Cerenkov Viewing Device (XCVD).

Enhancing Safeguards

State-level safeguards implementation

The Agency continued to develop and update existing State-level safeguards approaches (SLAs) for States with a broader conclusion in line with the refinements identified through the SLA improvement project. Standardized assessments of States' nuclear fuel cycle capabilities, technical objectives and performance targets were utilized together with enhanced IT tools and procedures to ensure effectiveness and consistency. During 2024, SLAs for 15 States with the broader conclusion were updated or developed for the first time applying the refined methodology.

Cooperation with State and regional authorities

In 2024, the Agency conducted 22 training events for personnel responsible for overseeing and implementing State systems of accounting for and control of nuclear material (SSACs) and regional systems of accounting for and control of nuclear material (RSACs). These activities, comprising a mix of in-person and virtual courses as well as scientific visits, allowed the Agency to train more than 300 experts from 97 States on safeguards-related topics. A highlight was the inaugural Masterclass on Advanced Safeguards, held in Australia in June 2024 and featuring an innovative programme that combined technical safeguards topics with training in soft skills, including leadership, knowledge management and communication. This work was carried out with the support of Australia, Japan, the Republic of Korea, the United States of America and the European Commission.

The Agency implemented the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS) in Bangladesh, the Plurinational State of Bolivia, Cameroon and Ghana as part of the current COMPASS cycle. The Agency also worked with partners and regional networks, including the Japan Atomic Energy Agency's Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN), the US Department of Energy's International Nuclear Safeguards and Engagement Program (INSEP), the Asia–Pacific Safeguards Network (APSN) and the African Commission on Nuclear Energy (AFCONE). Additional support was provided by Finland's Radiation and Nuclear Safety Authority (STUK).

The Agency updated the safeguards e-learning website on the Cyber Learning Platform for Network Education and Training, which was visited by more than 3600 new users over the course of the year. In total, more than 11 700 representatives from over 180 States were registered on the safeguards e-learning site by the end of the year.

The Agency continued its series of interactive webinars aimed at enhancing national authorities' understanding of safeguards obligations and supporting effective and efficient safeguards implementation. Five webinars were held, covering topics such as the legal and regulatory framework for safeguards, COMPASS, decommissioning and safeguards by design. With an average of 188 participants for each session, a total of over 940 individuals representing 97 States participated.

Safeguards equipment and tools

By the end of 2024, the Agency had 752 surveillance systems with 1359 cameras operating or ready to use at 231 facilities in 33 States[6]. The Agency also supports and jointly uses 411 surveillance cameras that are owned by State or regional authorities. By the end of 2024, the Agency had deployed the remote data transmission system at 167 facilities in 32 countries[7] and deployed 180 unattended monitoring systems at 64 facilities or regional offices in 26 States. A total of 1170 non-destructive assay systems are deployed throughout the world, and in 2024 the Agency verified approximately 25 800 passive and active seals or containment systems that had been applied to nuclear material, facility critical equipment or Agency safeguards equipment at nuclear facilities.

In 2024, the robotized Cerenkov viewing device was authorized for use in routine inspections, as well as a new non-destructive assay system based on innovative cadmium zinc telluride modules. The same detector module is embedded in the new generation of hand-held monitors (HM-6), the design of which was finalized in 2024. The design of the wireless version of the active universal asymmetric seal (AUAS) was finalized in 2024.

Safeguards analytical services and methodologies

As of December 2024, the Agency's Network of Analytical Laboratories (NWAL) consisted of the Agency's Safeguards Analytical Laboratories and 26 other qualified laboratories in various Member States. During the year, three additional laboratories were in the process of qualification for various forms of sample analysis.

In 2024, the Agency collected 582 nuclear material samples for nuclear material accountancy and 99 nuclear material samples for material characterization. The large majority of these were analysed by the Agency's Nuclear Material Laboratory. In addition, one heavy water sample was collected for analysis by the NWAL. The Agency also collected 633 environmental samples, resulting in the analysis of 1240 subsamples. ◆

Developing the Safeguards Workforce

In 2024, the Agency conducted 58 distinct safeguards staff training courses (as some were held more than once, a total of 119 offerings were provided overall, of which 30 were held outside Vienna), helping to provide safeguards inspectors, analysts and support staff with the necessary core and functional competencies. The Introductory Course on Agency Safeguards for Agency inspectors was held for 11 inspectors.

The 24th Safeguards Traineeship Programme for young graduates and junior professionals ran from February to October 2024, involving eight participants, with a 50/50 female/male ratio, from the Democratic Republic of the Congo, Jordan, Kuwait, Namibia, the Philippines, Rwanda, Thailand and Togo. Since 1983, the Agency has trained 191 safeguards trainees from 75 States. ◆

Partnerships

During the course of the year, the Agency continued to draw on its numerous partnerships in support of Agency safeguards, including by leveraging the contributions of its 24 Member State Support Programmes (MSSPs) and by extending existing Practical Arrangements with four non-traditional partners. ◆

