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STRENGTHENING THE AGENCY'S ACTIVITIES RELATED TO NUCLEAR SCIENCE, TECHNOLOGY AND APPLICATIONS

Report by the Director General

Board of Governors General Conference

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Item 16 of the Conference's provisional agenda
(GC(68)/1 and Add.1)

Strengthening the Agency's Activities related to Nuclear Science, Technology and Applications

Report by the Director General

Summary

In response to General Conference resolutions GC(67)/RES/10 and GC(66)/RES/9, this document contains progress reports on

- Part A: Non-Power Nuclear Applications
 - General (Annex 1)
 - Development of the Sterile Insect Technique Package for the Management of Disease-Transmitting Mosquitoes (Annex 2)
 - Strengthening the Support to Member States in Food and Agriculture (Annex 3)
 - Use of Isotope Hydrology for Water Resources Management (Annex 4)
 - Support to the African Union's Pan African Tsetse and Trypanosomiasis Eradication Campaign (AU-PATTEC) (Annex 5)
 - Renovation of the Agency's Nuclear Applications Laboratories at Seibersdorf (Annex 6)
 - Zoonotic Disease Integrated Action (ZODIAC) Project (Annex 7)

- Part B: Nuclear Power Applications
 - Introduction (Annex 8)
 - IAEA Communication, Cooperation with Other Agencies and Stakeholder Involvement (Annex 9)
 - Nuclear Fuel Cycle and Waste Management (Annex 10)
 - Research Reactors (Annex 11)

- Operating Nuclear Power Plants (Annex 12)
- Agency Activities in the Development of Innovative Nuclear Power Technology (Annex 13)
- Approaches to Supporting Nuclear Power Infrastructure Development (Annex 14)
- Small and Medium Sized or Modular Reactors — Development and Deployment (Annex 15)
- Nuclear Knowledge Management (Annex 16)

Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2024* (document GC(68)/INF/4); the *IAEA Annual Report 2023* (GC(68)/2), in particular the section on nuclear technology; and the *Technical Cooperation Report for 2023* (GC(68)/INF/7).

Recommended Action

- It is recommended that the Board take note of Annexes 1–16 of this report and authorize the Director General to submit the report to the General Conference at its 68th regular session.

General Non-Power Nuclear Applications

A. Background

1. In resolution GC(67)RES/10.A.1, the General Conference requested the Director General, in conformity with the Statute, to continue to pursue, in consultation with Member States, the Agency's activities in the areas of nuclear science, technology and applications, with special emphasis on supporting the development of nuclear applications in Member States with a view to strengthening infrastructures and fostering science, technology and engineering for meeting the sustainable growth and development needs of Member States in a safe manner.
2. The General Conference recommended that the Secretariat report to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session on the progress made in the areas of nuclear science, technology and applications. This report has been prepared in response to that recommendation.

B. Progress Since the 67th Regular Session of the General Conference

3. The Agency continued to support Member States in enhancing their capabilities 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.
4. The Agency's Human Health Campus remained a critical resource for nuclear medicine, radiology, radiation oncology, medical physics, radiation metrology and nutrition professionals. During the reporting period, the Agency expanded the content of the campus to include new modules on mammography, radiobiology, e-contouring, and radiation oncology procedures.
5. In January 2024, the Agency established a new Collaborating Centre for human health — the first in North America for radiation oncology, medical physics, nuclear medicine, radiology and nutrition — to widen global access to cancer care. Joint activities with the centre included a regional training course on breast imaging held in Houston, United States of America (USA), in May 2024 for 43 medical professionals from 13 Member States in the Latin America and Caribbean region.



FIG. B.1. IAEA Director General Rafael Mariano Grossi and Senior Vice President, Strategy and Business Development Chris McKee, sign the Agreement between the IAEA and the University of Texas M. D. Anderson Cancer Center concerning the designation of the University of Texas M. D. Anderson Cancer Center as an IAEA Collaborating Centre in Vienna, Austria on 30 January 2024. (Source: IAEA)

6. Throughout the reporting period, the Agency continued to serve as an active member of the United Nations Interagency Task Force on the Prevention and Control of Non-communicable Diseases. The Agency hosted the 21st Meeting of the Task Force at its Headquarters in Vienna in October 2023, which it co-chaired together with the World Health Organization (WHO). At the meeting, Task Force members reviewed progress on actions agreed at the 20th Meeting, held in March 2023; reviewed commitments made by Member States at the high-level session held during the 78th session of the United Nations General Assembly relevant to the work of the Task Force; received updates on joint programmes and other workstreams; and agreed an approach for an independent joint evaluation.

7. Under Rays of Hope, the Agency continued to provide technical support to participating Member States. It continued to review applications from cancer institutes interested in becoming Rays of Hope ‘anchor centres’. The first five centres — in Algeria, Morocco, Jordan, Pakistan and Türkiye — were established in September 2023 during the sixty-seventh regular session of the General Conference. An additional anchor centre was established in Japan in March 2024; and three more centres in Argentina, Slovenia and South Africa in June 2024, bringing the total number of centres to nine Rays of Hope Anchor Centres. As capacity building and knowledge hubs, these centres strengthen cancer care within their respective regions by providing targeted support to neighbouring countries in key areas such as education, training, research, innovation and quality assurance.



*FIG. B.2. Rays of Hope signing of Anchor Centre Agreements between the IAEA and Argentina, Slovenia and South Africa held at the Agency headquarters in Vienna, Austria on 6 June 2024.
(Source: IAEA)*

8. The Agency continued its activities under seven active Coordinated Research Projects (CRPs), examining topics such as long-term iron absorption and loss; amino acid supplementation to treat environmental enteric dysfunction among children at risk of malnutrition; and total energy expenditure across the life course in low and middle-income countries (LMICs). The Agency's three nutrition-related databases continue to be utilized by researchers and investigators worldwide. The Doubly Labelled Water Database now holds more than ten peer reviewed publications that redefine understanding of human energy metabolism.

9. A new Agency database on body composition was launched on World Obesity Day on 4 March 2024 to help countries around the world devise better health policies to combat increasing challenges relating to obesity. The new database brings together body composition data collected using the non-invasive stable isotope technique of deuterium dilution. This growing global collection contains data from nearly 2600 study participants in 13 countries in Latin America, Asia, and Africa.

10. In addressing the critical shortage of nutrition professionals across Africa, the Agency supported the development of an innovative master's degree in nutrition and nuclear techniques. Launched in Dakar, Senegal, in November 2023 at the Fifth Federation of African Nutrition Societies (FANUS) Conference, the curriculum equips the next generation with the requisite skills and training in the use of nuclear techniques for improved health and wellbeing. The first cohort of 19 students from the region have begun their training in Morocco and South Africa, in French and English, respectively.

11. To better assist countries in improving nutrition through the use of nuclear techniques, the Agency held a technical meeting in Vienna from 10 to 13 October 2023. More than 40 nutrition experts and specialists from 17 Member States and three United Nations entities (the United Nations Children's Fund (UNICEF), the World Food Programme and the WHO) reviewed potential new methods and areas of application. They identified research gaps, outlined future directions, and highlighted the need for strengthened capacity building.

12. Throughout the reporting period, the Agency updated and maintained its Nuclear Medicine Database (NUMDAB) and the IAEA Medical Imaging and Nuclear Medicine Global Resources

Database (IMAGINE). Data collected in these databases are used to provide advice to Member States on needs within the fields of nuclear medicine and radiology, as well as on diagnostic and therapeutic applications to tackle the burden of non-communicable and communicable diseases. The information in these databases continues to enable researchers, practitioners, and policymakers to better understand the current state of infrastructural, technological, and educational resources for medical practice, training, and research. It continues to be actively utilized in peer reviewed publications.

13. The Agency continued to support the professional development of nuclear medicine and radiology practitioners worldwide, particularly those in LMICs. To that end, it facilitated complementary livestream access to five major medical conferences organized by partner professional organizations (the American Society of Nuclear Cardiology, the European Association of Nuclear Medicine, the European Society of Radiology, the International Society of Radiology, and the Radiological Society of North America) for 3550 imaging professionals from over 100 Member States.

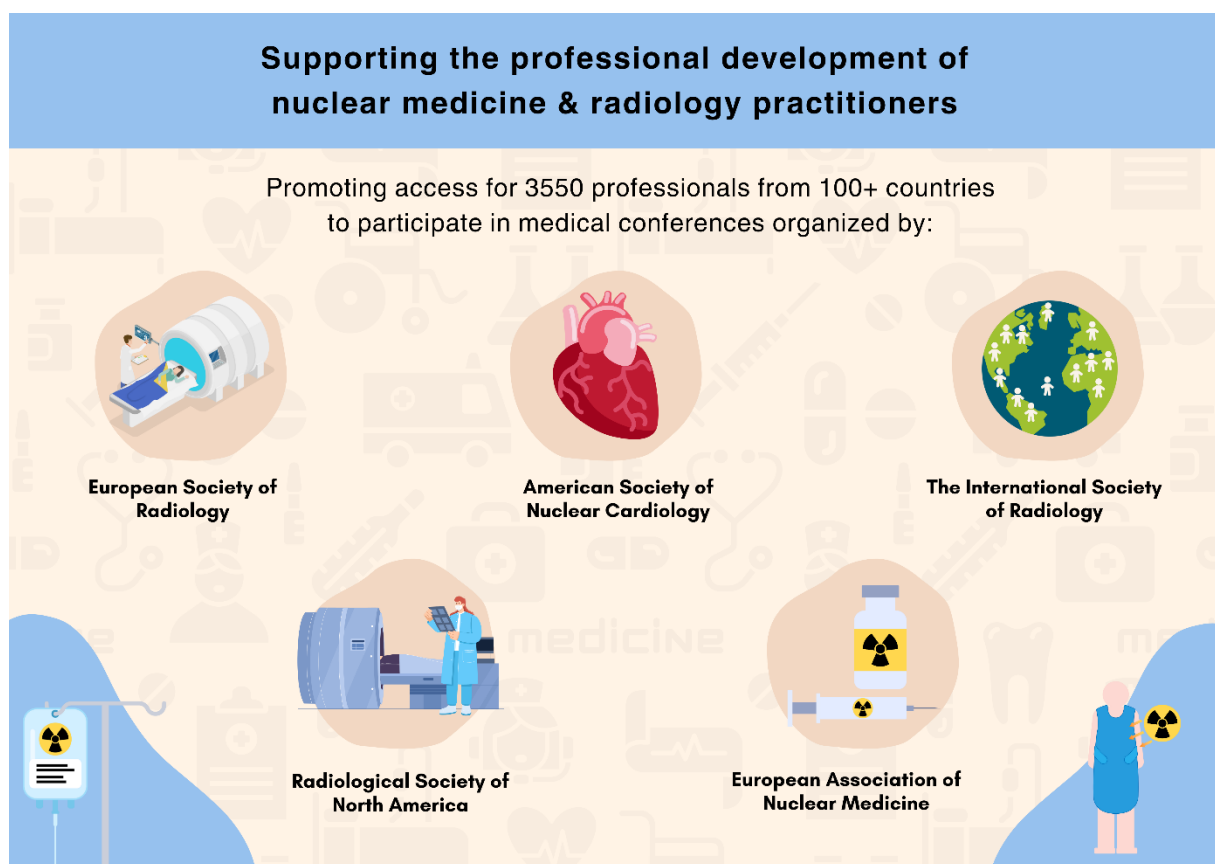


FIG. B.3. A figure showing the five organizations that held medical conferences where the Agency promoted livestream access for imaging professionals. (Source: IAEA)

14. During the reporting period, the Agency continued to conduct the Quality Management Audits in Nuclear Medicine Practices (QUANUM) and Quality Assurance Audit for Diagnostic Radiology Improvement and Learning (QUAADRIL) programmes, thereby helping to improve patient care in Member States. Under the QUANUM programme, the Agency has undertaken risk assessments in nuclear medicine.

15. The Agency continued its efforts to promote the education and training of radiation oncologists and radiation therapists, in particular by leveraging the use of innovative and cutting-edge tools. For example, new radiobiology modules have been developed utilizing microlearning features that cover all the fundamental principles of radiation biology clinical practice involving ionizing radiation.

16. The Agency developed virtual reality modules for radiation oncology procedures in external beam radiotherapy and two-dimensional and three-dimensional brachytherapy. This immersive learning environment enables oncologists, radiation therapists and medical physicists to develop an in-depth understanding of radiotherapy set-ups. This approach is especially advantageous when the necessary medical equipment is either unavailable in cancer centres or has not yet been commissioned for clinical use. First debuted in July 2023 during a national training course in Mozambique, these virtual reality modules have been used to train nearly 180 medical professionals in Africa, including through an e-contouring workshop organized by the Agency at the African Organisation for Research and Training in Cancer's 14th International Conference on Cancer in Senegal in November 2023.



FIG. B.4. Virtual reality goggles and the Agency's "Patient Setup and Positioning for Cervical Cancer External Beam Radiotherapy" module. (Source: IAEA)

17. Throughout the reporting period, the Agency continued to strengthen its partnership with the WHO. The Agency continued to provide recommendations for the adoption of advanced techniques and radiotherapy equipment in Member States. Both the Agency and the WHO continued their joint work on cancer care by developing technical guidance.

18. To improve diagnostic, treatment and symptom management capacities for common cancers — in particular cervical, breast and childhood cancers — training and networking activities with global outreach were organized jointly with the WHO to focus on radiation oncology as an integral part of comprehensive cancer care within the framework of the Cervical Cancer Elimination Initiative, the Global Breast Cancer Initiative and the Global Initiative for Childhood Cancer. The Agency provided technical expertise to the working groups under these initiatives.

19. In dosimetry and medical physics, the Agency continued its activities under five active CRPs on quality assurance, diagnostic radiology, and advanced physics. Data from a project on dosimetry audit methodologies, for example, has resulted in the development and establishment of a new brachytherapy

audit service. For LMICs in particular, this new service will help to ensure the safe and effective treatment of gynaecological cancers.

20. The Agency regularly updated and maintained its register of laboratories in the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories (IAEA/WHO SSDL Network); the Dosimetry Audit Network database; and the Directory of Radiotherapy Centres (DIRAC), which remains the world's most comprehensive database on radiotherapy resources for patient treatment. DIRAC data helped the World Intellectual Property Organization (WIPO) to reveal an alarming trend in its Global Innovation Index 2023: cancer cases requiring radiotherapy are outpacing the available technology. DIRAC data showed that only 20.9% of countries met the minimum radiotherapy resource requirements in 2022. DIRAC data is informing the development of WIPO's Global Innovation Index 2024.

21. The Agency continued to promote the training and education of medical physicists, including by supporting Master of Advanced Studies in Medical Physics conducted by the Abdus Salam International Centre for Theoretical Physics (ICTP); organizing training courses with the ICTP and the Argonne National Laboratory (ANL) in the USA; and collaborating with other partners. Trainings have included the Joint ICTP–IAEA Workshop on Quantitative Imaging and Analysis Methods in Modern Nuclear Medicine held in Trieste, Italy, in April 2024, and the Joint ANL–IAEA Regional Training Course on Volumetric Modulated Arc Radiation Therapy and Image-Guided Radiation Therapy held in Houston, USA, in August 2024.

22. In addition to supporting the role of radiation metrology for ensuring traceability, the Agency continued to improve accuracy in radiation dosimetry globally through the IAEA/WHO SSDL Network, which consists of 89 laboratories in 76 countries and is in the process of updating its charter. As the network's central laboratory, the Agency's Dosimetry Laboratory in Seibersdorf, Austria, provided reference dosimeter calibrations, comparisons and reference irradiations. These services facilitated traceability between end users such as hospital staff and the international measurement system for ionizing radiation, while ensuring consistency across all countries. The Dosimetry Laboratory also checked beams in hospitals around the world through the IAEA/WHO thermoluminescent dosimeter postal dose audit programme, thereby helping to ensure the safety and accuracy of radiotherapy treatments for cancer patients.

23. To further support countries in the accurate measurement of radiation doses, the Agency issued two international codes of practice: the first ever code of practice on brachytherapy dosimetry entitled *Dosimetry in Brachytherapy – An International Code of Practice for Secondary Standards Dosimetry Laboratories and Hospitals* (IAEA Technical Reports Series No. 492), and an updated version of *Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry Based on Standards of Absorbed Dose to Water* (IAEA Technical Reports Series No. 398 (Rev. 1)). Both publications address the need for a systemic, unified and internationally harmonized approach and will have a significant impact on the quality and standardization of dosimetry globally, ensuring that cancer patients receive care in a consistent and verifiable manner wherever they are. The Agency is in the process of issuing both codes of practice in other official languages of the United Nations.

24. To facilitate the effective and appropriate application of artificial intelligence (AI)-based tools within clinical settings for medical physicists, the Agency supported Member States by developing *Artificial Intelligence in Medical Physics: Roles, Responsibilities, Education and Training of Clinically Qualified Medical Physicists* (IAEA Training Course Series No. 83), which sets out the roles and responsibilities of clinically qualified medical physicists; provides guidance on the competencies they need; outlines an elective module for postgraduate academic programmes; and suggests continuing professional development activities. Together with the ICTP, the Agency organized a Joint ICTP–IAEA

Workshop on Artificial Intelligence in Ionizing Radiation for Medical Physicists, held in Trieste, Italy, in November 2023. The training equipped 59 early- to mid-career medical physicists from 50 countries with the knowledge and skills to use and implement AI-based tools within their respective clinics.



FIG. B.5. Early- to mid-career medical physicists from 50 countries participating in a joint IAEA–ICTP training workshop on artificial intelligence in ionizing radiation. (Source: IAEA)

25. Through its Marine Environment Laboratories, the Agency, as a member of the UN-Oceans mechanism and the UN Environment Management Group, continued to ensure coordination among United Nations agencies, contributing to the Intergovernmental Negotiating Committee on Plastic Pollution to develop a legally binding instrument to end with plastic pollution, including in the marine environment, and to the elaboration, development and implementation of a common approach towards achieving a pollution-free planet.

26. Under the Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics) initiative, more than 80 Member States are being supported to monitor microplastic abundance and polymer types in coastal zones. A new interregional project on marine microplastics, entitled “Contributing to the Global Monitoring of Marine Plastic Pollution under the IAEA Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics) Initiative” was launched at a kick-off meeting held at the Agency’s Headquarters in early July 2024.

27. The Agency supported Member State institutions, through the Research Network of Marine-Coastal Stressors in Latin America and the Caribbean, to develop harmonized microplastics sampling protocols to guide the collection and analysis of samples for the monitoring of microplastics in coastal areas.



FIG. B.6. IAEA Director General Rafael Mariano Grossi together with H.E. President of Argentina Javier Gerardo Milei and IAEA Scientific experts from the Marine Environment Laboratories in Monaco travelled to Antarctica to collect samples for analysis under the IAEA's NUTEC Plastic initiative in January 2024. (Source: IAEA)

28. At the 2024 Conference of the United Nations Decade of Ocean Science for Sustainable Development organized by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Agency co-organized a satellite event entitled “Global Awareness, Research Activities and Network to Address Ocean Microplastic Pollution”.

29. Through the Ocean Acidification International Coordination Centre (OA-ICC), the Agency continued to support Member States in their efforts to tackle ocean acidification. The OA-ICC provided expert input and support to develop the methodology to report ocean acidification data through its dedicated Data Portal — a tool for the submission, storage and sharing of ocean acidification data and metadata hosted by the Intergovernmental Oceanographic Commission UNESCO.