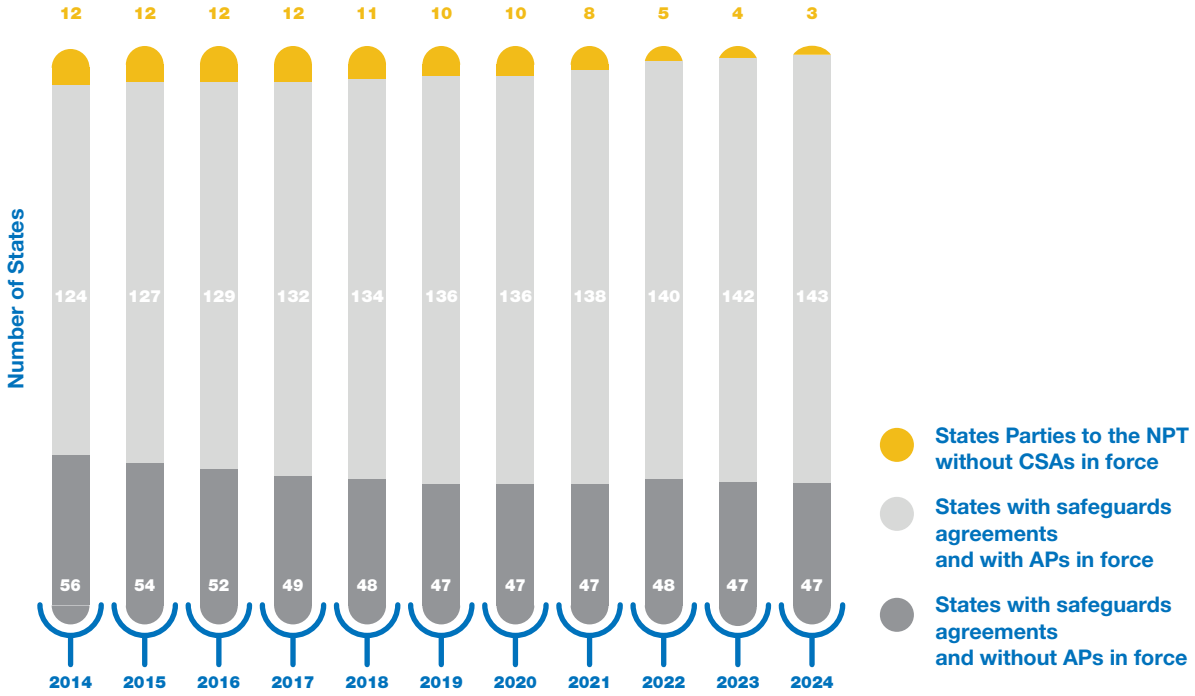
The Director General and the Deputy Director General and Head of the Department of Safeguards at the Technical Meeting of the Coordinators of Safeguards Member State Support Programmes, February 2024.

[6] And Taiwan, China.
[7] And Taiwan, China.

Nuclear Verification

States with safeguards agreements and APs in force, 2014–2024

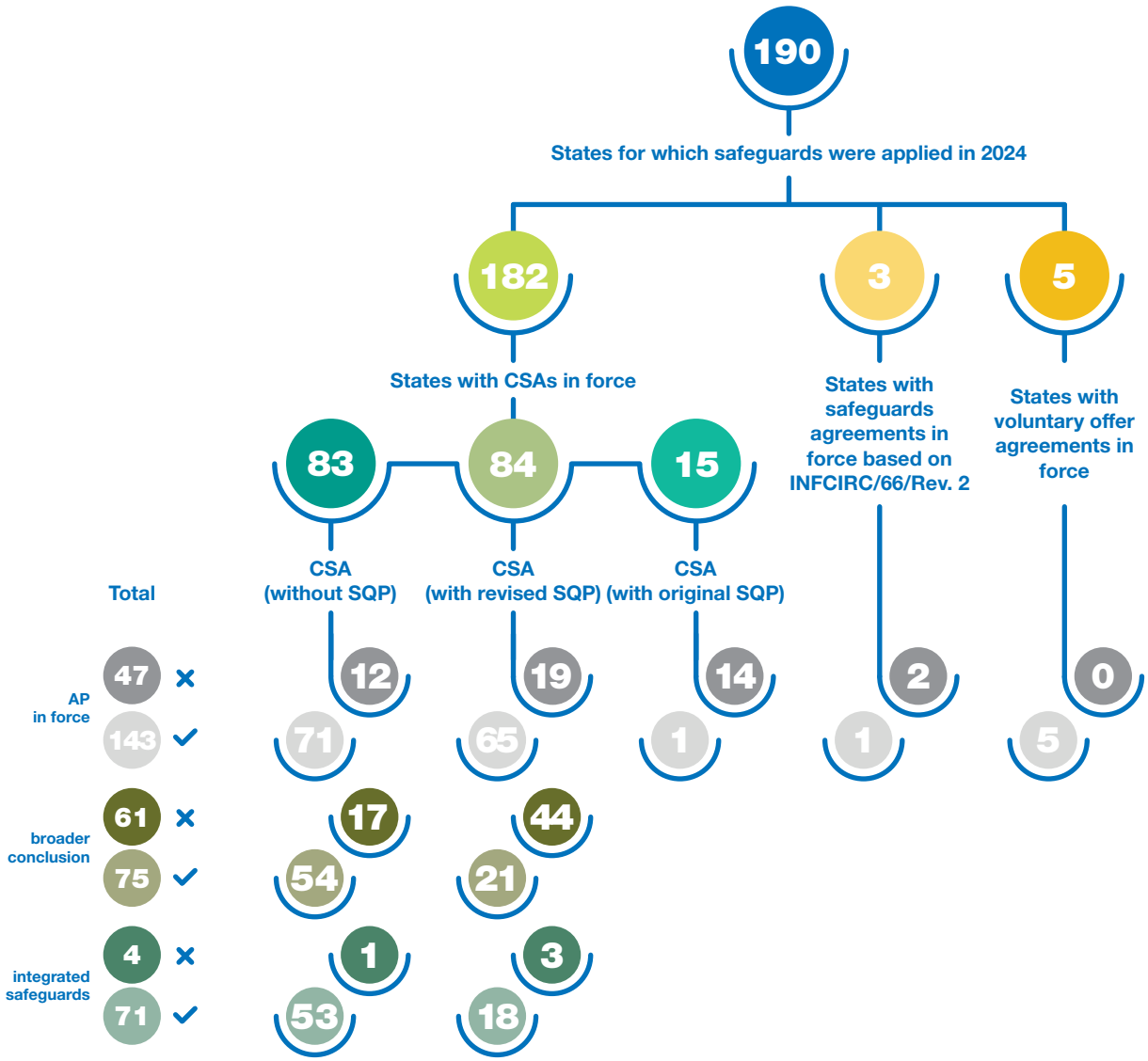
(the Democratic People's Republic of Korea is not included)



Number of States with SQPs, 2014–2024



Status of Agency safeguards in 2024
(the Democratic People's Republic of Korea is not included)



TECHNICAL COOPERATION FOR DEVELOPMENT

In 2024, the Agency continued to support socioeconomic development through its demand-driven technical cooperation programme. This key delivery mechanism helped countries in their efforts to strengthen cancer control, boost food production and combat plastic pollution, as well as supporting efforts for energy security, including through advanced models such as small modular reactors. Strengthening radiation safety infrastructure in Member States was also a key focus for the programme. The Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme was successfully held with great satisfaction and the Ministerial Declaration adopted recognized the important role of the TC programme as a major mechanism in transferring technology to Member States.

Hua Liu
Deputy Director General
and Head of the Department of Technical Cooperation

Technical Cooperation for Development

Projects and Missions

151
countries and territories received support through the technical cooperation programme

including **36** least developed countries

810
active projects

193
projects closed

1142
projects in closure at the end of 2024

9
imPACT Review missions, plus **2** follow-up missions

Extrabudgetary Funds Allotted to Support Major Initiatives

RAYS OF HOPE: €11.7 million

ZODIAC: €95 000

NUTEC PLASTICS: €2.9 million

ATOMS4FOOD: €6.5 million

OTHERS: €13 million

Knowledge Sharing

1098
fellows [424 women]

685
scientific visitors [205 women]

3063
expert and lecturer assignments [994 women]

3710
training course participants [1596 women]

180
regional and interregional training courses

6030
participants [2440 women]

in **605** meetings

Collaboration and other Arrangements

26 Country Programme Frameworks signed and **3** extended

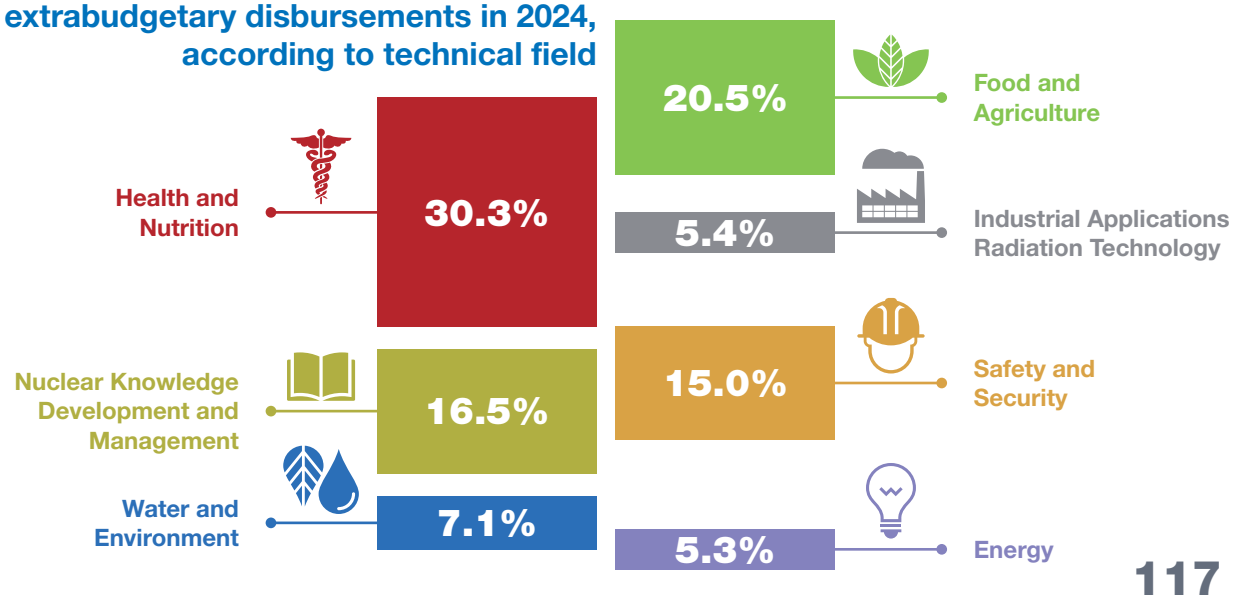
12 Practical Arrangements

2 Letters of Intent

1 Statement of Intent

8 other arrangements in a variety of areas

Distribution of assistance through Technical Cooperation Fund and extrabudgetary disbursements in 2024, according to technical field



TECHNICAL COOPERATION FOR DEVELOPMENT

OBJECTIVE

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

Participants in the International Nuclear Science Olympiad at the Philippines Nuclear Research Institute (PNRI), August 2024. (Photograph courtesy of the PNRI)

96 million
TCF target

91.2 million
TCF contributions received

95%
TCF rate of attainment

34.1 million
extrabudgetary funds allotted

KEY OUTPUTS

The Technical Cooperation Programme in 2024

In 2024, 151 countries and territories took part in the technical cooperation (TC) programme, with 810 projects open at the end of the year. The programme focused on supporting national efforts to address priorities in health and nutrition, food and agriculture, water and the environment, industrial applications, and nuclear knowledge development and management. Member States also received TC assistance for climate change monitoring and adaptation and clean energy, and to build new generations of nuclear scientists and researchers.

At the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29) in Baku, the Agency organized a side event with the Italian Special Envoy for Climate Change on South-South cooperation for **Atoms4Food**, hosted by CGIAR. Another event, 'Welcoming the Next Nuclear Generation' brought together young nuclear professionals to support intergenerational dialogue. Two side events organized by the Agency and co-chaired by Azerbaijan and China were held on 'Introducing and/or Expanding Nuclear Power Programmes: Partnership, Infrastructure Development and Safety First', showcasing the Agency's 12-year assistance programme for Member States in nuclear power infrastructure development and the deployment of small modular reactors. In addition, the Agency was represented at the High-Level Forum on South-South Cooperation on Climate Change and at a United Nations Office for South–South Cooperation (UNOSSC) side event on its recently launched South-South Solutions Lab.

In 2024, two cohorts comprising 17 National Liaison Assistants participated in the regular group fellowship at Agency headquarters that supports strengthened national delivery of the TC programme. ◆

Jointly organized by the Department of Technical Cooperation and Department of Nuclear Sciences and Applications, the **Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme** took place in November 2024 in Vienna. It brought together over 1500 experts, scientists and senior policymakers and decision makers, including some 50 at the ministerial level, to discuss the role of nuclear science and technology in addressing current global challenges. The resulting Ministerial Declaration recognized the important role of the TC programme in transferring, expanding and further accelerating Member States' access to nuclear technology, materials, equipment and expertise for peaceful purposes; and in supporting Member States in building, strengthening and maintaining their capacity to use nuclear technology in a safe, secure and sustainable manner.