30. The OA-ICC was represented at the 28th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP28), organizing and participating in side events and round table discussions addressing aspects of ocean acidification research, policy and governance, capacity building, and interdisciplinary and cross-sectoral approaches to climate change adaptation and mitigation, including nature-based solutions. At the 2024 Conference of the United Nations Decade of Ocean Science for Sustainable Development held in Barcelona, Spain in April 2024, the Agency, jointly with the Ocean Acidification Alliance, and National Oceanic and Atmospheric Administration in partnership with the Global Ocean Acidification Observation Network and the Ocean

Acidification research for Sustainability, co-organized a satellite event entitled “Moving from Science to Action on Ocean Acidification: Why Does It Matter? How Is It Being Achieved?”.

31. The Agency participated in the High-Level Event on Ocean Action: Immersed in Change organized by the Government of Costa Rica — which will co-host the 2025 United Nations Ocean Conference with France — to exchange best practices and share successful experiences in the use of global networks to address global threats to the ocean.

32. During the reporting period, the Agency supported projects in 30 Member States, jointly with research institutes, in the use of radionuclides to assess rates of carbon sequestration in vegetated coastal areas and to aid Member States in data collection to evaluate the capacity of these ecosystems for long-term carbon storage. In Africa, the Agency is working with 16 Member States in capacity building in the area of blue carbon through a regional technical cooperation project.

33. The Agency continued to support regional seas programmes such as the United Nations Environment Programme (UNEP) Mediterranean Action Plan, the Convention for the Protection of the Marine Environment of the North-East Atlantic, the Baltic Marine Environment Protection Commission, and international conventions such as the Minamata Convention on Mercury and the Stockholm Convention on Persistent Organic Pollutants in their effectiveness evaluation by providing matrix certified reference materials of high quality and by organizing interlaboratory comparisons and proficiency tests for the analysis of contaminants in marine matrices. During the reporting period, two new certified reference materials for trace elements and persistent organic pollutants were released to support reliable and highly accurate monitoring of harmful contaminants in the marine environment. A proficiency test for radionuclides in seawater attracted over 100 participating laboratories keen to test and document their analytical performance and the comparability and reliability of their marine monitoring data.

34. The Agency continued to conduct research using radioactive and stable isotopes together with associated analytical techniques to advance knowledge of the provenance, transfer and bioaccumulation of contaminants such as heavy metals, persistent organic pollutants, microplastics and biotoxins in the marine environment, and specifically in ‘blue foods’, so as to minimize the health risks of consuming contaminated seafood.

35. The Agency, through its Marine Environment Laboratories is working closely with UNEP in the framework of several conventions, in particular the UNEP Mediterranean Action Plan’s Programme for the Assessment and Control of Pollution in the Mediterranean Region (MED POL)), the Minamata Convention on Mercury, and the Stockholm Convention on Persistent Organic Pollutants. A formal agreement exists with the former on the provision of services to harmonize and coordinate quality assurance of contaminant monitoring in the Mediterranean Sea. Two regional interlaboratory comparisons and two training courses for the analysis of trace elements and organic contaminants in marine matrices were conducted to assist MED POL Member States in maintaining and improving the reliability of their analytical measurements in marine pollution.

36. As a partner in the UNEP Environmental Global Mercury Partnership, the linkages between the Agency and the UNEP Minamata Convention Secretariat, specifically relating to evaluation of the effectiveness of the Convention’s implementation with regard to the marine environment, have been maintained. During the reporting period, one further reference material for mercury and methyl mercury was established to support high precision monitoring of mercury in the marine environment.

37. During the reporting period, the Marine Radioactivity Information System (MARIS) was upgraded to effectively serve marine radioactivity research and applications, monitoring and assessment and to ensure information dissemination to the general public and to authorities.

38. The Agency launched the first ever contest for start-up companies together with the International Telecommunication Union (ITU), the Food and Agriculture Organization of the United Nations (FAO), and UNESCO to advance the development of solutions that utilize AI to address the impact of climate change on food security and sustainable water resources. The contest, which was launched at the AI for Good Global Summit 2023 in Geneva, Switzerland, is part of the AI for Good platform developed by the ITU, which gives start-ups a global stage to promote and grow innovative, AI-powered and climate-driven solutions. The winners of the contest participated in a side event at COP28, organized by the Agency, the ITU, the FAO and UNESCO, dedicated to promoting innovative ideas from all participating organizations.



FIG. B.7. UN Side Event held at COP28 on Crowdsourcing AI Solutions for Climate Change together with ITU, FAO and UNESCO in Dubai, United Arab Emirates on December 2, 2023. (Source: ITU)

39. The Agency continued to support capacity building, emergency interventions and South–South cooperation through the Veterinary Diagnostic Laboratory (VETLAB) Network, a scientific and technical network of national veterinary laboratories in 46 countries in Africa, 19 in Asia, 17 in the Latin America and the Caribbean region, and 27 in Eastern Europe. Support is provided through training, diagnostic kits, standard operating procedures (SOPs), and equipment and material for the control and prevention of transboundary animal and zoonotic diseases.



FIG. B.8. Training Course for VETLAB partners on Multiparametric Detection of Pathogens Causing Major Transboundary Animal Diseases and Zoonoses, Animal Production and Health Laboratory, 25 September to 6 October 2023. (Source: IAEA)

40. The Agency continued to support food safety and quality control systems critical to protecting consumers, facilitating global trade among Member States, and building resilience to crises affecting the food supply chain. Food safety laboratories including the Latin American and Caribbean Analytical Network (57 institutions in 21 countries), the African Food Safety Network (115 laboratories in 46 countries) and the Food Safety Asia Network (46 institutions in 29 countries) have continued to enhance capabilities in food safety and food control systems through training, workshops, interlaboratory trials, technical networking and capacity building.

41. The Agency continued to support more than 80 countries in building and strengthening their food safety and control systems — including those relating to consumer protection from harmful chemical and biological hazards — and in addressing the challenges of food authenticity and fraud and enhancing the use of ionizing irradiation. Awareness of the profitable use of ionizing radiation in sanitary and phytosanitary applications was also enhanced in a number of Member States in Asia, Africa and the Latin America and the Caribbean region.



FIG. B.9. IAEA Director General Rafael Mariano Grossi delivers opening remarks at the International Symposium on Food Safety and Control, “Safe Food for a Better Life”, held in Vienna, Austria on 27 May 2024. (Source: IAEA)

42. The Agency supported Member States in strengthening research capabilities for conducting radiolabelled food animal studies required to support the process of setting national or international food safety standards (Codex Alimentarius). A notable example is the in-house production of radioactive zinc (zinc-65) and the labelling of the antimicrobial amoxicillin to conduct depletion studies in fish. This is a new scientific development that could encourage other countries to use cyclotrons or related facilities to produce radiopharmaceuticals for non-human use, thereby avoiding the cost of purchasing and the burden of shipping radiolabelled material across borders.



FIG. B.10. Workers in Viet Nam preparing boxes filled with fruit prior to irradiation, a phytosanitary procedure that kills pests with little impact on the fruit. (Source: Hanoi Irradiation Center)

43. The Agency registered 31 new mutant varieties in the FAO/IAEA Mutant Variety Database that were released for farmers in Bangladesh, China, India, the Islamic Republic of Iran, Kenya, the Philippines, Sierra Leone, Thailand, Türkiye and Yemen; 15 additional mutant varieties are being processed for inclusion in the database in 2024.

44. The Agency continued its efforts to support mutation breeding programmes in a number of Member States, in particular through the implementation of advanced nuclear and related technologies for a range of crops and traits. Through various technical cooperation projects to sustainably improve crop resilience to biotic and abiotic stressors, it supported more than 25 countries by providing enabling technologies for the application of modern genomic and associated biotechnologies and the deployment of advanced genomics methods for trait utilization.

45. The Agency supported Member State capacities in the use of isotopic, nuclear and related techniques to improve land and water management practices, adapt to the impact of climate change on land and water resources for sustainable food production, and respond to nuclear and extreme weather emergencies affecting food and agriculture. Climate-smart agricultural practices were developed to enhance the productivity of crops with lower environmental footprints, mitigate land degradation, and increase crop yields using fewer inputs. Partnerships were established with the International Center for Biosaline Agriculture and Anglo American Crop Nutrients to carry out collaborative research and development (R&D) to develop sustainable solutions to land degradation and crop productivity. A toolbox was developed to determine sources of pollution.

46. The Agency supported Member States to strengthen monitoring (through surveillance) and mitigation (through best practices) to better understand the dynamics of antimicrobial resistance in the

environment. Total synthesis of carbon-13 (^{13}C)-labelled sulfamethoxazole, an antibiotic commonly used in livestock disease control, has been produced and distributed to CRP participants for field monitoring of antibiotics and the development of antibiotic resistance in soil–water–plant systems. New protocols for sampling and extraction and analytical protocols to trace movement, and toolbox for diagnostic ^{13}C -labelled sulfamethoxazole in soils, water and plants were developed and tested. A detailed protocol for extracting genomic deoxyribonucleic acid from soil and water samples and for the use of a normal quantitative polymerase chain reaction (PCR) cyclers to quantify the abundance of multiple antibiotic resistance genes was developed.

47. In October 2023, the Agency launched a Webinar Series on Nuclear Analytical Techniques for World Heritage. The first two parts in the series highlighted the activities of partner organizations in Singapore and Australia and attracted more than 100 participants from around 50 Member States.

48. The Workshop on Enhancing Cross-Disciplinary Dialogue on the Authentication and Provenance of Heritage Objects Using Forensic Applications was held in Vienna from 29 November to 1 December 2023, with 15 participants from seven Member States and international organizations such as the International Criminal Police Organization – INTERPOL and the United Nations Interregional Crime and Justice Research Institute. Participants discussed practices, identified research gaps and established a fruitful dialogue between scientists and stakeholders from various disciplines to foster the uptake of nuclear analytical techniques for forensic applications.

49. The Joint ICTP–IAEA School on Fully Programmable Systems on Chip for Scientific Instrumentation and Reconfigurable Computing took place in Trieste, Italy from 20 November to 1 December 2023, with 44 participants from 27 Member States. The event allowed trainees to familiarize themselves with professional software design tools and hardware platforms through tutorials and hands-on activities, with an emphasis on the practical applications of modern nuclear instrumentation.

50. The analytical capabilities of close to 50 laboratories in 34 Member States were improved through the introduction of proficiency tests during the reporting period.

51. A Training Workshop on Mobile Radiological Mapping Using Instrumented Uncrewed Aerial and Ground Vehicles was held at the Agency's Seibersdorf laboratories from 13 to 17 May 2024 and was attended by 13 participants from 13 Member States. The latest knowledge and good practices in using uncrewed aerial and uncrewed ground vehicle technologies for mobile radiological mapping, including practical in-situ demonstration and training exercises, were shared.

52. The Third Training Workshop on Method Validation and Quality Control for X-Ray Fluorescence Laboratories Participating in Proficiency Tests was held at the Seibersdorf laboratories from 10 to 14 June 2024, with 13 participants from 8 Member States. The event provided analytical laboratories that have underperformed in proficiency tests with dedicated training and guidance to help them address their deficiencies in the use of X-ray fluorescence analysis.

53. A Joint IAEA–French Alternative Energies and Atomic Energy Commission Workshop on Muon Tomography: From Basic Principles to Practical Usage and Applications was held from 17 to 28 June at Gif-sur-Yvette, France, in order to familiarize participants with the methodology and instrumentation used for muon tomography through demonstrations and case studies in the field of non-destructive testing and verification. The event was attended by 12 participants from 11 Member States.

54. In September 2023, the Agency designated the Massachusetts Institute of Technology's (MIT) Plasma Science and Fusion Center (PSFC) as its first Collaborating Centre in the field of fusion. The partnership with the PSFC will help the Agency to deliver its fusion research and technology activities for an initial period of four years (2023–2027). Under the agreement, the Agency will be able to access

the PSFC's expertise in the area of AI applied to fusion and plasma science by bringing together these innovations in an integrated manner while training a new generation of fusion scientists.



FIG. B.11. Signing of the IAEA Collaborating Centre agreement between the IAEA and MIT's PSFC as its first Collaborating Centre in the field of AI for Fusion in Massachusetts, United States of America. (Source: IAEA)

55. In September 2023, the Agency released *Fundamentals of Magnetic Fusion Technology*, a high-level textbook focusing on fusion technology for graduate students and established plasma physicists and others working in the field who require a comprehensive overview. This publication contributes to the consolidation and better exploitation of past achievements so as to tackle current challenges in preparing the workforce in different areas, with a particular focus on continuous professional development and lifelong learning. It includes chapters on fusion technology relevant to diagnostics, confinement and plasma control, and on plasma heating and current drive technology, plasma-facing components, neutronics, reactor materials, vacuum pumping and fuelling, tritium handling and remote maintenance.

56. In October 2023, the Agency released the *IAEA World Fusion Outlook 2023 — Fusion Energy: Present and Future*. This publication is intended to be the global reference for authoritative information and updates on fusion energy and outlines achievements in fusion energy; its safety, security, safeguards, nuclear law and liability challenges; and the role of the Agency and its ongoing efforts in this area.

57. The Agency published *Plasma Physics and Technology Aspects of the Deuterium–Tritium Fuel Cycle for Fusion Energy* (IAEA-TECDOC-2049) in March 2024. This publication provides an overview of plasma physics and technology aspects of the deuterium–tritium (D–T) fuel cycle in magnetic fusion devices, from the ITER energy project to the demonstration fusion power plants.

58. A Joint ICTP–IAEA Fusion Energy School was held from 6 to 17 May 2024 in Trieste, Italy. The event was attended by 33 participants from 23 Member States. Two week-long intensive schools,

featuring lectures by experts from academia and the private sector, aimed to broaden participants' understanding of fusion energy and provide them with opportunities to connect with leading researchers and other stakeholders.

59. The Third Research Coordination Meeting on Pathways to Energy from Inertial Fusion: Materials Research and Technology Development was held in a virtual format from 12 to 15 December 2023 with 28 participants from 17 Member States. The event reviewed and summarized the ongoing activities of the CRP with the same title and initiated the drafting of the associated Agency publication.

60. A Training Workshop on Advanced Use of Neutron Imaging for Research and Applications was held in Pretoria, South Africa, in cooperation with the South African Nuclear Energy Corporation (Necsa) from 30 October to 3 November 2023. The event was attended by 18 participants from 14 Member States. Through lectures and hands-on training exercises, the meeting introduced and delivered concise and up-to-date information on the use of neutron imaging for basic research and industrial applications.

61. An Integrated Research Reactor Utilization Review (IRRUR) mission was conducted at the research reactor at McMaster University, Canada, from 22 to 26 January 2024. The mission examined how McMaster University could better utilize its research reactor in several areas such as radioisotope production and neutron-based sciences, and education and training opportunities that integrate the reactor with all McMaster faculties and could help prepare Canada's future nuclear workforce.

62. A Technical Meeting on Advances in Neutron Scattering and Imaging at Low and Medium Flux Accelerator- and Research Reactor-based Neutron Sources was held at the Agency's Headquarters in Vienna from 22 to 26 April 2024, with 16 participants from 12 Member States. The event brought together practitioners, users and other stakeholders interested in neutron beam techniques using both research reactor- and accelerator-based neutron sources in order to share information on existing experience, good practices, lessons learned, and the challenges related to these techniques.

63. The Agency published *Central Nervous System Radiotracer Development: Bench to Bedside* (IAEA-TECDOC-2052) in April 2024, which provides a reference guideline for the development of central nervous system radiotracers for clinical applications and discusses different aspects and stages of development and consideration for first-in-human studies.

64. In May 2024, the Agency initiated a new five-year CRP entitled "Development of new generation of Tc-99m kits" which focuses on expanding the application of molybdenum-99 (^{99}Mo)/technetium-99m ($^{99\text{m}}\text{Tc}$) generators by introducing new series of $^{99\text{m}}\text{Tc}$ radiopharmaceuticals for imaging various biological substrates of relevant clinical interest using the most efficient methods of $^{99\text{m}}\text{Tc}$ labelling.

65. Collaborative activities between the Agency and the WHO were strengthened in the area of radiopharmaceuticals. Additional good manufacturing practices (GMP) guidelines (the third in the series) specifically addressing GMP requirements for in-house cold kits for radiopharmaceutical preparation were published in April 2024 in *TRS 1052 — 57th Report of the WHO Expert Committee on Specifications for Pharmaceutical Preparations*.

66. In response to requests by Member States to provide centralized information on developments in radiopharmaceuticals and the current availability of a range of radionuclides and ligands, the Agency created an interactive Radiopharmacy Database, which includes a survey link to gather information from all facilities engaged in the research or routine production of radioisotopes and radiopharmaceuticals.

67. The Agency, together with Member States, continued to strengthen efforts to develop more accessible industrial irradiation facilities, including industrial electron beam (e-Beam) accelerators, so

as to expand the field of application to include health, industry, the environment, agrifood and cultural heritage.

68. In April 2024, the Agency launched the NUTEC Plastics portal, which contains all relevant materials and updates related to NUTEC Plastics and the Agency's efforts to accelerate the transition to a circular plastic economy and mitigate plastic pollution, including progress reports, guideline documents and useful tools.

69. NUTEC Plastics continued to support 39 countries in developing innovative and tailored radiation technology for the treatment of plastic waste, following the initiative's four-stage approach.

70. In May 2024, the Agency initiated the Radiation Processing Webinar Series to continue support to Member States in the radiation grafting field. Webinars held in May, June and July 2024 focused on machine learning for radiation-induced grafting.

71. The Agency is strengthening Member States' measurement capabilities through its Worldwide Proficiency Test Exercise. The most recent exercise had 505 participants from 98 countries. The exercise helps to develop, maintain and reinforce Member States' expertise for measuring radioactivity in environmental samples, foodstuffs and other materials, and strengthens networking between laboratories. Two new reference materials to support Member States' laboratory quality assurance systems will be released in 2024: IAEA-482 Fish Material, and IAEA-RGU-2 Uranium Ore.

72. IAEA International Experts Meeting reached an agreement on the baseline against which all carbon stable isotope measurements are made (known as the 'carbon delta scale'). This was highly significant, as it impacts the global comparability of data from isotopic measurements of greenhouse gases (carbon dioxide and methane) and the use of such data in modelling predictions of the impact of greenhouse gases on global warming.