Programme Delivery and Financial Highlights

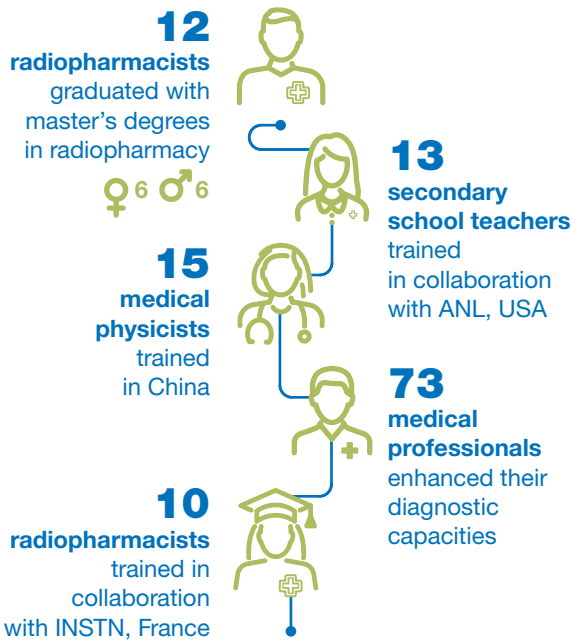
The TC programme provides support in the form of capacity building, knowledge sharing, partnership building, support for networking and procurement. The Technical Cooperation Fund (TCF) implementation rate for 2024 was 86%, with support provided, inter alia, for 1098 fellowships, 685 scientific visits and participation in 605 meetings and 180 training courses. In total, the Agency supported participation in the TC programme in 21 400 instances, with women representing 38% of all participants.

The TCF rate of attainment reached 95% by the end of December 2024, representing some €91.2 million. Extrabudgetary funds of €34.1 million were allotted to activities related to the major initiatives and unfunded components of the TC programme, not including an amount of €0.3 million in in-kind contributions. ◆

Achievements in Africa

At the regional meeting of National Liaison Officers and National Coordinators of the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) in Rabat in February 2024, 51 participants from 37 African countries discussed important regional issues, such as the challenges and lessons learned in delivering the TC programme during the COVID-19 pandemic, the promotion of women in nuclear science and technology, the development of partnerships under the TC programme in Africa, and strategic aspects of key thematic areas in support of the realization of the 2030 Agenda for Sustainable Development. The 35th AFRA Technical Working Group Meeting took place in Addis Ababa in June 2024, where National Coordinators discussed the performance of the AFRA programme and made recommendations to improve its delivery and effectiveness. The 35th Meeting of AFRA Representatives was held on the margins of the 68th regular session of the Agency's General Conference in September 2024 and participants endorsed the 2023 AFRA annual report.

In 2024, Mauritius inaugurated its National Cancer Centre. The Agency provided a PET-CT machine, trained staff and provided technical expertise to ensure the facility's safe operation. In Ethiopia, the nuclear medicine facility at Black Lion Hospital in Addis Ababa started operations, together with a radiotherapy centre in Hawassa. The Agency supported the procurement of equipment, with government cost-sharing, for the refurbished facility at Black Lion Hospital and provided one-year fellowships for a total of 17 nuclear medicine residents. For the centre in Hawassa, the Agency procured linear accelerator (linac) quality assurance equipment. Côte d'Ivoire's nuclear medicine facility also became operational, with the Agency providing training for two nuclear medicine physicians and procuring a gamma camera and quality assurance equipment. Capacity for the early detection of cancer in the United Republic of Tanzania was enhanced through Agency training on diagnostic imaging and radiation safety, focusing on the use of newly installed, government-procured CT-scanners. The Niger inaugurated its first linac radiotherapy facility with support from **Rays of Hope** and procurement was initiated for two linacs each in Kenya and Malawi. In addition, an Agency-procured cobalt-60 calibration system was inaugurated in the Kenya Bureau of Standards, supporting efforts to ensure the safety and quality of radiation therapy.



In Mauritius, new varieties of cauliflower and cabbage developed with Agency support were released and in Zanzibar, the Agency supported a multiplication campaign at five sites for four disease-resistant rice cultivars. A cobalt-60 irradiator was installed and commissioned at a new sterile insect technique (SIT) facility in Morocco, and progress was made in building staff capacity. In Burundi, the Agency provided support for cattle breeding and disease prevention.

Comoros promulgated a nuclear law with Agency legislative assistance, which will facilitate the establishment of an independent regulatory body to ensure radiation safety in the country.

The Agency worked with Kenya and South Africa to develop and deploy systems to measure radionuclides in beach and aquatic sediments, which allowed Kenya to map sediment transportation and ensure that shipping channels in harbours are safe for navigation. A radioisotope hydrology laboratory was established in Rwanda, with the Agency providing state-of-the-art equipment and training to support evidence-based water planning decisions, and an atlas of isotopes illustrating the recharge zones of boreholes and rivers was finalized in Mauritius, supporting the management of water quality.

In Uganda, an Integrated Uranium Production Cycle Review team assessed capabilities to develop a uranium exploration programme to potentially support a domestic nuclear power programme.

The curriculum for the first Master of Science in Nutrition and Nuclear Techniques was approved for use at universities in Ghana, Morocco, Senegal, South Africa and Zambia. Sixteen students from African Member States were enrolled on the course at the International University of Rabat and three were enrolled at South Africa's North-West University.

Two national Women in Nuclear chapters were established in Burkina Faso and the United Republic of Tanzania, with the goal of boosting female participation in the nuclear sector. ◆

In October 2024, Qatar hosted a regional training course for 16 ARASIA States Parties participants on bioinformatics and genetic improvement for crops and methodologies for screening biotic stress. This course has contributed to capacity building for the mutation breeding of essential crops in the region, supporting climate-smart and sustainable agricultural practices. (Photograph courtesy of Qatar Ministry of Municipality)

Achievements in Asia and the Pacific

In Cambodia, support for the resumption of iodine-131 therapy was provided to Calmette Hospital in Phnom Penh, revitalizing thyroid cancer treatment after a four-year hiatus. In the Lao People's Democratic Republic, cancer care infrastructure was strengthened with the installation of the first mammography unit at Mittaphab Hospital in Vientiane.

The Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA) developed a strategic action plan to improve outreach, resource mobilization and partnerships. Tools include a website, social media platforms and outreach material, including a new publication on nuclear medicine launched during the 68th regular session of the Agency's General Conference.

Under the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA), over 750 professionals, including almost 300 women, from Asia and the Pacific attended regional training courses, technical workshops and meetings, and regional initiatives were carried out on phased array ultrasonic testing, mutation breeding and isotopic techniques.

Activities under the Agency's Sub-Regional Approach to the Pacific Islands (SAPI) provided support through five regional projects focusing on nutrition, mutation breeding, water, radiation safety infrastructure and radiotherapy. Participants from six Pacific islands were trained on nuclear techniques to support agriculture and nutrition programmes. ◆

Nuclear Science and Technology Education in the Asia and the Pacific region

The Agency co-organized the first International Nuclear Science Olympiad, held in August 2024 at the Philippines Nuclear Research Institute (PNRI) with the participation of 14 Member States. In addition, the Agency-supported Asia and the Pacific Youth Virtual Challenge 2024 was launched on UN Virtual Worlds Day in June 2024, with student teams designing facilities for radioactive waste management and plastic recycling on the Minecraft Education e-learning platform.

At the tertiary level, collaboration between the International Nuclear Science and Technology Academy (INSTA), the Asian Network for Education in Nuclear Technology (ANENT) and the Agency was strengthened at a regional meeting on nuclear science and technology education in Shenzhen, China, and through ANENT-hosted webinars that attracted over 520 virtual participants to explore such topics as radiation therapy, radiopharmaceuticals, food safety, nuclear waste management and lessons from nuclear accidents.

Also in 2024, the Agency expanded PhD and MSc opportunities, including through the pilot launch of the East China University of Technology PhD and MSc fellowship programme, the Phoenix Leader Education Program for Renaissance from Radiation Disaster at Hiroshima University, the Tsinghua University International Master's Program in Nuclear Engineering and Management and two postgraduate educational courses in Jordan and Malaysia.

Achievements in Europe and Central Asia

In Ukraine, the Bukovinian Clinical Oncology Center received Agency support to operate a second linac provided by the Ministry of Health, and equipment was provided for cancer diagnosis and treatment. The Grigoriev Institute for Medical Radiology and Oncology in Kharkiv received dosimetry and quality control equipment and a thermoluminescence reader. The institute is the only entity outside Kyiv responsible for centralized individual dosimetry monitoring, for approximately 6500 medical personnel.

In the Republic of Moldova, a new brachytherapy facility was inaugurated at the Institute of Oncology with support from the Agency and a linac was purchased with government cost-sharing, significantly improving the availability of oncology services.

Uzbekistan requested the Agency to support capacity building under a national oncology project, financed through an Islamic Development Bank loan agreement. An agreement to facilitate this request was signed in September 2024.

Climate-smart agricultural practices using isotopic techniques supported through the TC programme significantly enhanced cotton production in Azerbaijan. Through innovative soil, nutrient and water management strategies, yields more than doubled from three to eight tonnes per hectare in a single season.

Stakeholders from nuclear energy agencies, regulatory bodies, operators and technical support organizations are benefitting from several Agency capacity building activities related to small modular reactors (SMRs). In December 2024, 150 experts from 45 countries participated in a technical visit to Beijing and Rongcheng, China, on SMR design, construction, commissioning and operation, and in a workshop in Haikou, China, focusing on key considerations for infrastructure development.

Dosimetry equipment and accessories were delivered to the secondary standards dosimetry laboratory in the Agency's newest Member State in Europe and Central Asia, Turkmenistan, and staff were trained in calibration. In addition, the delivery of a thermoluminescence reader enabled the establishment of the country's first thermoluminescence dosimetry laboratory and individual monitoring services for occupationally exposed workers are under way.

An Agency technical document, *Measurement of the Stable Carbon Isotope Ratio in Atmospheric CH4 Using Laser Spectroscopy for CH4 Source Characterization*, was published under an interregional project to support the use of stable isotopic techniques to identify the source of greenhouse gases in the atmosphere. ◆

Achievements in Latin America and the Caribbean

The Agency has been engaging with partners to support the implementation of the TC programme in the region: with the Pan-American Health Organization (PAHO) on projects related to the application of the SIT to control *aedes aegypti*; and with the Inter-American Institute for Cooperation on Agriculture, the International Regional Organization for Plant and Animal Health, the World Organisation for Animal Health, the US Department of Agriculture and the regional FAO office on actions to support the eradication of New World screw worm.

The Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) celebrated its 40th anniversary at a side event at the Ministerial Conference on Nuclear Science, Technology and Applications and the Technical Cooperation Programme. At the side event, the preliminary results of the impact evaluation process being undertaken by the ARCAL monitoring and evaluation group in relation to projects in human health, food and agriculture, the environment and energy were presented.

The fourth edition of the regional master's degree in advanced radiotherapy took place in Chile, with nine radiotherapists trained.

The Director General visiting Peru's National Institute of Neoplastic Diseases (INEN), June 2024.

The first mobile electron beam linear accelerator for industrial effluent treatment was installed in Brazil and training for its installation, operation and maintenance was completed in 2024.

A new Spanish-language e-learning course on radiation protection for occupationally exposed workers was developed and made available to Member States.

Lastly, a new TC project entitled 'Strengthening Gender Equality in National Nuclear Institutions (ARCAL CXCVI)' aims to contribute to the sustainability of national nuclear institutions by strengthening gender equality, and the fourth iteration of a workshop for young professional women in nuclear fields was held in Chile, with a related follow-up event held at the Ministerial Conference. ◆

Programme of Action for Cancer Therapy

Programme of Action for Cancer Therapy (PACT) activities centred on support to countries in assessing national cancer control capacities and needs and identifying priority interventions for an effective response. ImPACT Reviews with the World Health Organization (WHO) and the International Agency for Research on Cancer were conducted in the Plurinational State of Bolivia, Eswatini, The Gambia, Guatemala, Indonesia, Mongolia, Mozambique, Nigeria and Peru, with preparatory work initiated for assessments in Chile, Madagascar, Paraguay, Rwanda, Sri Lanka and Turkmenistan. Follow-up to imPACT Reviews was conducted in Indonesia and Nepal and support was provided for the elaboration of national cancer control programmes in the Plurinational State of Bolivia, The Gambia, Indonesia and Peru. To promote South-South cooperation and gender equity, the pool of international experts for imPACT Reviews was expanded in 2024 with 24 new experts (14 women and 10 men) from Africa, the Americas and Asia.