Development of the Sterile Insect Technique Package for the Management of Disease-Transmitting Mosquitoes

A. Background

1. In resolution GC(66)/RES/9.A.6, the General Conference noted with serious concern that in recent years, “mosquito-transmitted dengue, now the world’s most common mosquito-borne disease, has become a major international public health concern with an incidence growing more than 30-fold during the last 50 years”, and that “dengue is estimated to infect around 400 million people per year, and over half of the world’s population is at risk of the disease”.
2. The General Conference noted that “the suppression of disease-transmitting mosquitoes using the SIT [sterile insect technique] will be suitable mostly in urban areas, where aerial spraying with insecticides is prohibited or not indicated”, and that “an area-wide approach is required, which represents a novel and potentially powerful supplement to existing community-based programmes”. The General Conference noted with appreciation “the interest shown by some donors in and their support for R&D and technology transfer on the SIT for combating malaria-, dengue-, Zika- and other disease-transmitting mosquitoes”.
3. The General Conference requested the Agency to continue and strengthen “the research, both in the laboratory and in the field, required to be able to refine and validate the use of the SIT for the integrated management of malaria-, dengue-, Zika- and other disease-transmitting mosquitoes”. It requested the Agency to “increasingly involve developing Member States’ scientific and research institutes in the research programme in order to ensure their participation, leading to ownership by the affected countries”. The General Conference also requested the Agency to “increase efforts to continue developing and transferring more efficient sex separation systems, including genetic sexing strains, that allow complete removal of the female mosquitoes in production facilities and to develop cost-effective methods to release and monitor sterile males in the field”.
4. The General Conference requested the Agency to “allocate adequate resources and to attract extrabudgetary funds so as to continue the recently expanded mosquito research programme, laboratory/office space and staffing”.
5. The General Conference also requested the Agency to “strengthen capacity building and networking in Latin America, Asia and the Pacific, and Africa through regional TC projects and to continue supporting field projects against *Aedes* and *Anopheles* mosquitoes through national TC projects for assessing the potential of the SIT as an efficient control tactic for disease-transmitting mosquitoes”.
6. The General Conference invited the Agency to “act upon the recommendation made by the experts of the revised Thematic Plan for the Development and Application of the Sterile Insect Technique (SIT) and Related Genetic and Biological Control Methods for Disease Transmitting Mosquitoes to invest in supporting the management of the mosquito vector species through continuous funding of the development of the SIT and related methods”.

7. The General Conference requested the Director General to report on the progress made in the implementation of the resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 66th Regular Session of the General Conference

8. The Agency continued to work on the development of the SIT package for disease-transmitting mosquitoes, i.e. *Anopheles arabiensis*, a vector of malaria, and *Aedes aegypti* and *Aedes albopictus*, the main vectors of dengue, Zika, chikungunya and yellow fever. The Agency is currently maintaining mosquito strains from 16 countries, including strains with morphological and other markers, which are currently being evaluated for potential use in SIT-based approaches.

9. The Agency continued its efforts to develop robust and efficient methods for sex separation, including genetic sexing. Two *Ae. aegypti* genetic sexing strains (GSSs), one based on red eye colour and the other on white eye colour, were developed and validated under laboratory conditions. The *Ae. aegypti* red-eye GSS is robust. An irradiation-induced chromosomal inversion was integrated into the red-eye GSS to enhance its genetic stability. Both the red-eye selectable marker and the irradiation-induced chromosomal inversion have been introgressed into different genomic backgrounds and have maintained their functionality, both in respect of sexing properties and long-term genetic stability.

10. Mutagenesis screens, as well as screening of wild populations and laboratory strains of *Ae. aegypti*, are being carried out to discover novel mutations that could potentially be used as selectable markers for genetic sexing as early in development as possible. In the context of these efforts, a temperature-sensitive lethal mutation has been induced in *Ae. aegypti* using the CRISPR/Cas9 gene editing technology and is currently being evaluated for its suitability as a sex separation marker. Two new mutations targeting body pigmentation in *Ae. aegypti* have been developed using the CRISPR/Cas9 technology, and their fitness evaluated.

11. Thermosensitive and thermoresistant lines of *Ae. aegypti* have been established after wide screening of wild-type and red-eye populations. Induction of novel mutations that could potentially be used as selectable markers are being carried out and constantly evaluated. A new camera software has been tested for its ability to distinguish black- and red-eye *Ae. aegypti* larvae, with the aim of developing a prototype sorter using red-eye as a selectable marker. *Ae. albopictus* rearing was improved by testing different protocols for egg drying and egg hatching. The new hatching protocol increased the rearing efficiency of *Ae. albopictus* and reduced the associated workload.

12. In terms of mosquito mass rearing technology, the Agency has developed and validated several tools, pieces of equipment and procedures with the aim of reducing production costs and increasing the quality of the biological material. For example, a novel automated pupal sorter developed in Singapore has been evaluated for two *Aedes* species by comparing it against another automatic sex sorter developed in China. This represents a significant step towards large-scale SIT operations.

13. A selection process was applied to a mother colony of *Ae. aegypti* (Brazil strain) to reduce protandry and increase size differences between the sexes over generations. This makes it possible to increase the recovery rate of both male (over 80%) and female pupae in one mass rearing rack-tilt event while maintaining low female contamination in the males, which is encouraging in terms of cost efficiency.

14. Dissolvable capsules containing *Aedes* eggs and diet powder were developed and successfully tested for *Ae. aegypti* and *Ae. albopictus*. This method is anticipated to strongly facilitate mass rearing procedures without the use of large numbers of costly and mechanized electronic procedures.

15. Recognizing the increasing challenges associated with the use of isotopic irradiators for the sterilization of mosquitoes and the anticipated expansion of mosquito suppression projects, the Agency assessed the relative biological effectiveness of X-rays and gamma rays to induce sterility in male pupae and adults of *An. arabiensis*, *Ae. albopictus* and *Ae. aegypti*. Although relative biological effectiveness was shown to be comparable, longer exposure times in the available X-ray irradiators results in a need to maintain temperatures close to seven degrees Celsius to keep the adults immobilized and avoid physical damage. A novel three-dimensional printed canister with an outer wall filled with phase change material was tested and shown to be effective for irradiating chilled adult mosquitoes. Downstream quality parameters of sterile *Aedes* and *Anopheles* males were assessed after irradiation at the pupae versus adult stage. Longevity, flight ability and mating competitiveness were better when males were irradiated at the adult stage.

16. A novel mass transport protocol was developed, tested and implemented (in Cyprus, France (Réunion Island) and Senegal), allowing for long distance shipments of chilled sterile *Ae. aegypti* males for up to two days without a significant impact on survival (less than 10% recorded mortality), flight ability and damage. The protocol is now being tested for *Ae. albopictus* to ascertain whether any adjustments are needed for this species.

17. Molecular tools to diagnose mosquito-borne diseases and pathogens in mosquito colonies were developed in collaboration with 'Infravec 2', a research project funded by the European Commission. These molecular tools will prove crucial in maintaining pathogen-free colonies in SIT programmes.



FIG. B.1. IAEA Director General Rafael Mariano Grossi signed an Atoms4Food agreement with H.E. Javier González-Olaechea, Peru's Foreign Minister, in June 2024, building on the IAEA's efforts to enhance agricultural practices in Peru. Through Agency support Peru adopted SIT. As a result, it has established areas free of the Mediterranean fruit fly export in the south of the country and can export mangos without quarantine restrictions. (Source: IAEA)

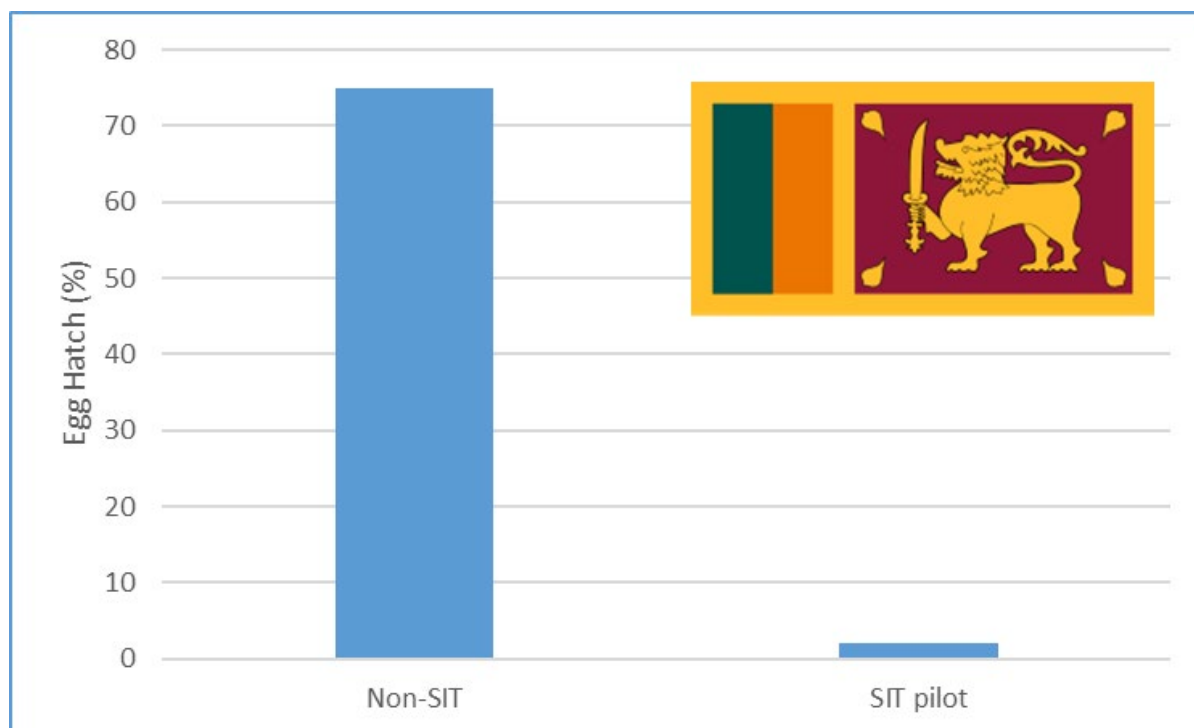
18. Following the successful suppression of target populations of *Ae. albopictus* in Guangzhou, China, through a combination of the SIT and the incompatible insect technique, successful results were also obtained in Singapore against *Ae. aegypti*, where the target population was significantly suppressed, and dengue cases reduced by up to 70%. In Mauritius, an open field pilot trial using the SIT to suppress the population of *Ae. albopictus* started in 2023, resulting in a reduction in mosquito population density of approximately 50%.

19. The CRP entitled “Mosquito Irradiation, Sterilization and Quality Control” is now in its final year. Significant irradiation and quality control results have been generated by the participants, and standard irradiation and dosimetry protocols have been adopted and implemented in irradiation-based studies. The Agency has established a new CRP entitled “Reproductive Biology of Male Aedes Mosquitoes for SIT applications” in response to requests from Member States. This new CRP aims to investigate the factors contributing to the mating success of sterile males in SIT programmes, with a particular focus on investigating the reproductive biology of male mosquitoes, which will benefit SIT field projects.

20. The Agency continued to provide Member States with support through three regional technical cooperation projects covering the European region (RER5026 “Enhancing the Capacity to Integrate Sterile Insect Technique in the Effective Management of Invasive Aedes Mosquitoes”); the Asia-Pacific region (RAS5095 “Enhancing the Capacity and the Utilization of the Sterile Insect Technique for Aedes Mosquito Control”); and the Latin America and the Caribbean region (RLA5083 “Enhancing Capacity for the Use of the Sterile Insect Technique as a Component of Mosquito Control Programs”). Regional capacities were strengthened and harmonized in respect of information about the SIT package, with the support of the above projects.

21. A new regional technical cooperation project (RLA5092 “Enhancing Regional Capacity for the Adoption of the Sterile Insect Technique as a Component of Mosquito Control Programmes”) started in January 2024 under the framework of the Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) to continue building and enhancing capacities to support the implementation of new SIT projects to combat *Aedes* mosquitoes.

22. Through the Technical Cooperation Programme, the Agency continued to provide support to the following Member States: Bangladesh, Brazil, Burkina Faso, Cuba, Cyprus, Ecuador, Jamaica, Mauritius, Mexico, the Philippines, Portugal, Serbia, South Africa, Sri Lanka, Sudan and Türkiye. The Agency has supported pilot trials for the application of the SIT to combat mosquitoes in Croatia, Cyprus, Italy, Mauritius, Portugal, Serbia, Spain and the USA.



*FIG. B.2. A pilot trial using SIT against *Aedes albopictus* in Sri Lanka showed a reduction of more than 90% egg hatching rate. (Source: IAEA)*

23. The Agency launched a phased conditional approach scheme through which Member States can test and implement the SIT for vector control in circumstances, where advancing to the next phase depends on the completion of activities in the previous phase, with the objective of progressing towards the implementation of SIT field programmes. 42 pilot trials are currently ongoing globally, following this approach.

C. Conclusions

24. Mosquito-borne diseases such as malaria, dengue, yellow fever, chikungunya, Zika and others remain among the most severe threats to the health of millions of people worldwide. Due to globalization and climate change, many species of mosquitoes are spreading to areas previously free of the vectors of these diseases. This has resulted in more frequent outbreaks of these diseases over the past decade. Most of the relevant mosquito populations are currently being controlled using insecticide-based methods, which create other health threats and build resistance in mosquitoes.



*FIG. C.1. Recapture of mated females in semi-field cages to assess sterile male competitiveness.
(Source: IAEA)*

25. The SIT is part of an area-wide integrated vector management approach. The Agency, through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture (Joint FAO/IAEA Centre), has continued with the development, validation and optimization of the SIT package as a complementary tool for the management of mosquito populations. Good progress has been made in collaboration with Member States on two of the main challenges — the development of efficient sex separation methods that would allow male-only releases, and the aerial release of mosquitoes. The development and validation of a mosquito release system mounted on remotely piloted aircraft is a great achievement that paves the way for large-scale and cost-efficient releases over sparsely or densely populated areas.

26. The current developments in sexing and drone release will make it possible to test the SIT approach in pilot trials to demonstrate that it is a safe, biosecure and responsible approach to managing mosquito populations. A crucial objective is to demonstrate, in collaboration with the WHO, that the suppression of *Aedes* populations below a certain threshold will limit or prevent the transmission of all these diseases (dengue, chikungunya, Zika, yellow fever or any new or re-emerging diseases).

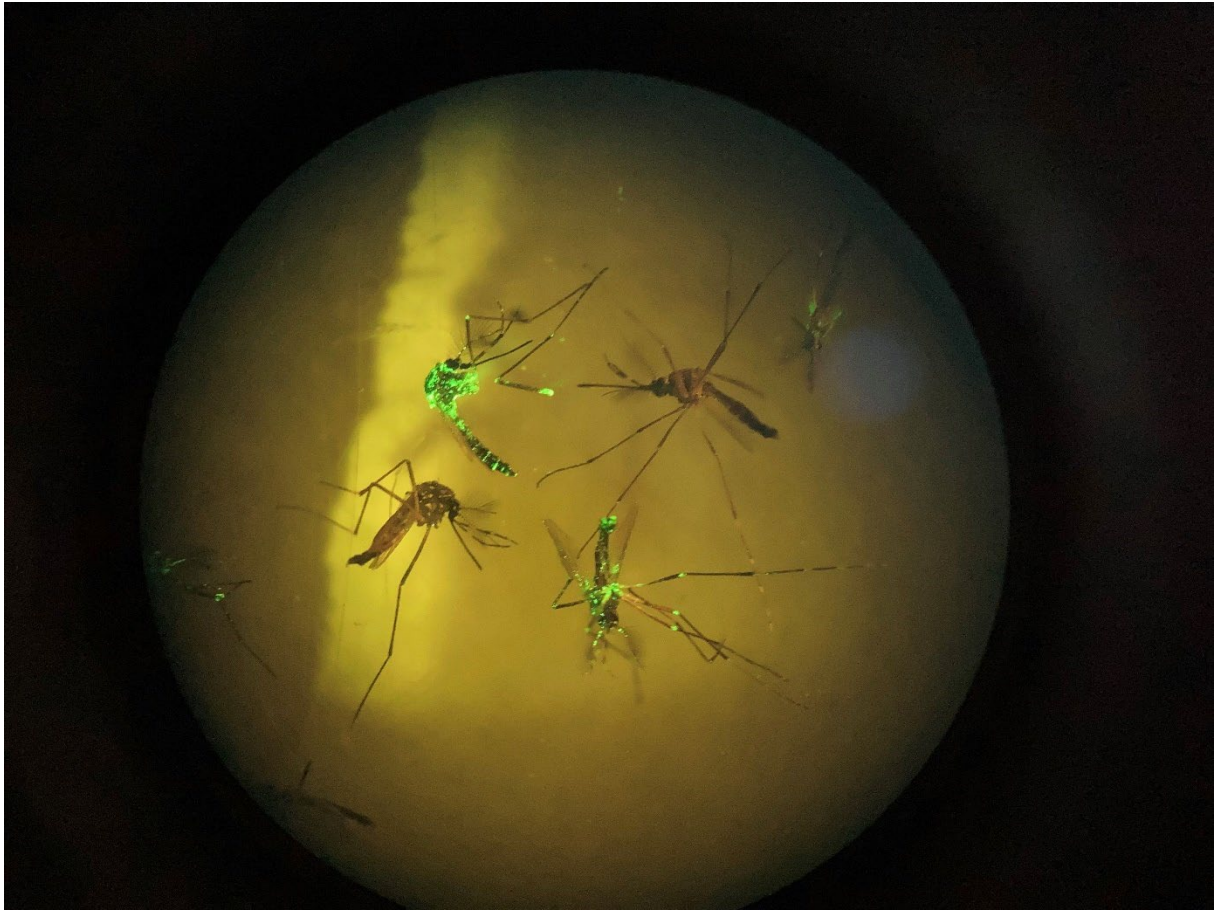


FIG. C.2. Recaptured sterile (marked green) and fertile (unmarked) males from competitiveness studies. (Source: IAEA)

Strengthening the Support to Member States in Food and Agriculture

A. Background

1. It is estimated that between 691 and 783 million people faced hunger in 2022. Projections indicate that almost 600 million people will be chronically undernourished in 2030.
2. Since 1964, the FAO and the Agency have collaboratively pursued their mandates through the Joint FAO/IAEA Centre, which leads the progression and practical application of nuclear and related techniques in the realm of food and agriculture within the FAO and the Agency's Member States. The overarching objective is to significantly contribute to global food security and foster sustainable agricultural development on a global scale.
3. Functioning as a key hub for scientific research and development in nuclear and related techniques in food and agriculture, the Joint FAO/IAEA Centre focuses on five key thematic areas: animal production and health; food safety and control; insect pest control; plant breeding and genetics; and soil and water management and crop nutrition supported by five laboratories located in Seibersdorf, Austria. This unique setting provides an optimal environment for innovative scientific endeavours, fostering advancements that resonate globally. The Agency, through the Joint FAO/IAEA Centre coordinates more than 25 CRPs involving some 400 research institutions and experimental stations in food and agriculture as well as capacity building and technology transfer through over 200 national and regional technical cooperation projects.
4. The General Conference, in resolution GC(66)/RES/9.A.8, requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 66th Regular Session of the General Conference

5. In the field of space breeding, the Agency and the FAO, through the Joint FAO/IAEA Centre, have embarked on a groundbreaking initiative to conduct a feasibility study on seed irradiation in space for induced genetic diversity and to expedite plant mutation breeding. The model plant species *Arabidopsis thaliana* and *Sorghum bicolor* were sent into space for approximately five months, with the aim of generating novel genetic diversity through exposure to the harsh environment in space. This is part of ongoing work at the Agency's Seibersdorf laboratory on the space-returned seeds of *Arabidopsis* and *Sorghum* and part of a CRP focused on the characterization of biological and genomic variations in space-induced mutagenesis of wheat and cotton.



FIG. B.1. Next generation of Arabidopsis plants grown from space-irradiated seeds. (Source: IAEA)

6. The Agency responded to demand from Member States in the Latin America and the Caribbean region to combat the Banana Fusarium Wilt disease Tropical Race 4 (Foc TR4) by launching the interregional technical cooperation project entitled “Strengthening Member State Capacities to Combat Banana Fusarium Wilt (TR4) through Early Detection, New Resistant Varieties, and Integrated Management”. As part of this project, 13 countries from the Latin America and the Caribbean region have received support for the implementation of currently available disease management strategies and banana mutation breeding methods for resistance to Foc TR4.

7. The Agency continues to provide strategic leadership on plant health in global forums. It provided support to the International Plant Protection Convention (IPPC) by sharing technical resources on various aspects of Fusarium TR4 diagnostics, and joint training for national plant protection officers from 15 Common Market for Eastern and Southern Africa (COMESA) countries under the framework of a trade facilitation programme. These efforts have involved the coordination of various sub-activities, facilitated by global phytosanitary experts, to develop essential knowledge products, training materials, and emergency management strategies for addressing the emerging threat of TR4 in Africa.



FIG. B.2. IPPC workshop participants during a capacity development session on diagnostic techniques for Fusarium TR4 conducted at the Plant Breeding and Genetics Laboratories in Seibersdorf. (Source: IAEA)

8. The Agency, through the Joint FAO/IAEA Centre, provided emergency support to Member States in addressing the Avian Influenza A(H5N1) virus, which killed millions of poultry birds and can cause severe disease and death in humans. For the first time, it has been detected in poultry and wild birds in several countries in Central and South America (Bolivia, Chile, Colombia, Costa Rica, Ecuador, Honduras, Panama, Peru and Venezuela). In close coordination with the FAO, the Agency, through the Joint FAO/IAEA Centre, organized an emergency technical response and provided assistance to laboratories in the affected regions to strengthen their capacities in the response to and rapid diagnosis of the disease. Additionally, a series of webinars on avian influenza surveillance, laboratory diagnostics and biosafety were offered in Spanish. Following the recent Highly Pathogenic Avian Influenza (HPAI) outbreak in April–May 2024, the Agency delivered a webinar on HPAI to all VETLAB Network directors and their staff and all Zoonotic Disease Integrated Action (ZODIAC) National Laboratories.

9. At the request of four Member States in Europe (Bosnia and Herzegovina, Croatia, Montenegro and Serbia) affected by sudden and severe outbreaks of African swine fever, the Agency provided emergency support through the provision of early detection tools. The support encompassed the provision of diagnostic kits for rapid detection of the disease before the clinical signs are apparent, kits for characterizing the virus, and kits for speeding up testing and the delivery of results.

10. A training course on the capture and sampling of wildlife including bats, rodents, wild carnivores and wild ruminants was held in Serbia in 2023. Wild animals are important carriers of animal and zoonotic diseases, and often carry pathogens without showing specific clinical signs. It is therefore of

critical importance to understand the epidemiology of the priority diseases in wildlife and design appropriate science-based monitoring and control programmes. During the training courses, a set of teaching videos were produced and will be made available for Member States through the Agency's media channels.

11. The Agency continues to support Member States in their efforts to prevent and control peste des petits ruminants (PPR). In close coordination with the FAO, the Agency, through the Joint FAO/IAEA Centre, has supported Indonesia, a country at high risk of PPR introduction, by providing laboratory testing procedures, reagents and controls for the early detection and confirmation of the disease. A webinar was organized in collaboration with the FAO Office in Indonesia to train laboratory personnel, scientists and animal health officers in the field in the detection, differential diagnosis and surveillance of PPR. The webinar was attended by more than 350 participants from all over this vast country.

12. In collaboration with the FAO's PPR Secretariat, the Agency facilitated four training courses covering the detection and differential diagnosis of PPR and other small ruminants respiratory diseases. These courses were attended by 62 laboratory scientists from 29 African and Asian countries and focused on diagnostics, bioinformatics, and the molecular epidemiology of PPR virus, *mycoplasma capricolum subspecies capripneumoniae*, and capripoxvirus. SOPs for multiplex assays for small ruminants were disseminated to 31 scientists from 30 African and Asian countries during a syndromic testing training course.

13. The Agency supported the creation of pest-free production sites as a pest risk mitigation scheme, which was adopted by the Commission on Phytosanitary Measures and is increasingly being used to facilitate trade. Ecuador, as one of the countries that has benefited from this scheme, increased the number of such sites from 303 in 2018 to 1094 in September 2023. Under the scheme, Ecuador has been exporting non-traditional fruits including pitahaya (dragon fruit), tree tomato and Peruvian groundcherry (commonly known as golden berries or uchuva) to the USA and, more recently, to China and Peru. The possibility for fruit exports using this pest risk mitigation scheme, has been an incentive for the fruit industry that has expanded the production of these non-traditional crops. One of the measures being applied is the area-wide use of the SIT. Sterile flies are imported weekly from the MOSCAMED Programme's mass rearing and sterilization facility in El Pino, Guatemala, and released over the commercial fruit production areas.

14. The Agency engaged in the Montpellier Process, a global effort to reshape food systems. An event in France in March 2024 convened 300 experts from 60 countries, emphasizing transformation in line with the SDGs. Supported by the University of Montpellier and the Consultative Group on International Agricultural Research (CGIAR), the initiative promotes collaborative processes and knowledge sharing to address current challenges and achieve global goals by 2030, emphasizing the transformative impact of collective intelligence and inclusive collaboration in closing the gap between science and policy.

15. During the reporting period, the successful implementation of cosmic ray neutron sensors (CRNSs) on a global scale has begun to revolutionize soil moisture data collection. Integrating this technology with high resolution satellite imagery offers unparalleled insights into soil moisture dynamics, bolstering agricultural practices and facilitating water and soil management endeavours. The wealth of data generated holds immense promise for informed decision making in agriculture. The collaboration with the FAO is actively progressing, aiming to incorporate CRNS data into the FAO's Hand-in-Hand Geospatial Platform.



FIG. B.3. A cosmic ray neutron sensor installed in high Andean Bolivian wetlands to study their role in buffering water in the context of climate change. (Source: Trenton Franz)

B.1. Strengthening the FAO–IAEA Partnership

16. In October 2022, the FAO and the IAEA enhanced their collaboration through the signing of a memorandum of *understanding* (MoU) by the Director-General of the FAO, QU Dongyu, and IAEA Director General Rafael Mariano Grossi to leverage innovative R&D to provide enhanced and effective support for Member States and millions of people. The MoU paves the way for the joint development of a roadmap towards a stronger strategic partnership, including joint resource mobilization and the implementation of activities related to the marine environment, physical and chemical sciences, and human health.

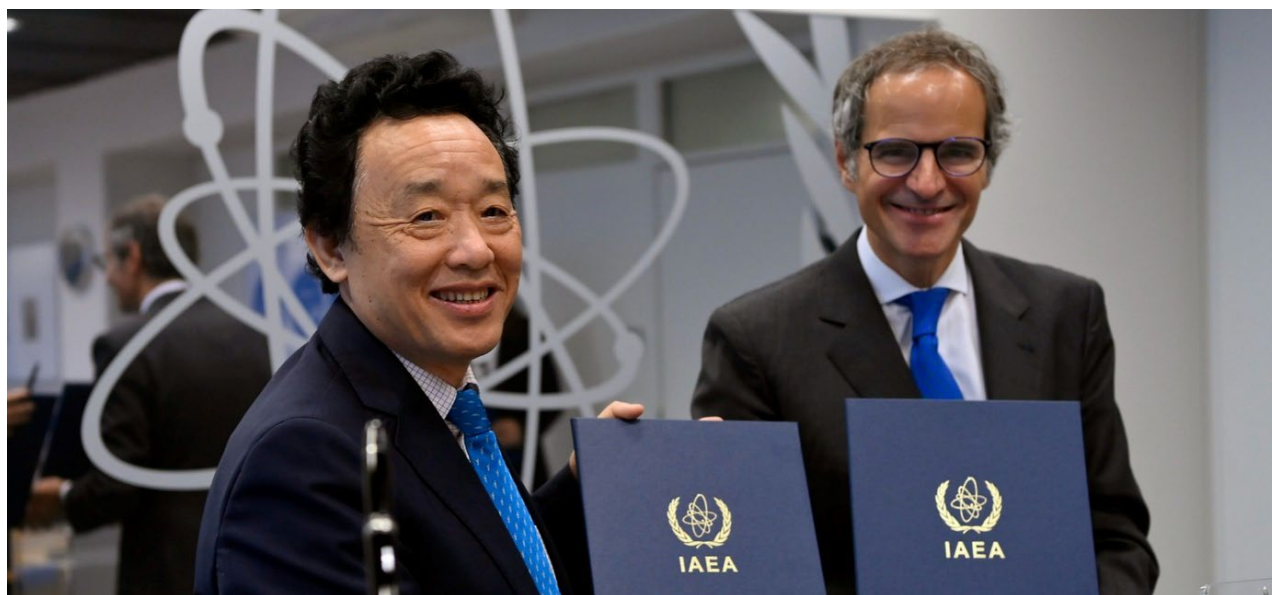


FIG. B.4. IAEA Director General and FAO Director-General sign MoU to scale up collaboration on peaceful nuclear technologies for agrifood systems at IAEA Headquarters in Vienna, Austria, in October 2022. (Source: IAEA)

17. Further, the IAEA and FAO jointly organized a hybrid meeting with the African Groups based in Vienna and Rome, held on 11 May 2023. The meeting demonstrated the importance of the longstanding strategic partnership between the FAO and the Agency in food and agriculture, and showcased their successful cooperation in Africa in various areas. The event was attended by the Director General of the IAEA and the Director-General of the FAO, as well as some 200 delegates and representatives of African countries in Vienna and in Rome, representatives of the African Union, and Permanent Representatives of donor countries.

18. Since May 2023, the FAO and the IAEA, through the Joint FAO/IAEA Centre, have collaborated on the Soil Mapping for Resilient Agrifood Systems (SoilFER) project. This project aims to build national capacity for improving the robustness and accuracy of soil information systems. The implementation period runs for four years, until 2027, in the target countries: Ghana, Guatemala, Honduras, Kenya and Zambia.



FIG. B.5. IAEA Director General at the opening of a hybrid meeting with the African Groups based in Vienna and Rome, held on 11 May 2023. (Source: IAEA)

19. At the World Food Forum in Rome, held from 16 to 20 October 2023, the FAO and the Agency launched the Atoms4Food initiative. Atoms4Food seeks to provide countries with ground-breaking solutions tailored to their specific needs and circumstances by harnessing the advantages of nuclear techniques and other advanced technologies to enhance agricultural and livestock productivity and natural resources management, reduce food losses, ensure food safety, improve nutrition and adapt to the challenges of climate change. The initiative covers six priority action areas, in addition to an Assessment Mission to map the specific needs of countries. The Atoms4Food Initiative Roadmap has been finalized and cleared by the steering committee members.

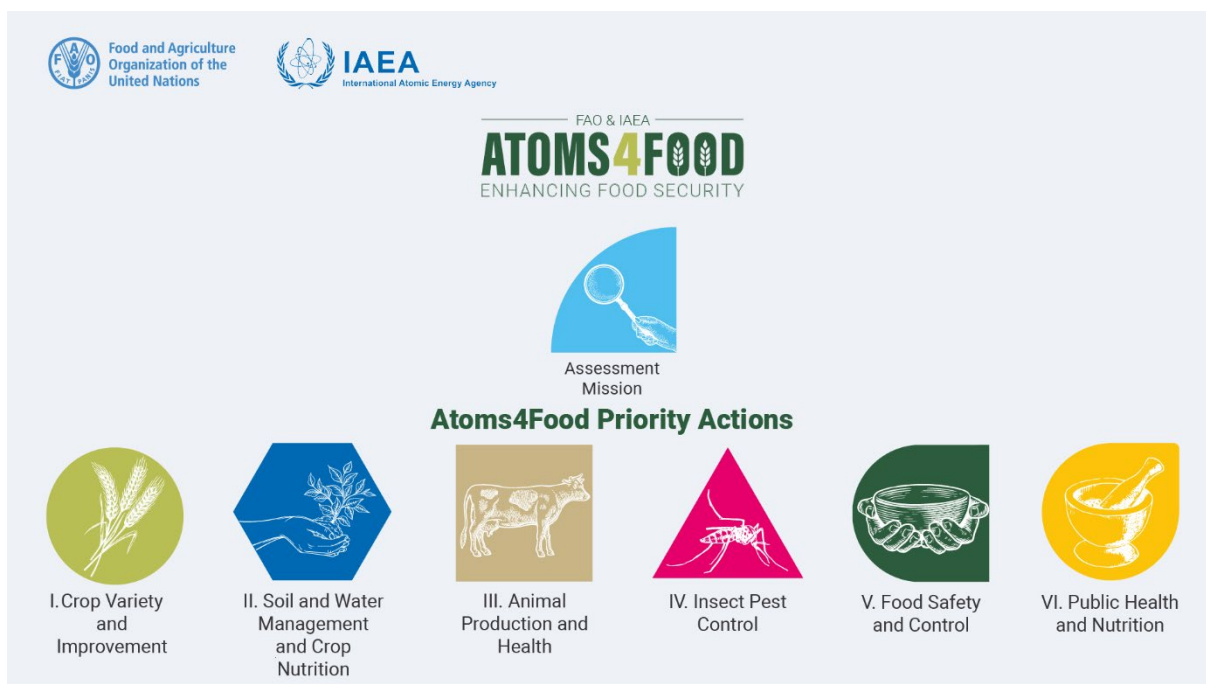


FIG. B.6. The figure shows the six priority action areas of the Atoms4Food Initiative. (Source: IAEA)

20. Partnership and collaboration with traditional and non-traditional partners — including other United Nations agencies, CGIAR, international financial institutions, development agencies, foundations, industry, and national academic and research institutions — are fundamental to the implementation of this initiative.



FIG. B.7. IAEA Director General and FAO Director-General launch Atoms4Food on the sidelines of the World Food Forum in Rome, Italy, on 18 October 2023. (Source: IAEA)

21. At a joint IAEA–FAO high-level event held on 1 December 2023 during COP28, the Director General of the IAEA, together with the Director-General of the FAO, presented the Atoms4Food initiative. The event raised awareness among Member States of the work that FAO and IAEA conduct together on climate change adaptation and mitigation through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture.



FIG. B.8. A joint IAEA–FAO high-level event was held on 1 December 2023 during COP28.

(Source: IAEA)

C. Conclusion

22. The Agency, through the Joint FAO/IAEA Centre, leads the progression and practical application of nuclear and related techniques in the realm of food and agriculture in FAO and IAEA Member States. The overarching objective is to significantly contribute to global food security and foster sustainable agricultural development on a global scale. Since 2022, increased emphasis has been placed on the FAO–IAEA Partnership, demonstrated through a new MoU, the new Atoms4Food flagship initiative and several joint high-level events. Securing extrabudgetary funding for the Joint FAO/IAEA Centre has been at the forefront of this collaboration, as the sharing of the resources under the SoilFER project has shown. PUI projects have complemented the extrabudgetary resources portfolio since September 2022.

Use of Isotope Hydrology for Water Resources Management

A. Background

1. At its 66th regular session in September 2022, the General Conference, through resolution GC(66)/RES/9, requested the Director General, subject to the availability of resources, to continue to further strengthen efforts to fully exploit the potential of isotope and nuclear techniques for water resources development and management in interested countries; to continue to help Member States obtain easy access to isotopic analysis by upgrading selected laboratories; to further strengthen the Isotope Hydrology Laboratory (IHL) at the Agency's Headquarters in Vienna; to expand activities related to the IAEA Water Availability Enhancement (IWAVE) Project and groundwater management; to provide easier access for Member States to noble gas isotopes for the age-dating of groundwater; to provide easier access for Member States to improvements in the analysis of tritium in the hydrological cycle; to strengthen activities which contribute to the understanding of climate and its impact on the water cycle; to contribute to the success of the International Decade for Action, Water for Sustainable Development, 2018-2028; to expand the use of geochemical and isotope tools to enhance hydrological models in mining areas; to expand the use of nitrogen-15 and isotopes for water quality studies and carry out international intercomparison exercises; to strengthen efforts to enhance the coverage of the Agency's global isotope monitoring programmes for precipitation and rivers as well as other water bodies; to consider participating in high-level international conferences related to water resources management including the UN 2023 Water conference; and to continue to develop human resources in isotope hydrology. It further requested the Director General to report on achievements in implementing resolution GC (66)/RES/9 to the Board of Governors and to the General Conference at its 68th (2024) regular session.

2. The General Conference, in resolution GC(66)/RES/9.A.5, requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 66th Regular Session of the General Conference

B.1. Strengthening Isotope Hydrology Activities — Isotope Hydrology Laboratory

3. In 2023, the Agency hosted a Technical Meeting on short-lived radioisotopes that was published as a comprehensive review and led to the development of a method for measuring the cosmogenic, short-lived radionuclide sulphur-35 in natural water samples in the IHL.



FIG. B.1. Testing the collection of water samples for analysis of sulphur-35 to determine short residence times in groundwater. (Source: IAEA)

4. The Agency acquired a laser absorption spectrometer capable of analysing all naturally occurring rare stable isotopes of the water molecule (hydrogen-2, oxygen-18 and oxygen-17) in order to secure its analytical capabilities and upgrade one of the older laser absorption spectrometers. The instrument is equipped with a novel autosampler and will be used primarily for testing and training purposes.
5. The Agency acquired a new liquid scintillation counter for the analysis of ultra-low levels of tritium in water samples. The instrument is equipped with three photomultipliers for enhanced radiation detection efficiency and has a lead heavy shield (weighing 550 kilograms) and an active guard detector for background radiation suppression. The instrument has been widely tested for hydrogen-3 and sulphur-35 analysis in the underground counting facility at IHL with a view to its adoption in Member State laboratories.
6. The Agency developed low-cost, easy-to-operate tritium enrichment units (TEUs) based on polymer electrolytic membrane technologies. The TEUs are used to conduct simpler and faster tritium measurements in groundwater and precipitation samples. Expanded analytical facilities for tritium in natural waters are required for the assessment of groundwater replenishment rates and to facilitate groundwater vulnerability mapping for Member States.
7. The development of an ultra-low-level tritium analysis system, centred on a helium-3 mass spectrometer, has been extended and realized for practical applications in the analysis of organically bound tritium (OBT). This system incorporates an independent OBT sample preprocessing system alongside the established analysis of water samples. Currently, the system routinely operates a vacuum degassing system for helium-3 ingrowth in freeze-dried samples, following the extraction of tissue-free water from fish samples. Simultaneously, an analysis routine that combines traditional combustion

methods for OBT extraction with liquid scintillation counting has been established, allowing for OBT analysis using two independent methods. This configuration allows for independent verification of the OBT concentrations in samples. These techniques are effectively utilized in the verification project associated with the release of Advanced Liquid Processing System-treated water.

8. The Agency published a new method for the collection and preprocessing of gas samples for dating groundwater using radio-krypton. This method features a field gas extraction device and a krypton purification system, both of which were designed and implemented in Agency facilities. The device collects dissolved gases from groundwater that are then processed to isolate and purify trace amounts of krypton for atom trap trace analysis (ATTA). The paper, submitted to the journal *Applied Radiation and Isotopes*, details the set-up and performance of these systems.



FIG. B.2. IAEA Director-General Rafael Mariano Grossi, delivers his opening remarks at the International Symposium on Isotope Hydrology: Sustainable Water Resources in a Changing World, held at the Agency headquarters on 3 July 2023. (Source: IAEA)

B.2. Strengthening Isotope Hydrology Activities

9. Eight isotope hydrology laboratories were equipped with or upgraded their laser spectrometry analysers during the 2022–2024 reporting period. Since the laser technology for stable isotope analyses became available 15 years ago, a total of 116 laboratories in 78 Member States have benefited from the Agency’s support to acquire and operate laser spectroscopy instruments used to measure stable oxygen and hydrogen isotopes in water samples.