Cooperation continued with WHO on global initiatives for breast, cervical and childhood cancers. In addition, intensified coordination with WHO regional offices, St. Jude Children's Research Hospital, City Cancer Challenge and the Union for International Cancer Control helped to align strategies and programmes. PACT participation in the World Health Assembly, London Global Cancer Week, the WHO South-East Asia regional cancer control workshop, the Regional Committee of WHO for the Americas and events of the Sustained Dialogue on Peaceful Uses helped to promote Agency cancer-related activities and initiatives, particularly **Rays of Hope**. The programme also supported the participation of 16 Member States in the World Cancer Congress to foster professional development and partnerships.

PACT participated in a workshop to implement a memorandum of understanding between Portugal and the United States of America on cooperation in cancer research, prevention, control and management in Lusophone African countries. In addition, it raised awareness of **Rays of Hope** at a UN General Assembly high-level side event on HPV-related cancer elimination, the White House Africa Cancer Care Forum, a White House roundtable event on a Global Cancer Fund and the World Health Summit. ◆

Support to the Technical Cooperation Programme through the Major Initiatives

Technical cooperation efforts to enhance pandemic preparedness continued, with **ZODIAC** National Laboratories (ZNLs) in Ethiopia, Guinea and Lesotho receiving equipment to improve diagnostic capacities. A regional training course for African countries on the latest serological and molecular techniques was held in Ethiopia, and a regional meeting on **ZODIAC** implementation in Africa, held in Morocco, brought together representatives from 34 African ZNLs. In Asia and the Pacific, a new regional project to enhance ZNL capacity brought together participants from 16 Member States to strengthen skills in antimicrobial resistance surveillance, diagnostics and animal husbandry.

To support Rays of Hope, the Agency signed Practical Arrangements with three leading companies in the field of dosimetry and quality assurance.

At the 4th International Conference on Small Island Developing States, the Deputy Director General and Head of the Department of Technical Cooperation reinforced the Agency's commitment to supporting SIDS.

A **Rays of Hope** forum in Vienna in February 2024, attended by Member States, the private sector and international financial institutions, showcased progress in Member States, including the establishment of anchor centres, the implementation of imPACT Reviews and the preparation of bankable documents. The first regional workshop on paediatric radiotherapy services in Europe and Central Asia was held at the **Rays of Hope** anchor centre at Ege University, Türkiye, and attended by 100 participants from the region. It resulted in a firm commitment to collaborating on improved cancer care for children and a concrete roadmap for expanding access to paediatric radiotherapy services. In Latin America and the Caribbean, triangular collaboration with Japan and the Agency was initiated to increase cancer care capacities in Honduras. **Rays of Hope** support was also provided, inter alia, to Cambodia, Kenya, the Lao People's Democratic Republic, Malawi and the Niger.

Under **NUTEC Plastics**, Indonesia and the Philippines validated upcycling technologies in laboratory settings and Malaysia advanced preparations for a pilot plant. Partnership agreements with industry were signed in the three countries to support upcycling technology development. In Latin America and the Caribbean, Brazil and Chile signed memoranda of understanding with the Agency to monitor microplastics in their respective Antarctic territories. An interregional TC project was launched in July 2024 to establish a global network for microplastics monitoring and two follow-up expert meetings discussed protocol harmonization and IT architecture for a related database.

A new regional project on agriculture and food security was launched in Africa under **Atoms4Food** and meetings were held with Benin and Burkina Faso. Activities are under way to support livestock production in Côte d'Ivoire and enhance food safety in Mauritania. The Food Safety Asia Network was strengthened through a new online knowledge hub and over 100 participants were trained in multiclass food hazard monitoring and surveillance. New molecular laboratories and speed-breeding facilities were established in Viet Nam for climate-resilient crop varieties, and to scale up distribution of high-quality seeds to smallholder farmers. ◆

Technical Cooperation and the Global Development Context

During the UN High-Level Political Forum on Sustainable Development, the Agency presented ongoing initiatives at plenary sessions dedicated to food security, energy planning and SDG progress in Africa and small island developing States (SIDS). It also participated in the proceedings of the UN Commission on Science and Technology for Development (UNCSTD) and in several thematic sessions of the regional UN commissions.

Agency engagement with UN interagency mechanisms continued. Inputs were provided to the Preparatory Committee for the 4th International Conference on Small Island Developing States (SIDS4) and to the Preparatory Committee for the 4th International Conference on Financing for Development. At SIDS4, the Agency organized a side event with Antigua and Barbuda, the United States of America, the UN Environment Programme and UNOSSC to discuss harnessing environmental data for the benefit of SIDS. Beyond the UN system, the Agency raised awareness of its activities at the Paris Peace Forum and the annual meeting of the UNCSTD, among others. ◆

Emergency Response

In June 2024, emergency assistance was provided to the Syrian Arab Republic through an expert mission using non-destructive testing (NDT) techniques to assess the impact of the 2023 earthquake on civil engineering structures, cultural heritage and buildings. Syrian experts were trained at a national NDT workshop at the Atomic Energy Commission of Syria with equipment provided by the Agency. Emergency assistance was also provided to Grenada for the rehabilitation of health facilities damaged by Hurricane Beryl, and to Honduras in the form of X-ray systems. ◆

Technical Cooperation Programme Management

All recommendations by the Office of Internal Oversight Services due for completion by the end of 2024 were appropriately addressed. The guidelines for the planning and design of the 2026–2027 TC programme, outlining the criteria for ensuring consistently high-quality projects, were disseminated to Member States. Training on results based management, together with country programme review missions and project design meetings, ensure that Member States' needs and priorities are accurately reflected in proposed TC projects. ◆

Legislative Assistance and Treaty Event

The Agency provided 15 Member States with bilateral legislative drafting assistance in the form of comments and advice on draft and enacted national nuclear legislation. Bilateral meetings were held with decision makers, policymakers and other senior officials, as well as legislators in 11 Member States. Six national workshops on nuclear law were also held, with Brunei Darussalam, the Congo, Egypt, Kenya, Pakistan and Uganda.