10. The Water Isotope Interlaboratory Comparison 2024 proficiency test for water stable isotopes (such as oxygen-18 and hydrogen-2) was conducted on five natural test waters. A record number of 310 laboratories from 91 Member States have enrolled in the proficiency test.

11. As part of the second proficiency test for laboratories analysing stable isotopes of the water molecule in liquid samples from Latin America and the Caribbean using isotope-ratio mass spectrometry and laser absorption spectroscopy, 22 performance reports were sent to participating laboratories in 2023. 82% of the laboratories had satisfactory performance for both deuterium (hydrogen-2) and oxygen-18, indicating that the performance of laboratories had improved with regard to oxygen-18 measurements (54% of the laboratories showed satisfactory performance in 2020). Furthermore, the test revealed that measures taken based on the results of the first proficiency test improved performance by increasing awareness of quality assurance and quality control aspects of laser spectroscopy, and as a result of the distribution of a secondary standard kit developed at the IHL.

12. The results of the Tritium Intercomparison in 2022 have been evaluated, including through the analysis of tritium in test samples. A record number of 84 laboratories worldwide participated in the test. The results showed that approximately 50% of the laboratories produced reliable isotope data suitable for use in water resource investigations; however, around 50% underperformed, reporting “questionable” or “unsatisfactory” results owing to systemic errors, mistakes and poorly performing instrumentation. Several strategies to improve and correct analytical problems were recommended, such as the use of new data evaluation strategies and screening runs for contamination, as well as the inclusion of additional control standards.

13. The first nitrate interlaboratory comparison exercise was conducted in 2022 with the participation of 38 laboratories in 18 countries. Participating laboratories were asked to analyse six water samples containing nitrate with a 30-50‰ range of delta (δ) values. One sample was a blind duplicate to evaluate reproducibility and the effects of d¹⁸O in water. Laboratories used a range of methods to convert nitrate to the analysis gas phase for stable isotopic measurements. The results showed that 79% and 84% produced acceptable d¹⁵N and d¹⁸O results, respectively, falling within 0.8‰ and 1.1‰ of the benchmark values, respectively. The CRP entitled “Isotope Techniques for the Evaluation of Water Sources for Domestic Supply in Urban Areas” was completed in 2023. Fifteen teams from Argentina, Canada, Costa Rica, Ecuador, Ethiopia, India, Italy, Morocco, Nepal, Romania, Slovenia, South Africa, Ukraine, the USA, and Viet Nam used stable water isotopes to assess and manage urban drinking water sources globally.

14. The CRP entitled “Use of Long-lived Radionuclides for Dating Very Old Groundwaters” was completed in 2023. Fourteen teams from Algeria, Argentina, Australia, Brazil, Canada, China, Estonia, Germany, Hungary, India, Japan, Kuwait, Morocco and Tunisia used innovative isotopic techniques, including helium-4 and krypton-81, to determine the ages of ancient groundwater within diverse hydrogeological settings. Significant technical and methodological advancements were made, addressing challenges in sampling and analytical processes. The project’s achievements led to the development of standardized procedures for field sampling and analysis, which were synthesized into an IAEA Technical Document published in 2024.

15. The CRP entitled “Isotope-enabled Models for Improved Estimates of Water Balance in Catchments”, which began in 2018, was completed in 2023. Thirteen teams from Argentina, Australia, Canada, Chad, Costa Rica, Czech Republic, Ecuador, Ethiopia, France, Germany, Japan, Luxembourg and Viet Nam worked together to improve estimates of water balance in catchments using isotope-enabled models. The results of the CRP were published in *Towards Best Practices in Isotope-Enabled Hydrological Modelling Applications* (IAEA-TECDOC-2022) to support modellers and water managers interested in isotope-enabled modelling to address climate change. To continue to support Member States’ adaptation to the impact of climate change on water resources using isotope models, the annual Training Course on Isotope Enabled Water Balance Modelling was developed.

16. The CRP entitled “Isotope Techniques for the Evaluation of Water Sources in Irrigation Systems” was completed in 2024. Fourteen teams from Argentina, Ecuador, Egypt, India, Indonesia, Jordan, Mexico, Nigeria, Pakistan, Romania, Spain, Sri Lanka, Tunisia and Türkiye used environmental isotope techniques for better assessment and mapping of water sources to improve irrigation practices and sustainable water management in irrigated areas. Several scientific papers describing the results and recommendations of the studies conducted were published between 2020 and 2023.

B.2.1. The IWAVE Approach

17. Following the example of an earlier IWAVE pilot initiative (in Costa Rica, Oman and the Philippines), full stage IWAVE workshops and expert missions reported on in previous technical cooperation cycles have been successfully completed through regional and national projects in Africa (Benin, Cameroon, Eswatini, Ghana, Kenya, Mali, Niger, Nigeria, Senegal and Togo) and in the Latin America and the Caribbean region (Argentina, Bolivia, Brazil, Colombia, Ecuador, Mexico, Nicaragua and Paraguay).

18. During the previous biennium, an adapted IWAVE approach tailored to the specific needs and requirements of small island developing States was introduced through regional and national projects in the Caribbean region. Recent IWAVE preparatory studies or expert missions have been conducted in Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica and Haiti. A mid-level IWAVE progress and first workshop has been completed for Grenada, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago.

19. Furthermore, new IWAVE initiatives have commenced in El Salvador and Guatemala for the Latin America region, and in Bangladesh for the Asia and the Pacific region. Mauritania and Sri Lanka have advanced through IWAVE workshops and expert missions to a mid-level stage of the IWAVE process.

20. To address the specific needs of large countries where the water sector has a complex structure, Argentina and Brazil (which have both completed an IWAVE process in previous project periods) are commencing a new IWAVE iteration to consider different aquifers and basins in these countries.

B.3. Expanding Access to Isotope Techniques and Capacity Building

B.3.1. Capacity Development

21. A range of specialized training courses and technical workshops were developed and updated to build Member State capacity and expertise in isotope hydrology. This includes a new foundational level course on conceptual model development for isotope hydrology projects as well as two advanced courses: on isotope-enabled water balance modelling to evaluate water availability in different catchments, and on groundwater vulnerability mapping using AI and machine learning approaches. The Agency continues to transfer all teaching and training materials for virtual and in-person training courses to its e-learning platform.

22. The Agency continues to redevelop the in-person training courses to ensure that they are of benefit to Member State counterparts. Several courses have been divided into an initial virtual component that must be completed before the in-person component can be completed. The virtual components focus on theory, allowing more dedicated time for hands-on practical work during the in-person training courses. A similar approach has been implemented for the regional training courses conducted in Latin America, the Caribbean, Europe and Central Asia, and the development of these training courses in different languages has been organized in conjunction with the Technical Cooperation Programme.



FIG. B.2. Participants learning about isotope hydrology on the regional training course in El Salvador. (Source: Ministry of Environment, El Salvador)

B.3.2. Monitoring Networks

23. During the reporting period, through collaboration with Member State institutions the Global Network of Isotopes in Precipitation (GNIP) was extended with the addition of 72 sampling stations in 31 Member States. Twelve of these institutions (though not necessarily their Member States) are new to the GNIP programme. During the reporting period, 14 additional Member States participated in GNIP; in five of those GNIP samples are being collected for the first time. The total number of GNIP stations surpassed 500 active stations for the first time, with 524 stations in 103 Member States. The GNIP database has surpassed 152 000 records during the reporting period. In late 2023, the first global database of oxygen-17 measurements from GNIP samples taken between 2015 and 2021 was released.

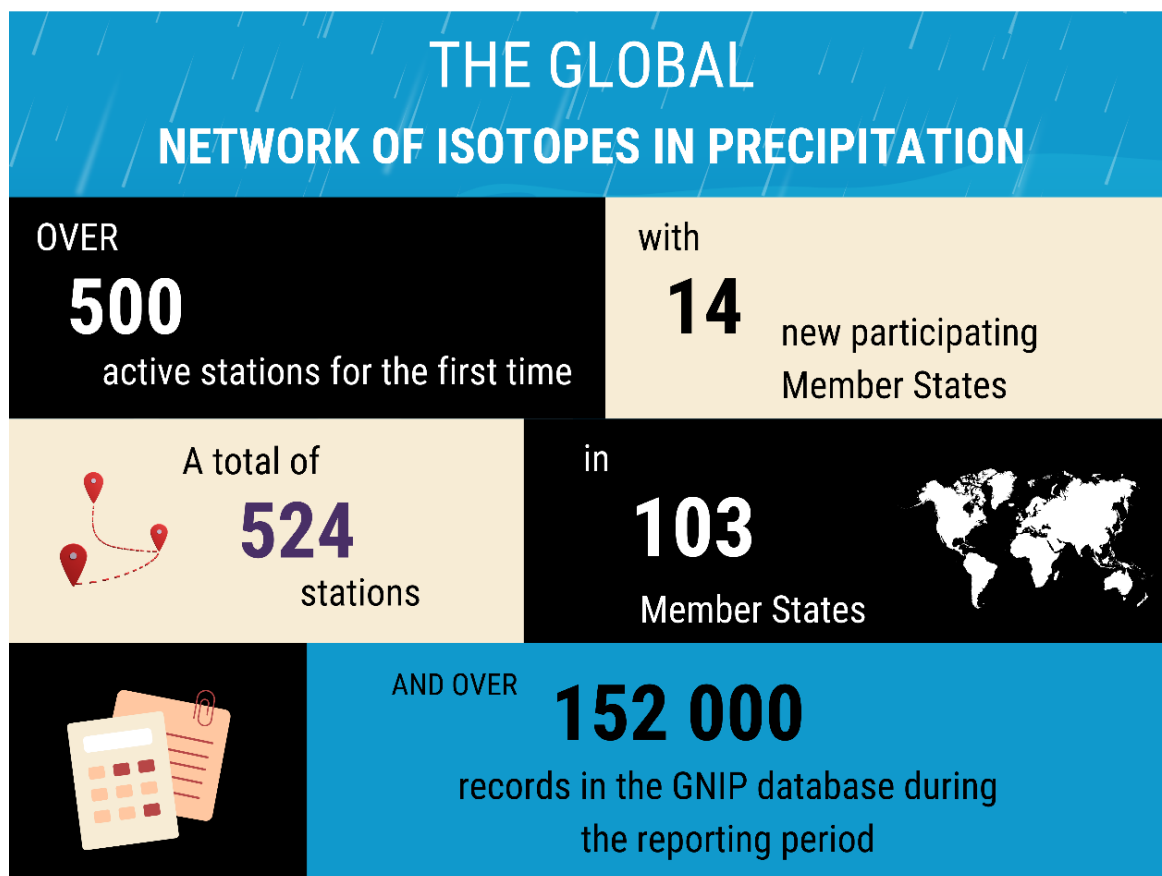


FIG. B.3. The figure shows the status of the Global Network of Isotopes in Precipitation stations
(Source: IAEA)

24. The Global Network of Isotopes in Rivers (GNIR) currently comprises 58 stations in 23 Member States, of which six (in three Member States) were developed during the reporting period. Several monitoring points have had to be discontinued due to difficulties in reaching specific river systems. The six pilot sites incorporating sampling for nitrogen-15 in dissolved nitrate ion have completed their sampling and the data are currently under evaluation, taking into account the different seasonal cycles between the isotopes of the water molecule (hydrogen-2 and oxygen-18) and those of the nitrate ion.

25. At the United Nations 2023 Water Conference, held in New York, USA, in March 2023, the Agency launched a global network to empower countries to develop tailored water management strategies. The Global Water Analysis Laboratory Network (GloWAL Network) provides assistance to Member States in generating data from water samples that can inform national water policies and governance and strengthen water management capacity through training fellowships and staff exchanges.



FIG. B.4. IAEA Director General delivers the opening statement at the GloWAL Network launch event at the United Nations 2023 Water Conference in New York, USA (Source: IAEA)

26. The GloWAL Network held its first coordination meeting between June 18-20, 2024 with 94 participants from 54 Member States and representatives from UNESCO, UNEP, the World Meteorological Organization (WMO), the United Nations Institute for Training and Research (UNITAR), the International Institute for Infrastructural Hydraulic and Environmental Engineering Delft Delft Institute for Water Education, and UNICEF. These agencies presented their water activities and intended interaction with the GloWAL Network. The outcome of the meeting was a set of implementation documents that outline the GloWAL Network's goals and objectives, the long-term strategy for building laboratory capacity, and capacity development needs. The event was attended by 3 international banks, and discussions on resource mobilization to support and build the GloWAL Network are ongoing.

27. To support the implementation of the GloWAL Network, a baseline survey was developed to identify and define the key indicators against which it would be evaluated. The survey is hosted on the International Research Integration System (IRIS) platform and is open to all isotope-enabled laboratories in all Member States. The survey will be repeated every three years to gauge progress.

B.3.3. Agency Contribution to UN Water Activities and the Water Action Agenda

28. The GloWAL Network launched at the United Nations 2023 Water Conference demonstrated the Agency's commitment to the Water Action Agenda. The concept of the network was well received and garnered significant media coverage, including in the United Nations News Daily Wrap, where it was the lead article. The event had high-level support from El Salvador, the Republic of Moldova, Namibia, Niger, Pakistan, Paraguay, Saint Kitts and Nevis, and Tajikistan, as well as the Secretary-General of the WMO.

29. The Agency participated in several events at the United Nations 2023 Water Conference, including a side event on glaciers organized by Tajikistan, at which the Director General delivered a statement at a high-level panel that included the Presidents of Bolivia and Tajikistan, and the King of the Kingdom of the Netherlands. The Agency also delivered statements at a side event on groundwater hosted by the

Republic of Korea and at a UNESCO-led side event on a science-based global water assessment mechanism. The Agency also delivered a plenary statement on its commitment to the Water Action Agenda at the United Nations General Assembly Hall.

30. The Agency continues to participate in UN-Water meetings and directly contributes to the development of the United Nations System-wide Strategy for Water and Sanitation and its implementation plan. The strategy was requested by the United Nations Secretary General in response to the United Nations 2023 Water Conference.

31. The Agency has an advisory role on the Technical Advisory Committee of the World Water Quality Alliance hosted by UNEP and engages with the Global Environment Monitoring System Water Programme (GEMS/Water), also hosted by UNEP. GEMS/Water is the custodian of indicator 6.3.2 (proportion of bodies of water with good ambient water quality) under SDG 6 and is working with the Agency to verify and improve the quality of water data used in the determination of the indicator.

B.4. Climate Change and Water Resources

32. The Agency completed a pilot project to leverage archived precipitation samples from GNIP and perform laboratory analyses for oxygen-17, the rarest naturally occurring oxygen isotope, and oxygen-17 excess (the relationship between oxygen-17 and oxygen-18). These parameters have been identified as potential tracers in the hydrological cycle and link it to carbonate, sulphate or silicate cycles, where they are poised to complement paleoclimate research that studies the triple-oxygen isotope signal encapsulated in ice cores or rock proxies, extending the calibration period of atmospheric circulation models and enhancing their forecasting capabilities. An interpretation of the data and the global spatiotemporal patterns of oxygen-17 and oxygen-17 excess in global precipitation were published in the international journal *Nature Scientific Reports*.

33. Glacierized catchments are at the forefront of climate change, as rising global temperatures have increased the rate at which glaciers are melting and contributed to the reduction in snow cover. These processes have profound implications for groundwater recharge and water resources management across a range of industries. The Agency is working with Member States to understand the implications of glacier retreat. A meeting of cryosphere experts at the Agency recommended that a new CRP entitled “Understanding Hydrological Processes in Glacierized Catchments under Changing Climate using Isotope-Based Methodologies” be initiated. This CRP was approved during 2024 and applications are currently being evaluated.

34. Agency staff, along with counterparts from Costa Rica, Germany and South Africa, have been developing isotope-enabled water balance models that can aid water resource managers in understanding the source of different water components and the sustainability of their supply. The models are open-source and use an AI component to generate the required data sets. The results have been published in the journal *Hydrology Sciences* and a new training course has been developed to train Member State counterparts in using the software and to assist them in generating their own models.

B.4.1. Water Quality

35. The CRP entitled “Global Monitoring of Nitrogen Isotopes in Atmospheric Waters”, implemented by the Agency’s Isotope Hydrology Section between 2018 and 2023, was completed in 2023. Seventeen teams from the Americas and the Caribbean (Brazil, Costa Rica, Cuba and the USA); Europe (Belgium, Estonia, Greece and Italy); Africa (Ghana and Kenya); Asia (China, India, Singapore, Sri Lanka, Thailand and Viet Nam); and Oceania (Australia) worked together to develop the global database and recommendations on spatiotemporal monitoring and analysis of nitrogen isotopes in precipitation as a potential source of nitrogen pollution of water resources. The results of the CRP were published in

Monitoring Stable Nitrogen and Oxygen Isotope Compositions of Nitrate in Atmospheric Precipitation (IAEA-TECDOC-2050) and were presented in master's and doctoral theses.

36. The Agency, together with an international team including UNEP, the WMO, the European Commission's Joint Research Centre and UNITAR published a paper entitled *Innovative solutions for global water quality challenges: insights from a collaborative hackathon event*. The paper is an output of the Workshop Series on Water Quality Monitoring hosted under the banner of the World Water Quality Alliance and coordinated by the WMO, UNEP, UNESCO, WHO as well as the IAEA.

37. The Agency, together with scientists from Switzerland, published a paper on groundwater vulnerability to pollution in the Sahel region of Africa. The paper was published in the high-profile journal *Nature Sustainability* and is the output of a reanalysis of important public data produced in context of the regional technical cooperation project RAF7011 "Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region". The study used tritium data from groundwater to evaluate where it was more vulnerable to surface contamination. The modelling approach can be applied to a range of different environmental contexts and is used to show the importance of low-level tritium in groundwater as a tracer of water quality.

38. A new CRP entitled "Tritium and Noble Gases for Pollution Vulnerability Assessment of Shallow Aquifers" commenced in 2023. Twelve teams from Argentina, Australia, Brazil, Canada, China, Egypt, Greece, India, Switzerland, Tunisia, the USA and Viet Nam are sampling, measuring and interpreting stable and radioactive isotopes present in precipitation, unsaturated zones and groundwater samples (including oxygen-18, deuterium, tritium, helium-3 and other noble gas isotopes and pollutant specific isotopes) to develop an optimal integrated approach to environmental tracers and pollutant specific isotopic signature or concentrations to produce refined vulnerability assessments.

Support to the African Union’s Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC)

A. Background

1. In resolution GC(67)/RES/10/A.2, the General Conference recognized that “tsetse flies and the trypanosomosis [T&T] problem which they cause constitute one of the greatest constraints on the African continent’s socioeconomic development, affecting the health of humans and livestock, limiting sustainable rural development, and thus causing increased poverty and food insecurity”.
2. The General Conference requested “the Agency and other partners to strengthen capacity building in Member States for informed decision making regarding the choice of efficient strategies to control T&T and the cost-effective integration of SIT operations in [area-wide integrated pest management] AW-IPM campaigns”. The General Conference also requested the Secretariat, in cooperation with Member States and other partners, to maintain funding through the Regular Budget and the Technical Cooperation Fund for consistent assistance to operational SIT field projects and to strengthen its support for R&D and technology transfer to African Member States to complement their efforts to create and expand tsetse-free zones.
3. The General Conference, in resolution GC(67)/RES/10.A.2, requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress since the 67th Regular Session of the General Conference

B.1. Strengthening Collaboration with AU-PATTEC

4. The Agency has continued its collaboration with the African Union’s Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) on its goal to eliminate T&T through the creation of sustainable T&T-free areas. The Agency was represented at the 36th General Conference of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC), held in Mombasa, Kenya, in September 2023. The aim of the conference was to discuss sustainable T&T control for socioeconomic development. During the conference, the Agency updated AU-PATTEC members on the activities supported by the Technical Cooperation Programme as well as on R&D activities conducted at the Agency’s Insect Pest Control Laboratory (IPCL) in support of T&T control.

B.2. Capacity Building Through Applied Research and Technical Cooperation

5. The Agency continued to respond to Member States’ requests for support in incorporating the SIT into AW-IPM through regional project RAF5087 “Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (AFRA)” for 2022–2025 to eliminate or control tsetse-transmitted trypanosomosis. The disease is recognized as a major constraint on both livestock and agricultural crop production in sub-Saharan

Africa. The support has included the provision of technical advice; the procurement of equipment and materials; training courses and workshops; fellowships and scientific visits through the relevant technical cooperation projects; and research conducted at the ICPL at the FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf, Austria. In addition, experts from affected Member States continued to participate in the CRP entitled “Improvement of Colony Management in Insect Mass-rearing for Sterile Insect Technique Applications”, which includes a research group on tsetse flies.

6. The Agency’s support strengthened capacities in Member States, enabling them to obtain and analyse baseline data to support informed decision making regarding the choice and feasibility of available T&T suppression or eradication strategies, including the cost-effective integration of SIT operations into AW-IPM campaigns. In that context, the Agency continued providing support through national technical cooperation projects to Burkina Faso, Chad, Ethiopia, Senegal, South Africa, and the United Republic of Tanzania.



FIG. B.1. A PhD student from Burkina Faso setting up the model 812 irradiator to expose the tsetse pupae. (Source: IAEA)

7. The Agency is currently maintaining tsetse strains from seven countries. Research activities at the Agency continued to focus on improving sterile male quality by refining feeding, sterilization, release and quality control protocols and understanding the impact of pathogenic viruses and symbiotic bacteria on the productivity and performance of tsetse colonies.

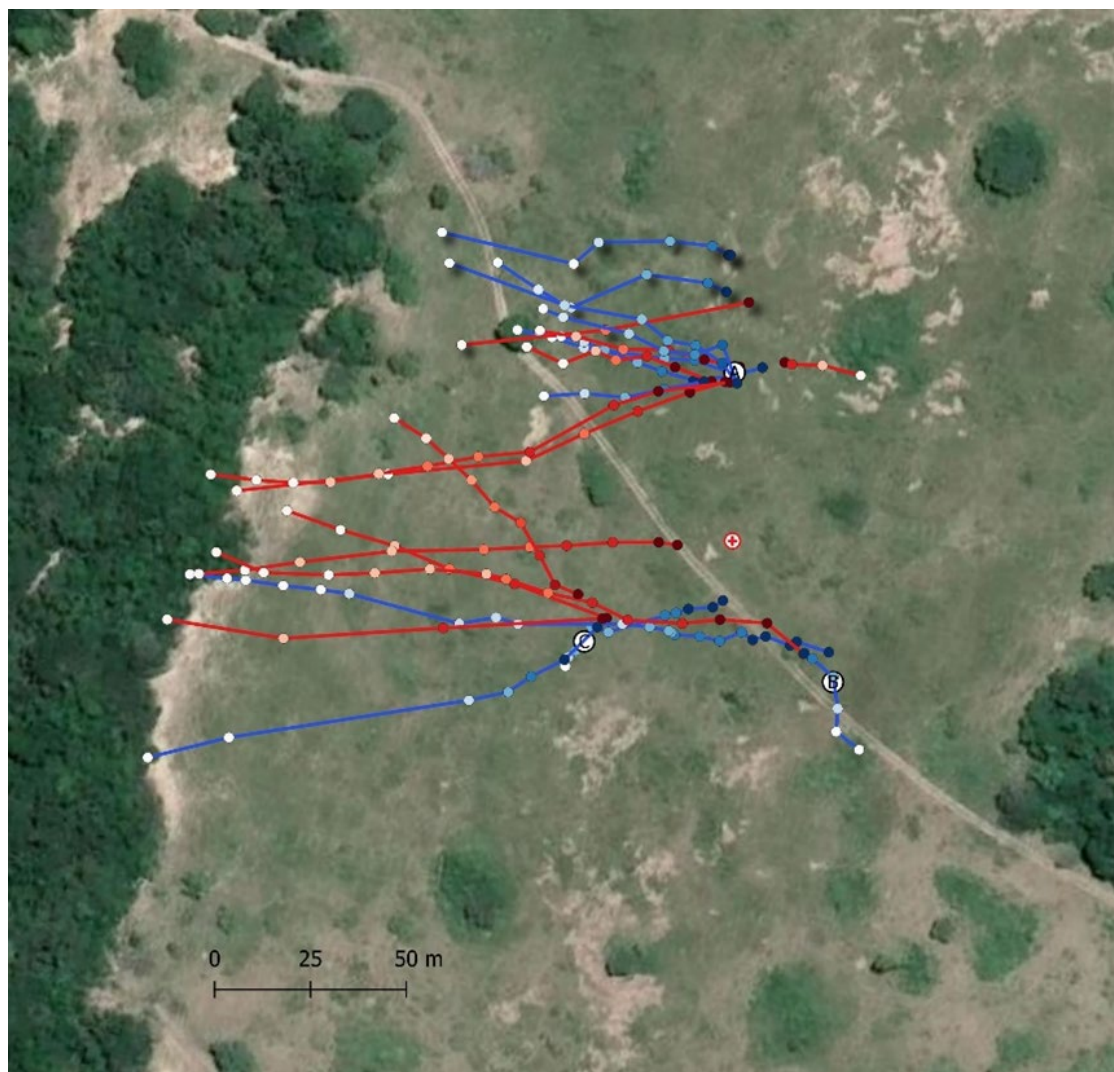
8. Recognizing the increasing challenges associated with using isotopic irradiators for the sterilization of tsetse, the Agency assessed the relative efficiency of X-rays and gamma rays to induce sterility in

male tsetse pupae. The Agency also assessed the major factors impacting dose response and quality of tsetse, including, temperature, atmospheric conditions, and life stage. An off-the-shelf X-ray blood irradiator has been characterized and assessed for its applicability in tsetse sterilization.

9. The Agency, in collaboration with research institutions in Italy and Mozambique, tested a harmonic radar system to follow the flight paths of sterile tsetse males on an individual level for the first time under field conditions. This led to a better understanding of sterile male mobility and dispersal — crucial information which is needed to develop improved sterile male release protocols.



*FIG. B.2 Collecting wild tsetse in Mozambique to be tracked with a harmonic radar system.
(Source: IAEA)*



*FIG. B.3 The harmonic radar shows that tracks of both wild and sterile *Glossina brevipalpis* escape flight paths are similar in an open field trial in Mozambique. (Source: IAEA)*

10. The Agency, in collaboration with universities in Austria and the Netherlands, continued to enhance capacity building in Member States through the training of interns, fellows and doctoral candidates, as evidenced by the graduation of the latter from Burkina Faso (two candidates), Kenya (one candidate) and Senegal (one candidate).

11. The Agency continued supporting the European Commission-funded Horizon 2020 project “Controlling and Progressively Minimizing the Burden of Animal Trypanosomosis” (COMBAT) by making a technical contribution to its external advisory board. As part of this collaboration under COMBAT, the Agency also supported an expert mission to assist the United Republic of Tanzania in developing a national atlas of tsetse flies and African animal trypanosomosis.

12. The Agency supports the Horizon 2020 project “Insect Doctors”, which aims to enhance capacity building in Member States through the training of doctoral candidates in the field of insect pathology to improve the mass production of insects for purposes including the SIT.

13. Advances in knowledge and applicable technologies arising from the above-mentioned research activities are widely disseminated through publications in peer reviewed scientific journals, as well as at conferences.

B.3. Support for the Planning and Implementation of SIT Activities

14. Under the regional technical cooperation project RAF5087 “Enhancing Regional Capacity for the Implementation of the Sterile Insect Technique as a Component for Area-Wide Tsetse and Trypanosomosis Management (AFRA)”, the Agency continued to provide training to support area-wide T&T management programmes to improve livestock productivity and to supply equipment and consumables for field entomological surveillance activities and the operation of mass rearing facilities and molecular biology laboratories in Angola, Burkina Faso, Cameroon, Chad, the Congo, Ethiopia, Ghana, Kenya, Mali, Mozambique, Nigeria, Senegal, South Africa, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe. Capacity building activities also included the implementation of regional training courses to develop knowledge, skills and capabilities in 17 Member States in genetic population studies and the requirements for collecting data to understand the impact of African animal trypanosomosis in the field, with the aim of supporting tsetse intervention programmes.



FIG. B.3. An expert from Cameroon instructing participants of the FAO/IAEA Regional training course on genetic population studies to support tsetse field projects. (Source: IAEA)

15. The regional technical cooperation project RAF5087 supported the attendance of five African Member States (the Congo, Burkina Faso, Mali, the United Republic of Tanzania and Zimbabwe) at the 36th General Conference of the ISCTRC, held in Mombasa, Kenya. Moreover, with the support of this project, a consultancy meeting was organized through the Joint FAO/IAEA Centre to review and update the Thematic Plan for the Development and Application of the Sterile Insect Technique for Tsetse Area-Wide Integrated Pest Management Programmes with the participation of recognized experts from Burkina Faso, France, Kenya, Senegal, South Africa, Zimbabwe and United Republic of Tanzania. At the meeting, special consideration was given to the advantages, constraints, gaps and challenges related

to the implementation of field operational programmes within the SIT component targeting tsetse species. As an outcome of the meeting, a report was produced containing key recommendations from Member States to the Agency to continue supporting the T&T control following the phased conditional approach in an AW-IPM strategy. The Agency supplied materials and equipment to continue enhancing Member States' capacities to combat tsetse flies and the trypanosomosis problem.



FIG. B.4. An expert from the United Republic of Tanzania performing a tsetse mating test in a field cage. (Source: IAEA)

16. Through the Technical Cooperation Programme, the Agency continued to provide technical support to Senegal in its efforts to eradicate *Glossina palpalis gambiensis*, a species of tsetse fly, from the highly productive agricultural region of Niayes, to the north-east of Dakar, using an AW-IPM approach with an SIT component. Analysis of the disease incidence in resident cattle indicates that transmission of animal trypanosomosis has ceased. Senegal continues to import more productive cattle into the area. Extensive tsetse monitoring is currently under way to identify in a timely manner any residual tsetse populations; when such populations are found they will be treated with sterile male releases.

17. In Burkina Faso, the Agency continued to provide technical support to the Insectarium de Bobo-Dioulasso – Campagne d’Eradication de la Mouche Tsé-Tsé et de la Trypanosomose

(IBD-CETT), which resulted in the continued production of sterile males of *Glossina palpalis gambiensis* for release under the SIT project in Senegal.



FIG. B.5. A fellow from Burkina Faso assessing Tsetse reproductive status through dissection.
(Source: IAEA)

18. In Chad, pre-operational activities have continued in the Mandoul area. The Agency continued to provide technical support to Chad to enhance capacity building for tsetse suppression activities in the field.

19. In Chad, Ethiopia, Senegal, South Africa and the United Republic of Tanzania, the Agency continues to provide technical support through fellowships and scientific visits and enhance capacity building by supplying tsetse monitoring and mass rearing equipment.

20. African trypanosomiasis affecting livestock continues to pose a significant constraint on development in much of sub-Saharan Africa, especially rural areas. Where technically feasible, the SIT, as a component of AW-IPM interventions, can be a significant tool for alleviating this constraint. It provides an environmentally friendly option for eradicating tsetse fly vector populations, removing the risk not only of animal trypanosomiasis, but also of human trypanosomiasis (sleeping sickness) where it occurs. The benefits achieved, such as the improved ability to rear livestock for milk, and meat, crop productivity, and the use of animals for transporting and traction can significantly contribute to an increase in the quality of people's lives. The Agency continues to assist in building and enhancing capacities in this area for the benefit of 23 Member States in sub-Saharan Africa.

21. The constraints on successful and more widespread application of SIT in suitable areas continue to be the difficulties of the MSs in securing and mobilizing sustainable funds for targeted AW-IPM programmes because the lack of current socio-economic data to measure the cost-benefit of AW-IPM against tsetse with an SIT component.



*FIG. B.6. The harmonic radar system used in Mozambique to track individual tsetse flight.
(Source: IAEA)*

Renovation of the Agency's Nuclear Applications Laboratories at Seibersdorf

A. Background

1. During the 56th regular session of the General Conference in September 2012, the Director General called for an initiative to modernize and renovate the eight laboratories of the Department of Nuclear Sciences and Applications in Seibersdorf, Austria, to enable them to meet the growing and evolving needs of Member States. The General Conference supported the initiative of the Director General in resolution GC(56)/RES/12.A.5, and the Renovation of the Nuclear Applications Laboratories (ReNuAL) project was officially launched on 1 January 2014. The strategy for the project was issued in May 2014 in documents GOV/INF/2014/11 and GOV/INF/2014/11/Corr.1.

2. ReNuAL Plus (ReNuAL+) was delineated in an addendum to the strategy that was issued in September 2014 (document GOV/INF/2014/11/Add.1) to provide for improvements required by the laboratories that could not be accommodated within the scope of the ReNuAL project. In February 2017, the Secretariat issued document GOV/INF/2017/1, *Renovation of the Nuclear Applications Laboratories (ReNuAL) Project*, which updated Member States on the status of ReNuAL and ReNuAL+ and provided details on the implementation of ReNuAL, the scoping and costing of ReNuAL+, and efforts on resource mobilization.

3. The combined ReNuAL/ReNuAL+ phase of the initiative delivered new laboratory buildings to house four of the eight nuclear applications laboratories in Seibersdorf and provided a new linear accelerator facility for the Agency's Dosimetry Laboratory. It was expected that the four remaining laboratories would be expanded, and core infrastructure enhanced in the existing buildings once the other laboratories then sharing those facilities moved into their new space. However, in early March 2020, an assessment by external experts concluded that the full renovation of the existing 60-year-old laboratory building, intended to make the laboratories 'fit for purpose' to support Member State requirements, would likely take longer, cost more and result in lower-quality laboratory space than the construction of a new building to house three of the laboratories (the Terrestrial Environmental Radiochemistry Laboratory, the Plant Breeding and Genetics Laboratory, and the Nuclear Science and Instrumentation Laboratory). The ReNuAL project management team determined the conclusions of the experts to be appropriate and concurred that a new building was the most suitable option for enhancing the three laboratories.

4. In that context, at the March 2020 meetings of the Board of Governors, the Director General announced plans to build a second new Flexible Modular Laboratory (FML2) to house the three above-mentioned laboratories. The Dosimetry Laboratory would be refurbished as originally planned in its current location adjacent to its new linear accelerator facility. Ageing greenhouses, on which the work of three laboratories heavily depends, will also be replaced. The Director General provided information on the resources required and further elaborated planning for this final phase of the project, known as 'ReNuAL2', during a technical briefing on 3 September 2020. On 6 September 2022, the Deputy Director General for Nuclear Sciences and Applications provided an informal technical briefing to Member States to present the revised ReNuAL2 project cost projections and timelines based on the rapidly escalating prices and supply chain challenges encountered in the bidding process for construction of FML2, the greenhouse foundations and the Dosimetry Laboratory refurbishment. The Deputy Director General provided data to show that, notwithstanding extensive value engineering and other

measures undertaken to hold down project costs, the total cost of the ReNuAL2 phase could rise to €41 million or more. The successful conclusion of this final project phase will enable the nuclear applications laboratories to respond to the growing and evolving needs of Member States and assist their efforts to achieve the SDGs.

5. The General Conference, in resolution GC(67)/RES/10.A.3, requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

B.1. Implementation Status

6. Separate tender processes for procurement of the outfitting of the new laboratories building and the new laboratory greenhouses (apart from their foundation, which is provided for under the FML2 laboratories building contract) were concluded with the signing of contracts in August and October 2023, respectively. These were the last two major construction contracts expected to be required under ReNuAL2.

7. Construction of FML2, begun in the first quarter of 2023, has progressed steadily. By October 2023, the building's frame was complete and its highest point reached. Work on the building's exterior and interior is ongoing, with major construction expected to be completed by September 2024. Internal outfitting of the laboratories building began in May 2024 and is expected to be completed in August 2024. The building is projected to be ready for commissioning by the end of 2024. Work on the Dosimetry Laboratory was completed in May, and the refurbished facility is expected to become fully operational in July 2024. Construction of the new laboratory greenhouses began at the end of April 2024 and is projected to be completed by the end of 2024. The nuclear applications laboratories will move into and become fully operational in the new laboratories building and greenhouses in the course of 2025, marking the conclusion of the ReNuAL2 project.



FIG. B.1. Works on the FML2 façade and roof insulation, September 2023. (Source: IAEA)



FIG. B.2. Exterior view of FML2, March 2024. (Source: IAEA)



FIG. B.3. Dosimetry Laboratory refurbishment works, March 2024. (Source: IAEA)



FIG. B.4. Completed greenhouses foundation, July 2024. (Source: IAEA)

B.2. Financial Status and Resource Mobilization

B.2.1. Financial Status

8. Over €39 million in extrabudgetary funds were raised for ReNuAL and ReNuAL+, with financial and in-kind contributions received from 42 Member States and additional financial and in-kind support received from non-traditional donors. The combined ReNuAL/ReNuAL+ project target budget of €57.8 million was exceeded by approximately €590 000, which was ultimately made available to the ReNuAL2 project in addition to €9.7 million from this project budget that was initially designated to address the requirements of the four remaining laboratories in the ReNuAL2 project phase. The ReNuAL2 phase includes the ongoing construction of a new laboratories building (FML2), construction of new greenhouses and refurbishment of the Dosimetry Laboratory.

9. Preliminary cost estimates totalling €34.5 million for the final phase of laboratory modernization were provided to Member States in the Director General's technical briefing in September 2020. With €9.7 million initially made available from the ReNuAL/ReNuAL+ budget to address the needs of these laboratories, the Director General requested Member State support to raise the remaining €24.8 million. As of the beginning of the third quarter of 2024, the estimated total budget was €44.96 million, which includes cost elements identified as required to complete the project but not previously included in the project budget, such as laboratory transition, information technology infrastructure, photovoltaic and project energy costs.

10. Following the conclusion of contracting for all major project elements in October 2023, at the November 2023 meetings of the Board of Governors, the Director General highlighted the completion of major fundraising for ReNuAL2, while indicating that contributions to cover some smaller expenses were still needed and welcome through to March 2024. On 19 March 2024, the Deputy Director General for Nuclear Sciences and Applications provided Member States with a comprehensive project update in the context of a Friends of ReNuAL briefing, co-chaired by Germany and South Africa. Member States were informed that, while the completion of all major contracting reduced the risk of any further significant budget increase, the current cost projection for major project elements stood at €43.2 million, reflecting the high rate of inflation and construction market pressures that existed throughout the ReNuAL2 tendering process that concluded in October 2023. The current total estimated cost of the ReNuAL2 project includes €1.76 million in costs to complete the project, that were not previously included in the project budget. The Agency informed at the briefing that further extrabudgetary contributions to ReNuAL2 were no longer required.