The Agency held regional and subregional workshops for Member States in Africa in Cairo in July 2024 and in Abidjan in November 2024; for Pacific Island Member States in Vienna in September 2024; and for Member States in Asia and the Pacific in Manila in December 2024.

The annual Treaty Event took place during the 68th regular session of the General Conference, providing two Member States (Liberia and South Africa) with an opportunity to deposit their instruments of ratification, acceptance or approval of, or accession to, the multilateral treaties relating to nuclear safety and nuclear security, deposited with the Director General, as well as AFRA.

In October 2024, the 12th session of the Nuclear Law Institute, supported through the TC programme, was held in Vienna and attended by 64 participants from 59 Member States who acquired a solid understanding of all aspects of nuclear law, with a particular focus on legislative drafting. The first advanced interregional training course on nuclear law for all Member States was held in Belgrade in October and November 2024, enabling 33 lawyers and officials from 29 countries to gain further knowledge in this area.

As part of the pilot University Partnership Programme on Nuclear Law with six universities, launched at the Agency's First International Conference on Nuclear Law in 2022, an introductory course was held at the University of the Witwatersrand in South Africa in March 2024. In May 2024, the University of Buenos Aires launched a postgraduate course, with the other five institutions expected to launch their courses in 2025. ◆

Participants in the nuclear law postgraduate programme at the University of Buenos Aires visit the Atucha II nuclear power plant in Argentina, May 2024.

The Director General with participants in the Nuclear Law Institute, October 2024.

Technical Cooperation in 2024

Goodwill partnership arrangements signed in 2024

New

- Ministry of Science, Technology and Innovation of Brazil (NUTEC Plastics)
- Chile (NUTEC Plastics)
- Chilean Nuclear Energy Commission (sustainable mining)
- China National Nuclear Corporation (Rays of Hope, NUTEC Plastics, Atoms4NetZero)
- GE HealthCare (Rays of Hope)
- Hainan Nuclear Power Co. Ltd (SMRs)
- IBA Dosimetry (Rays of Hope)
- International Renewable Energy Agency (energy planning)
- Italian Society for Non-Destructive Testing Monitoring Diagnostics (non-destructive testing)
- Japan and Honduras (Rays of Hope)
- OPEC Fund (Rays of Hope, Atoms4Food)
- Peru (Atoms4Food)
- Ministry of Energy and Mines of Peru (sustainable mining)
- PTW-Freiburg (Rays of Hope)
- Radiological Society of North America (capacity building for health professionals, Rays of Hope)
- RAD-AID (radiology, radiation oncology and nuclear medicine for oncology, Rays of Hope)
- Sovereign Order of Malta (Rays of Hope)
- Spanish Radiation Protection Society (radiation protection)
- Standard Imaging (Rays of Hope)
- UN Office for South-South Cooperation (South-South cooperation)

Extended

- Asian Development Bank (NUTEC Plastics, Rays of Hope, ZODIAC, food and agriculture, energy planning)
- Enresa (radioactive waste management)
- Pakistan Atomic Energy Commission (cooperation in peaceful applications of atomic energy)

Interregional

19 interregional projects

131 fellowships and scientific visits

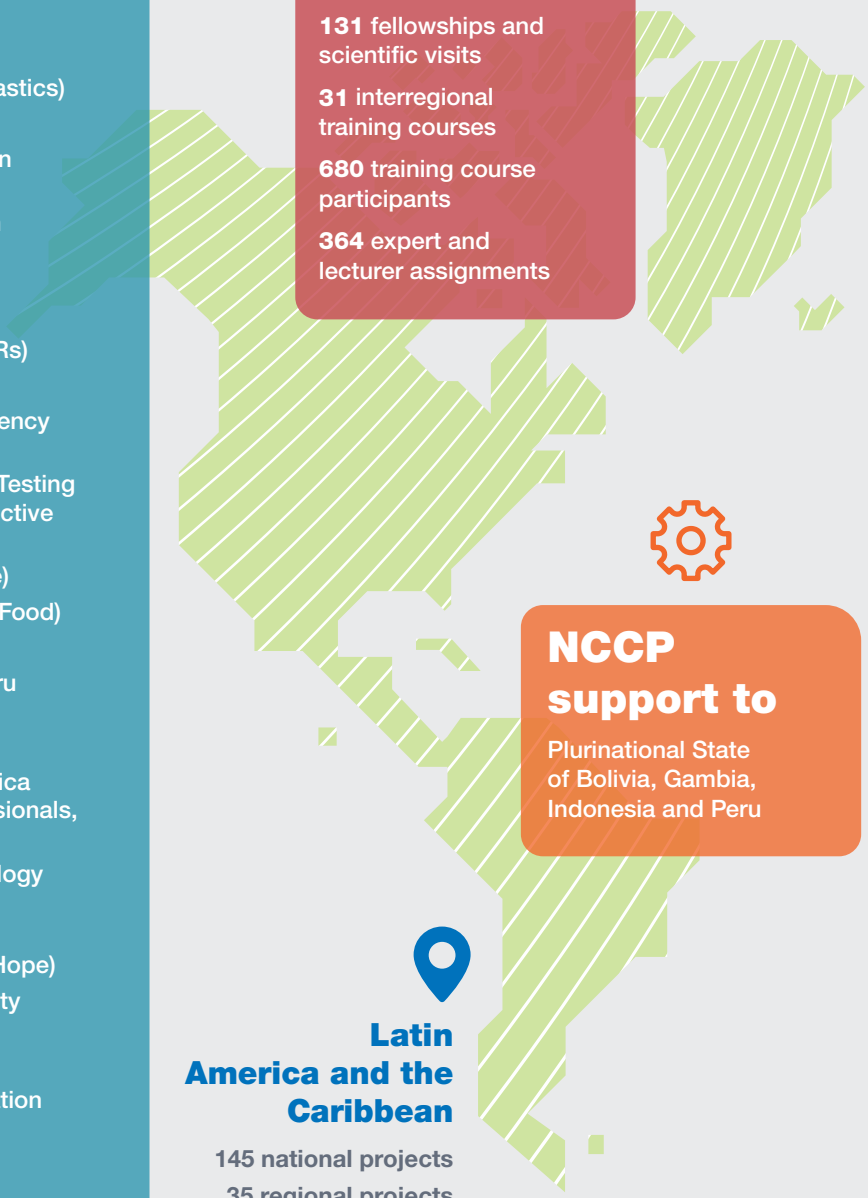
31 interregional training courses

680 training course participants

364 expert and lecturer assignments

NCCP support to

Plurinational State of Bolivia, Gambia, Indonesia and Peru



Latin America and the Caribbean

145 national projects

35 regional projects

211 fellowships and scientific visits

914 training course participants

46 regional training courses

Europe

122 national projects
26 regional projects
345 fellowships and scientific visits
574 training course participants
20 regional training courses

Nuclear Law

Bilateral legislative drafting assistance provided to The Bahamas, Barbados, Brunei Darussalam, Colombia, Côte d'Ivoire, El Salvador, Estonia, Gabon, Ghana, Honduras, Iraq, the Philippines, Sri Lanka, Qatar and Uganda

13 nuclear law workshops and training events held

Asia and the Pacific

223 national projects
52 regional projects
528 fellowships and scientific visits
1186 training course participants
48 regional training courses

Countries with new CPFs

Albania, Angola, Armenia, Azerbaijan, Bulgaria, Chad, Cuba, El Salvador, Eritrea, Eswatini, Ethiopia, Gambia, Grenada, Iraq, Morocco, Oman, Peru, Poland, Saudi Arabia, Senegal, Sierra Leone, South Africa, Uganda, Uruguay, Vanuatu and Yemen

In 2024, CPFs were extended for the first time (for Belize, Israel and North Macedonia)

Africa

165 national projects
23 regional projects
699 fellowships and scientific visits
1036 training course participants
29 regional training courses

imPACT Reviews

Plurinational State of Bolivia, Eswatini, Gambia, Guatemala, Indonesia, Mongolia, Mozambique, Nigeria and Peru

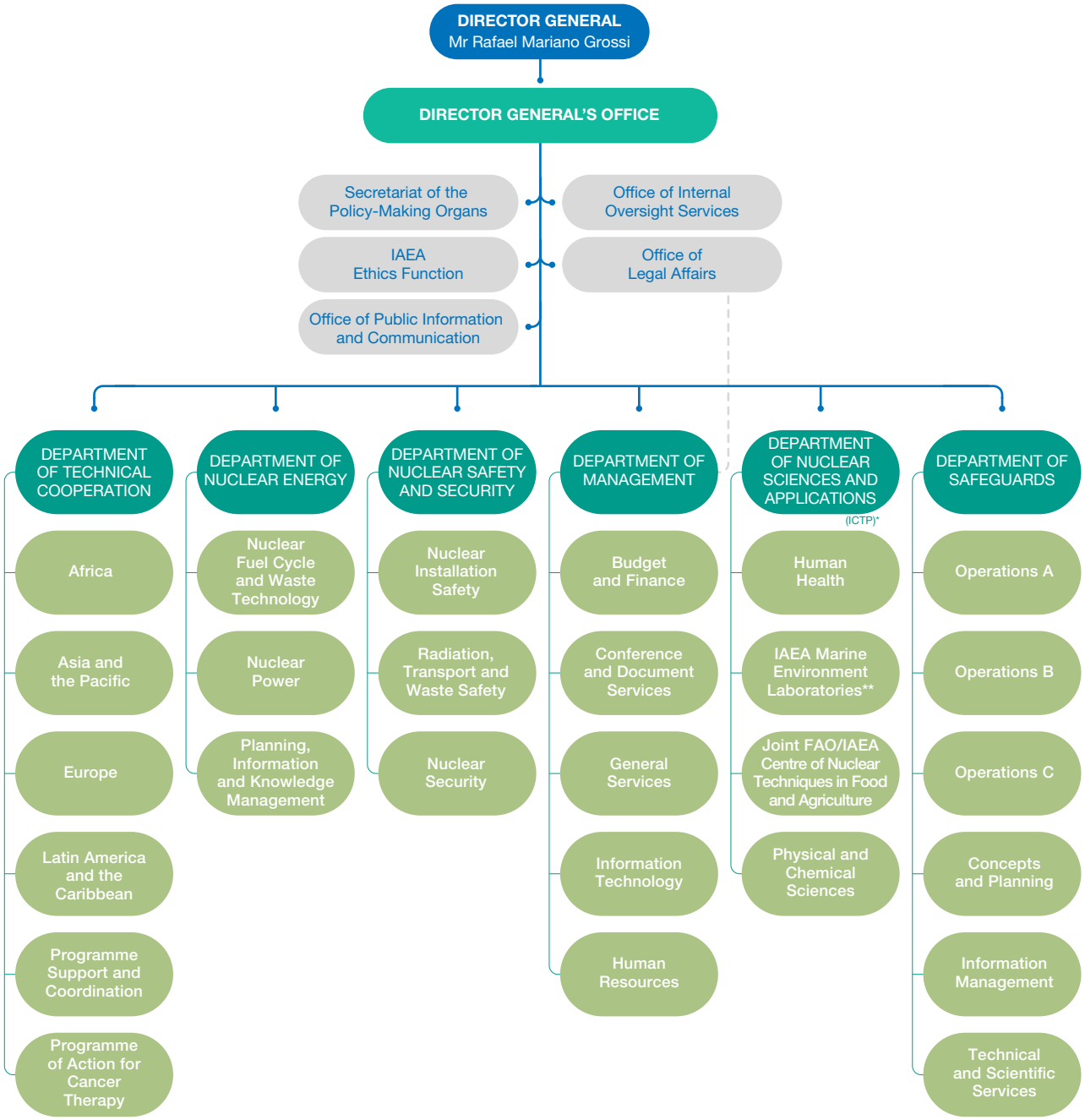
imPACT Review follow-up
Indonesia and Nepal

LIST OF ANNEX TABLES

Scan the QR code
to access the Annex
to this report.

(as of 31 December 2024)

ORGANIZATIONAL CHART



* 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.