11. As of the beginning of the third quarter of 2024, 38 Member States, one international organization, one private sector donor and two individuals had announced extrabudgetary contributions for the ReNuAL2 phase, totalling over €29 million. An additional €5.9 million in funding was provided from the Major Capital Investment Fund.

B.2.2. Funding Priorities

12. With major ReNuAL2 project elements all under contract and funded, the main remaining budget uncertainty involves additional costs to complete the project, which will only be known upon or nearer to project completion in 2025. Identified funding is expected to be sufficient for these additional costs.

B.2.3. Resource Mobilization Strategy

13. The Secretariat has pursued an element-specific resource mobilization strategy that seeks resources from Member States and non-traditional donors based on existing and estimated funding requirements. In support of this strategy, new and targeted resource mobilization products have been developed to

highlight the importance of the timely completion of laboratory modernization and the relevance of individual project elements to meeting Member States' demands for training, applied research and services. Tailored donor packages include comprehensive information on the remaining elements of the project and their funding requirements. Resource mobilization products have been continually updated to account for progress in completing specific project elements, any changes in expected costs, and expected resource requirements.

14. Laboratory tours remain invaluable to highlight the important work of the laboratories and have played an essential role in fundraising efforts. The number of laboratory visits continues to increase following a sharp but temporary decrease at the height of the COVID-19 pandemic. The Secretariat continues to develop and expand access to online resources, including virtual laboratory tours, as an additional means of highlighting the important work of the laboratories and the need to complete their modernization. Special events organized by the Secretariat, including side events at the March 2024 meetings of the Board of Governors, provided valuable additional support to resource mobilization efforts. A centrepiece of these events is a donor display on which new contributors to ReNuAL2 are recognized with a plaque. The donor display will be permanently installed in the lobby of the new laboratories building upon its completion.

B.2.4. Resource Mobilization Efforts with Member States

15. Throughout the ReNuAL initiative, the Secretariat has continually engaged in bilateral discussions with a large number of Member States to support fundraising, resulting in 42 Member States providing financial contributions towards the ReNuAL and ReNuAL+ phases of the initiative and 38 Member States announcing contributions to the ReNuAL2 phase. (A total of 52 Member States have contributed to one or both phases of the ReNuAL initiative.) Six Member States were honoured at the final ReNuAL2 donor recognition side event on the margins of the March 2024 meetings of the Board of Governors for contributions made subsequent to the 67th session of the General Conference, including by four first-time ReNuAL2 contributors (Brazil, Canada, Czech Republic and France) and two repeat donors (Ireland and the USA). The Friends of ReNuAL, an informal group open to all Member States and co-chaired by Germany and South Africa, continued to play an important role in resource mobilization. Participants in the group, which meets on a regular basis, have been significant bilateral contributors to the ReNuAL initiative, and the group remains an important vehicle for maintaining and increasing awareness of the importance of laboratory modernization and for generating Member State support for these efforts.



FIG. B.5. ReNuAL2 Side Event on the margins of the March Board of Governors Meeting held at the IAEA headquarters in Vienna, Austria. 5 March 2024 with IAEA Director General and Member State representatives. (Source: IAEA)

B.2.5. Resource Mobilization Efforts with Non-Traditional Donors

16. The ReNuAL Initiative has enjoyed success in securing support from non-traditional donors, particularly during the first phase, aligning the initiative with the guidance in the Agency’s 2012–2017 Medium Term Strategy calling on the Agency to “be more innovative in finding and justifying additional sources of funds”. Apart from Member States, the project received financial contributions in the ReNuAL2 phase from two private individuals, one international organization and one private sector donor.

C. Next Steps

17. With resource mobilization complete, focus for the remainder of the project will continue to be on the successful implementation of construction works and the handover and transition of the new facilities to their end users. These steps are expected to be completed for all new facilities in late 2024 and 2025, marking the end of the ReNuAL2 project.

Zoonotic Disease Integrated Action (ZODIAC) Project

A. Background

1. In resolution GC(67)/RES/10.A.4., the General Conference took note of the Director General's report as contained in document GOV/2023/34-GC(67)/11 submitted to the Board of Governors.
2. The General Conference recognized that the Agency has a longstanding practice of cooperation with other relevant international organizations and specialized agencies, and further recognized the importance of complementing the respective mandates of such organizations, as well as longstanding protocols that guide cooperation such as Taking a Multisectoral, One-Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries (the Tripartite Zoonoses Guide).
3. The General Conference noted that zoonotic diseases such as "COVID-19 and vector-borne diseases including malaria, yellow fever, chikungunya, and dengue, continue to have significant short-and long-term implications on human health and the socioeconomic development of Member States."
4. The General Conference recognized the importance of nuclear science, technology, and applications to detect, trace and control emerging pathogens that could develop into diseases and pandemics and further recognized the importance of making these technologies available to all Member States.
5. The General Conference noted that "ZODIAC could support Member States to enhance their preparedness to address emerging and re-emerging zoonotic diseases, through the use of molecular derived methods, including molecular biology, by enhancing capacity in Member States to detect, trace and respond to emerging pathogens that could develop into zoonotic diseases and pandemics."
6. The General Conference welcomed that ZODIAC builds upon existing, relevant Agency nuclear science and technology applications and structures, such as the VETLAB Network, and other delivery mechanisms such as CRPs and the Technical Cooperation Programme under TC project INT5157, and that they form part of the Agency's support to Member States in combating zoonotic diseases and preventing future pandemics.
7. The General Conference took note of the first meeting of the ZODIAC Ad-Hoc Scientific Panel, which was held in January 2023.
8. The General Conference, in resolution GC(67)/RES/10.A.4, requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its 68th (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

9. The Agency continued to respond to the needs and priorities of Member States by implementing all of its programmatic activities related to zoonotic diseases, pursuing its adaptive R&D activities in the field of animal health at its Animal Production and Health Laboratory (APHL) in Seibersdorf, coordinating the VETLAB Network, and supporting Member States in the context of animal health through relevant national and regional TC projects.

10. Among other R&D activities relevant to transboundary animal diseases and zoonoses, the Agency continued working, through CRPs and research in the APHL in Seibersdorf, on the improvement of diagnostic and vaccine tools for emerging and re-emerging animal health threats, notably genotype I African swine fever virus. The Agency also continued testing three key serological detection approaches for transboundary animal diseases and zoonoses: enzyme-linked immunosorbent assay (ELISA) for wider veterinary laboratory adoption, Luminex-based multiplex assays for the simultaneous detection of antibodies against multiple pathogens, and species-independent serology using luciferase immunoprecipitation systems (LIPS).

11. To minimize the risk of future epidemics and pandemics, effective disease surveillance at the wildlife–livestock–human interface is essential. Tools such as viral family-based screening tools can accelerate the detection of novel pathogens before they spread. When combined with portable and cost-effective sequencing tools, they establish a capacity for pathogen discovery and enhance disease surveillance in hotspots. In 2023, the Agency also developed viral family-based screening of zoonotic pathogens tools, targeting syndromic surveillance or specific animal or vector species surveillance.

12. The activities and timetable originally foreseen under ZODIAC at the time of its inception have changed due the use of virtual tools during its first years and funds being made available. The Secretariat is finalizing a ZODIAC Project Initiation Document that will lead to an update of the ZODIAC workplan on the basis of the above. The ZODIAC portal continues to be updated with activities and relevant information and has had a community of around 300 regular users in the past year.

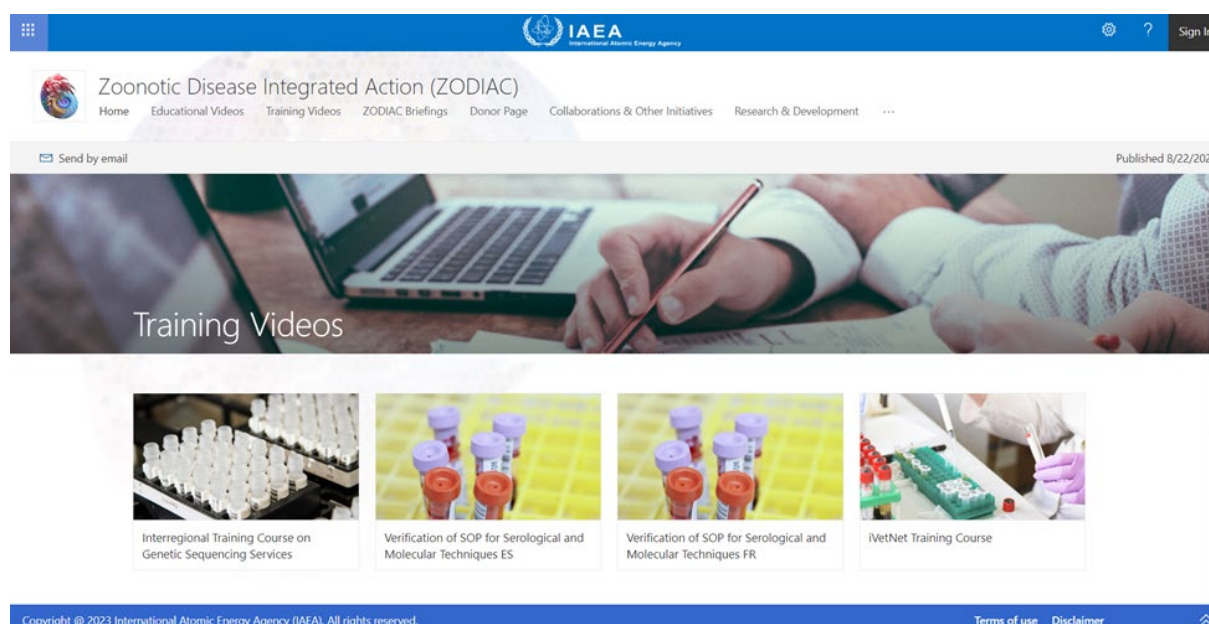


FIG. B.1. The ZODIAC Portal – The module with the training video materials produced under ZODIAC. (Source: IAEA)

13. Strengthening partnership with other organizations with complementary mandates continues to be a priority. Agency staff continued to be invited to participate in Joint External Evaluations (JEEs) organized by the WHO under One Health. Since September 2023, Agency staff have led two JEEs in Sri Lanka and Indonesia. The WHO regularly consults with the Agency on a variety of issues, including strategic discussions regarding strengthening the JEE country assessment process. JEEs continue to raise the profile of ZODIAC and help ensure that the Agency's work under ZODIAC is integrated into the global pandemic preparedness landscape.

14. The FAO's Emergency Management Centre for Animal Health (EMC-AH) requested Agency assistance when it deployed a team to Senegal from 4 to 12 March 2024, following an official request from the Government of Senegal on 29 February 2024. The purpose of the mission was to support the country's response to the control of screw worm. One of the Agency's primary roles was to confirm the identification of insect species through molecular biology methods used under ZODIAC. Several follow-up activities are under way, including the provision of Agency inputs to the EMC-AH Strategic Plan. The Agency also participated in the General Assembly of PREZODE in November 2023.

15. Building capacity through R&D in Member States remains an integral part of ZODIAC. Under Pillar 2, the first CRP under ZODIAC (CRP ZODIAC-ASIA) launched in 2023 with funding from the Republic of Korea, aimed at enhancing laboratory preparedness for the detection and control of emerging and re-emerging zoonotic diseases in Asia and the Pacific with participants from Cambodia, China, Indonesia, Italy, Japan, the Republic of Korea, Mongolia, Thailand, and Viet Nam. The First Research Coordination Meeting under this CRP took place in the Republic of Korea from 11 to 15 December 2023 and focused on reviewing work plans, aligning activities, expanding scope and establishing a robust research network. R&D on zoonotic diseases is ongoing and includes the development of assays for the detection of zoonotic respiratory viruses and endemic zoonoses.

16. Five research contract holders under the CRP have adopted the viral family-based approach developed within the project for screening animal and environmental samples as part of their research plans. This assay, which utilizes multiplex polymerase chain reaction and nanopore sequencing, was successfully validated using 119 clinical samples from diverse hosts and has been implemented in Senegal. Two species-independent serology tests developed within the project have proven effective in

detecting antibodies from a range of variants, including the SARS-CoV-2 variants alpha, beta, delta, and omicron (SARS-CoV-2 LIPS), as well as anti-lyssavirus antibodies in multiple animal species (PanLyssavirus LIPS).

17. New next-generation sequencing (NGS) procedures for whole genome sequencing and metagenomics analysis were established. Bioinformatics pipelines were developed, facilitating the genomic sequencing of the pathogens that cause rabies, influenza, Rift Valley fever, brucellosis and Q fever. They also facilitated the discovery of Pteropine orthoreovirus in bat samples from Indonesia, an emerging bat-borne virus that has been linked to cases of acute respiratory infection in humans. Information generation through R&D have been disseminated to Member States and published in peer reviewed journals. Four peer reviewed publications were produced, including one on syndromic testing of zoonotic abortifacient agents in ruminants and three on next generation sequencing procedures.



FIG. B.2. First Research Coordination Meeting for the ZODIAC-ASIA CRP. (Source: IAEA)

18. R&D on the human impact of zoonoses continued under ZODIAC. Under Pillar 4, ZODIAC focuses on the implementation of cloud-based solutions to enhance data processing, data analysis and collaboration for the improved detection and characterization of zoonotic pathogens. To that end, the CRP under Pillar 4 — “The ZODIAC Respiratory Disease Phenotype Observatory: an IAEA International Cooperative Study for Early Detection of New Pandemics (The IAEA CT Artificial Intelligence-Cooperative Study-ICAI Project)” — has developed the Observatory’s cloud-based server platform. Two of the research institutions participating in the project have conducted tests of the platform with the University of Vienna. Following this, the uploading of curated data will commence.

19. To further support Pillar 4, the Agency organized a consultancy meeting on the ethics, use and governance of AI in medical imaging, which was held in Vienna in April 2024. Four global experts from three Member States, together with representatives from the International Computing Centre, the ITU and the Agency, examined the current landscape of the use of AI within medical imaging. The identified best practices for effective governance frameworks will inform the development of ethical guidelines that will be made available to Member States.

20. After a steady increase in Member State participation during the first years of ZODIAC, the level of participation is, as expected, stabilizing. As of June 2024, 150 Member States had designated a

ZODIAC National Coordinator and 128 had designated a ZODIAC National Laboratory (ZNL), one more than in June 2023.



FIG. B.3. A figure showing the distribution of Member States that have officially nominated ZODIAC National Coordinators and Laboratories (Source: IAEA)

21. Equipping ZNLs remains a priority. Since September 2023, under Pillar 1 (through technical cooperation project INT5157) and using extrabudgetary contributions from three Member States, serology and molecular diagnostic equipment was procured for five laboratories in the Congo and Peru; serology or molecular diagnostic equipment was procured for six ZNLs in Chile, Mexico, Nepal, Panama, Paraguay and Viet Nam; and molecular diagnostic equipment was provided to the ZNL in Ukraine. Equipment for three more ZNLs will be procured once the recipient Member States have been identified and validated with the donor country.

22. Ensuring that the staff of ZNLs receive relevant training is paramount to the long-term sustainability of ZODIAC results. Under Pillar 1 (INT5157), the Agency trained staff from five ZNLs in viral family-based surveillance of zoonotic pathogens. In addition, over 40 scientists received training and SOPs for multiparametric detection of pathogens and next generation sequencing (ngs) bioinformatics and molecular phylogeny, enhancing their capabilities in rapid and early detection and surveillance of zoonotic diseases. The second group fellowship trainings in whole genome sequencing for the MiSeq platform (for fellows from Botswana and Thailand) and for the GeneStudio S5 platform (for fellows from Brazil) are currently being delivered. The organization of the third group fellowships to train staff at ZNLs in Argentina, Croatia and Portugal in the MiSeq platform is being finalized with Morocco.

23. After conducting an assessment of the biorisk management situation in over 130 ZNLs and other veterinary laboratories around the world between May 2022 and April 2023, the main gaps in biosafety and biosecurity were identified, making it possible to determine the priority procedures to be developed for biorisk management. These procedures are currently being developed by a group of international experts in biosafety and biosecurity. A manual of biorisk management will include these practical procedures for biorisk management and will serve as the teaching material for future virtual and hands-on training courses.

24. A generic SOP for verifying serological and molecular protocols was developed as the outcome of two virtual interregional training courses held in February 2022. The interest of ZNLs (approximately 600 participants from 94 Member States attended the courses) triggered the development of the SOP, which became the teaching material for the related, ongoing in-person training courses. The generic SOP is currently being peer reviewed by five experts from reference laboratories and will be published as a peer reviewed scientific article and made available to all ZNLs. The fifth planned in-person training course on generic verification of SOPs for serology and molecular diagnostics in ZNLs is currently being organized for English-speaking ZNLs in Africa and will be held in Ethiopia in September 2024. After this training, one staff member from each officially designated ZNL will be given the opportunity to train in serology and molecular diagnostics.

25. The workflow of whole genome sequencing and related bioinformatics for bacterial and viral pathogens is being developed with the support of international experts. Similarly, the extensive workflow for developing secondary standard reference materials for zoonotic disease detection and identification is being developed with the support of international experts. These workflows will be used as the teaching material for future virtual and hands-on training courses under the Technical Cooperation Programme.

26. Ensuring that ZNLs have access to an IT platform based upon iVETNet remains a priority. Under Pillar 3, the Secretariat has initiated the development of the essential modules of ZODIAC. Visualization and background data storage packages were developed for, inter alia: metadata connectivity and relationships; animal census per country (upload and visualization); an annual monitoring/control plan for animal health; a submission letter from the field to the laboratories (which is critical for the automatic upload of metadata needed for epidemiological analysis of the results); the upload of samples in the laboratories; an overview of the implementation of the national monitoring plan with the number of samples expected, collected and tested, and their status; and a visualization of outbreak management with filtering and basic statistical analysis of the animal populations present in the affected regions.

27. The availability of extrabudgetary funds to proceed with the implementation of ZODIAC is critical. As per June 2024, the Agency has mobilized a total of €14 million for 15 Member States. All funds contributed to ZODIAC have been allocated or disbursed. The implementation of ZODIAC will continue as planned as extrabudgetary contributions become available. In an effort to ensure that funding is identified to implement ZODIAC activities at Member State level, the Agency is in the process of developing an application to become an Implementing Entity for the World Bank's Pandemic Fund. The Pandemic Fund is a funding mechanism to strengthen critical pandemic prevention, preparedness and response capabilities in LMICs.



FIG. B.4. IAEA Director General presents the annual report of the IAEA to the UN General Assembly including progress on ZODIAC, NUTEC Plastics and Rays of Hope. (Photo: L. Felipe/UN)

Nuclear Power Applications

Introduction

A. Background

1. In resolution GC(67)/RES/10.B.1, the General Conference affirmed the importance of the role of the Agency in facilitating the development and use of nuclear energy for peaceful purposes, in fostering international cooperation among interested Member States, and in disseminating well-balanced information on nuclear energy to the public.
2. The General Conference requested the Director General to keep Member States informed on the progress of the implementation of the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP) and the Lise Meitner Programme (LMP).
3. The General Conference encouraged the Agency to continue its support to interested Member States in building their national capacities in the operation of nuclear power plants (NPPs) and their nuclear power infrastructure when embarking on new nuclear power programmes. It encouraged the Secretariat to support initiatives in the areas of knowledge management, including capacity building activities for senior management and the development of e-learning materials, and to facilitate participation in regional Nuclear Energy Management Schools (NEM Schools) for qualified students, in particular those from developing countries through regional funding or cooperation mechanisms. It also encouraged the Agency to maintain and strengthen the assistance and peer review and advisory services provided to Member States embarking on a nuclear power programme or expanding such programmes, including the coordination and integration of such services.
4. The General Conference commended the Secretariat's efforts in providing comprehensive information on nuclear energy's potential as a low carbon energy source and its potential to contribute to mitigating climate change, during the COP28 conference in Dubai, United Arab Emirates (UAE), and encouraged the Secretariat to continue these efforts in its preparations for COP29, to be held in November 2024 in Baku. The General Conference also noted the launch by the Secretariat of the Atoms4NetZero initiative and requested the Secretariat to keep Member State informed on its progress.
5. The General Conference acknowledged the importance of the Agency's TC projects for assisting Member States in energy analysis and planning, including to develop pathways towards net zero emissions through energy system modelling, and in establishing the infrastructure required for the safe, secure and efficient introduction and use of nuclear power.
6. The General Conference also encouraged the Secretariat to continue to enhance interested Member States' understanding of funding requirements for nuclear power infrastructure and potential approaches to financing nuclear power programmes, including management of radioactive waste and spent fuel.

7. The General Conference encouraged the Secretariat to analyse the technical and economic cost drivers for economic sustainability of nuclear power operation, especially with regard to decisions of Member States concerning the long term operation of NPPs, to determine the value of nuclear power in the energy mix considering environmental conditions and, inter alia, climate objectives.
8. The General Conference stressed the importance, when planning, deploying, or decommissioning nuclear energy facilities, including NPPs and related fuel cycle activities, of ensuring the highest standards of safety and emergency preparedness and response (EPR), security, non-proliferation, and environmental protection, of being informed of the best available technologies and practices, of continuously exchanging information on R&D addressing safety issues, of strengthening long term research programmes to learn about severe accidents and related decommissioning activities, and of enabling continuous improvement in this regard, and valued the Agency's role in fostering exchange of expertise and discussions within the international nuclear community on such issues.
9. The General Conference also welcomed the continuation of the PUI and all contributions announced by Member States or regional groups of States and encouraged Member States and groups of States in a position to do so to contribute to it, including through in-kind contributions.
10. The General Conference encouraged the Secretariat to finalize the establishment of the Technical Working Group on Nuclear Fuel Cycle Facilities, which would include ageing and upgrade challenges.
11. The General Conference encouraged the Secretariat to streamline, harmonize and improve peer review and advisory services based on Member States' needs, including through the Advisory and Peer Review Services Committee (APReSC).
12. The General Conference, in resolution GC(67)/RES10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

13. The Agency and Belgium organized the first Nuclear Energy Summit, held in Brussels in March 2024. Attended by world leaders from more than 30 countries and the European Union, the event highlighted the role of nuclear energy in addressing the global challenges to reduce the use of fossil fuels, enhance energy security and boost economic development. Statements from Heads of State and other high-level national representatives highlighted the status of nuclear in their countries and listed important factors in meeting deadlines for the clean energy transition, including technology neutral approaches, such as laws and regulations that do not favour one clean energy source over another.



Fig. B.1. IAEA Director General Rafael Mariano Grossi delivers his remarks at the opening of the Nuclear Energy Summit: Powering Tomorrow, Today, held in Brussels on 21 March 2024.

(Source: IAEA)

14. The 18th annual Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure, held in Vienna in March 2024, was attended by 80 participants representing 39 Member States and international organizations. The meeting continued to be the main forum for representatives from countries expanding, introducing or considering a new nuclear power programme to provide updates on their progress, share good practices and offer lessons learned from implementing the IAEA's Milestones Approach to establish the infrastructure required for a safe and successful nuclear power programme and prioritizing and sequencing the activities needed.

15. To disseminate new publications to Member States, the Agency organized three webinars on stakeholder engagement in September 2023, on managing siting activities in December 2023 and on the development of a comprehensive report in January 2024. A webinar on the publication on enhancing national safeguards infrastructure will be held in August 2024. Webinars provide a wide platform to

disseminate information, with typically around 400 registrations from approximately 70 Member States at each webinar.

16. With regard to the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP), the fourth application period concluded on 30 September 2023, resulting in the selection of 200 MSCFP students from 97 Member States studying in 54 countries. A total of 560 students from 121 Member States, studying in 72 countries, have been selected since programmes' inception in 2020.

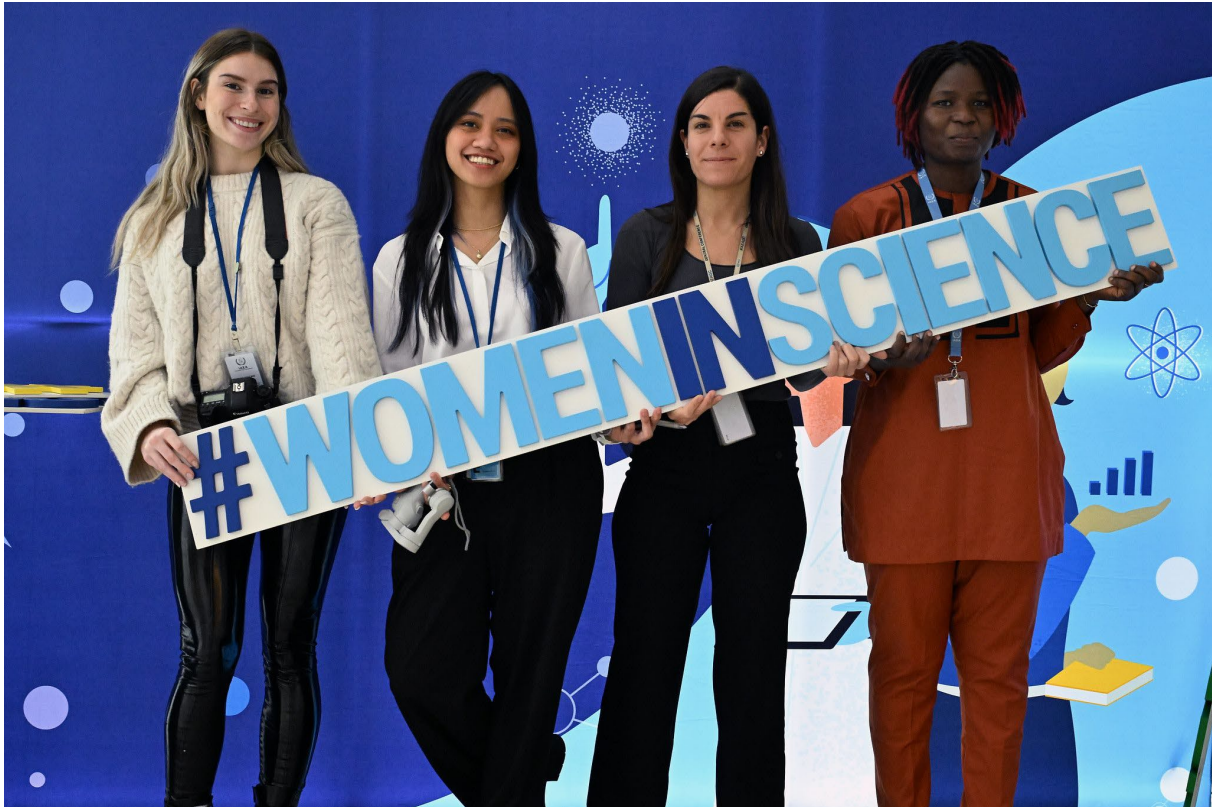


Fig. B.2. Recipients of the MSCFP scholarship at the event “For More Women in Nuclear: IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes”, held on 7–8 March 2024.

(Source: IAEA)

17. As of April 2024, 203 students had completed their master's programmes with support from the MSCFP. Of these graduates, 110 have been confirmed for an internship at the Agency's departments/laboratories (in Seibersdorf and Monaco) and at external organizations, including IAEA Collaborating Centres and other public or private sector partners in various countries including Belgium, Botswana, Chile, France, Italy, Mexico, Portugal, the Russian Federation, South Africa, Spain and the USA. The internships are linked to students' areas of specialization in diverse fields including nuclear energy, nuclear science and applications, nuclear non-proliferation, nuclear safety and security, and nuclear law.

18. As of April 2024, the MSCFP had received cash contributions of €11.9 million as well as in-kind contributions sponsoring 73 students. Donors include the European Union, 23 Member States, 2 Member State institutions, industry and one academic institution. The next MSCFP application period will open in mid-July 2024 and close on 30 September 2024.

19. In March 2024, the Agency event “For More Women in Nuclear: IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes” was held. More than 400 participants in the MSCFP and the Agency's Lise Meitner Programme (LMP) attended the event along with nuclear experts from Member

States, nuclear industry and academia. The event comprised several panel discussions, career talks break-out sessions with nuclear experts and industry professionals, networking events and industry exhibits. It brought together MSCFP students and alumnae and LMP participants to exchange ideas and strengthen communication and leadership skills. Several Member States and industry organizations sponsored the event.



Fig. B.3. Participants in the event “For More Women in Nuclear: IAEA Marie Skłodowska-Curie Fellowship and Lise Meitner Programmes”, held in Vienna on 7–8 March 2024 (Source: IAEA)

20. During the reporting period, two Lise Meitner visiting professional programmes were hosted. The second visiting professional programme, hosted by the Oak Ridge National Laboratory and the Idaho National Laboratory (INL), USA, from 16 to 27 October 2023, was attended by 11 women professionals (from Argentina, Canada, Jordan, Kenya, Nigeria, Poland, South Africa, Spain, Türkiye, and the USA). The focus of the programme was on nuclear reactor modelling and simulations and the virtual environment. Participants visited nuclear research laboratories and computational facilities and received hands-on training on various aspects of relevance to their professional advancement.

21. The LMP visiting professional programme, hosted by Korean Nuclear International Cooperation Foundation in the Republic of Korea from 25 March to 5 April 2024, was attended by 12 women professionals (from Ghana, Mongolia, Nigeria, Philippines, the Republic of Korea, Singapore, Slovakia, Spain, South Africa, Türkiye, and the USA). The focus was on NPP operations. Participants visited a NPP, research laboratories, a research reactor, a waste management facility, educational institutions and other facilities, and received hands-on exercises on various aspects of significance to professional advancements.



Fig. B.4. Participants of the Lise Meitner visiting professional programme in the Republic of Korea, 25 March–5 April 2024. (Source: IAEA)

22. By the end of June 2024, 3173 participants from 120 Member States had attended the Agency's NEM and Nuclear Knowledge Management (NKM) Schools.

23. The Agency continued to maintain and strengthen its assistance and peer review and advisory services to Member States embarking on or expanding a nuclear power programme through Integrated Nuclear Infrastructure Review (INIR) missions to assess the status of nuclear power infrastructure development. An INIR Phase 1 Mission to Estonia (in October 2023) and an INIR Phase 2 mission to Poland (in April 2024) were conducted at the request of those Member States. The Philippines officially requested an INIR follow-up mission in March 2024, in addition to the three missions already requested by Bangladesh (a Phase 3 INIR mission), Türkiye (a Phase 3 INIR mission) and Zambia (a Phase 1 INIR mission). The Agency has initiated a new development project to enhance its integrated support to Member States, which includes a web-based tool to facilitate Member States' effective self-evaluation of their infrastructure development.



Fig. B.5. Delivery of the INIR Phase 1 report to the Minister of Climate of Estonia, Mr Kristen Michal, on 16 January 2024 in Tallinn, Estonia. (Source: Ministry of Climate of Estonia)

24. Moreover, the Agency continued the revision and development of infrastructure-related publications. It completed the second revision of *Milestones in the Development of a National Infrastructure for Nuclear Power*, which was made available as preprint publication in September 2023, including an annex on infrastructure considerations for SMRs. The final publication is expected to be printed before the end of 2024.

25. The Agency continued to facilitate capacity building in energy planning for Member States, providing training in a suite of energy modelling tools to help them assess different pathways for meeting their energy needs while considering their environmental, climate and sustainable development objectives.

26. The Workshop on Advanced Energy System Modelling and the Use of the IAEA's Analytical Tools, held in Vilnius in May 2024, provided advanced training to energy planners from 13 Member States in the use of the Agency's MESSAGE model for energy supply assessment. The workshop served as a platform for professionals with advanced modelling skills to exchange practical experience in real case studies and enhance their teaching skills. The workshop thereby helped to train potential future trainers and instructors to deliver Agency capacity building services in energy planning, using the MESSAGE tool.



Fig. B.6. Participants in the Workshop on Advanced Energy System Modelling and the Use of the IAEA's Analytical Tools, held in Vilnius in May 2024. (Source: IAEA)

27. The Technical Meeting to Review the IAEA's Methodologies and Analytical Tools for Sustainable Energy Development, held in Vienna in June 2024, attracted 26 participants from 19 Member States and international organizations. The group of experts attending the meeting reviewed the status of the Agency's analytical tools and methods for energy planning, discussed and provided recommendations for enhancing and updating existing Agency tools according to Member States' needs, recommended new developments to strengthen the Agency's capacity building programme for energy planning, and set priorities for their implementation.

28. The Technical Working Group on Nuclear Power in Low-Carbon Energy Systems (TWG-NPLCES) held its third meeting in December 2023, where participants discussed the impact of climate change on the resilience of energy systems; energy planning and the modelling of transitions of energy systems to net zero; and activities on the economics and financing of nuclear power. The TWG-NPLCES was briefed on the outcomes of the Second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero, held in October 2023, and on the Agency's participation in COP28, and provided valuable input to the Agency. In May 2024, the Agency released an outlook on energy planning, entitled *From Knowledge to Action: IAEA Toolkit for Sustainable Energy Planning* as part of contribution to the G20 Energy Transition Working Group.

29. The second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero was held in Vienna from 9 to 13 October 2023. The conference, which included high-level panels, technical track sessions and side events, attracted over 500 participants with over a

thousand following sessions remotely. The conference discussed the role of nuclear power, in the context of the global clean energy transition, to provide security of supply, help decarbonize hard-to-abate sectors, and contribute to energy system resilience. Participants agreed that nuclear energy plays a pivotal role in addressing climate change but must overcome several challenges to achieve the doubling or more of the current capacity that several authoritative studies say is needed to achieve net zero emissions by 2050.



Fig. B.7. IAEA Director General Rafael Mariano Grossi delivers his opening remarks at the second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero, held at the Agency's Headquarters in Vienna, 9 October 2023. (Source: IAEA)

30. On the first day of the conference, the Agency published the 2023 edition of *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050* (Reference Data Series No. 1). For the third year in a row, the high case projection was revised upwards compared with the previous edition, with a projected capacity of 890 gigawatts (electrical) by 2050, very close to the nuclear capacity modelled by the International Energy Agency's (IEA's) updated Net Zero by 2050 roadmap.

31. The Agency participated actively at COP28 in Dubai, UAE, from 30 November to 13 December 2023, and organized at its Atoms4Climate pavilion together with partner Member States and industry organizations. In addition, the Agency released a statement at COP28 that was endorsed by over 40 Member States, emphasizing that net zero needs nuclear power.



Fig. B.8. IAEA Director General Rafael Mariano Grossi at the IAEA event “Net Zero Needs Nuclear Power”, held on the margins of COP28. (Source: IAEA)

32. At COP28, the Agency released three reports in the Outlooks series, in English and Arabic: *Nuclear Energy and Climate Change: Questions and Answers on Progress, Challenges and Opportunities*, *Nuclear Energy in Mitigation Pathways to Net Zero* and *Nuclear Energy in Climate Resilient Power Systems*. The first of these summarizes the Agency’s input of the to the first Global Stocktake process, submitted to the United Nations Framework Convention on Climate Change in April 2023.

33. The Agency continued to work on the challenge of financing nuclear power projects, in both nuclear and embarking countries. It organized high-level panel discussions on the topic at the second International Conference on Climate Change and the Role of Nuclear Power, at COP28, and at the Nuclear Energy Summit in Brussels in March 2024, with stakeholders including commercial banks, multilateral development banks, and ‘off-takers’.

34. In the context of Atoms4NetZero, the Agency supports Member States in developing energy demand and energy supply models using various Agency models and tools, including the Model for Analysis of Energy Demand (MAED), the Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE), and Framework for the Modelling of Energy Systems (FRAMES), consistent with countries’ net zero objectives and taking into account the potential role of nuclear power, including SMRs, to provide low carbon electricity, heat or hydrogen.

35. In particular, under Atoms4NetZero, the Agency is organizing a Workshop on Modelling the Contribution of Nuclear Power to Net Zero Transition Scenarios in July 2024, where experts from over 20 Member States will present their work on the use of modelling tools for energy planning and the representation of nuclear power. There will be discussions on specific challenges linked to integrated energy systems with high shares of variable renewables, and discussions on modelling assumptions, including for new and future nuclear technologies.

36. Additionally, the Agency will organize a Joint IAEA–ANL Training Course on the Identification of Viable Sustainable Development Paths Using Energy System Assessment Tools in August 2024, where Member States will discuss energy transition models using the Agency’s energy planning tools.

37. The Secretariat continued its efforts in enhancing Member States’ understanding of funding requirements for nuclear power infrastructure development and potential approaches to financing nuclear power programmes, including SMRs, through the publication of *Contracting and Ownership Approaches for New Nuclear Power Plants* (IAEA-TECDOC-1750 (Rev.1)), which explores the variety of contracting and ownership approaches for an NPP, illustrated with recent case studies, to assist Member States in understanding the range of options available and the associated benefits and challenges of each approach.

38. Additionally, the Agency organized two interregional training courses. The Interregional Training Course on Advanced Approaches in Financing Nuclear Power Plant (NPP) Projects, organized in cooperation with the ANL, was held in September 2023. Eighteen participants from 11 Member States learned about financing of NPPs, including contracting and ownership approaches. The Interregional Training Course on Funding, Financing and other Economic Aspects in Nuclear Infrastructure Development, organized in cooperation with Électricité de France, was held in November 2023, where 21 participants from 16 Member States learned about nuclear economics and the costs and benefits of a nuclear power programme to help them build a national position.

39. As part of its participation in the G20 Energy Transition Working Group, in April 2024 the Agency released an Outlooks entitled *Nuclear Energy for Net Zero: Accelerating Investment in Clean Energy Transitions*. A more in-depth analysis will be presented later in the year as part of the 2024 edition of *Climate Change and Nuclear Power*, subtitled “Financing Nuclear Power in Low Carbon Transitions”.

40. The Agency conducted the Technical Meeting on Cost-Benefit Analysis of New Nuclear Projects, hosted by the Emirates Nuclear Energy Corporation, held in the UAE in October 2023. There were 34 participants from 24 Member States. During the meeting, the participants learned about approaches to social cost–benefit analysis for new nuclear build projects, among other low carbon investments. Social cost–benefit analysis is a microeconomic evaluation approach that assesses the long term impact of a project on society by quantifying relevant costs and benefits in monetary terms.

41. The Agency organized a Workshop on the Role of Technological Innovation in Reducing Costs and Improving the Economics of Nuclear Power Generation held at the INL in Idaho, USA, in February–March 2024. The workshop addressed topics of interest to senior managers, project designers, cost estimators, and financial and economic analysts in Member States. These topics included nuclear technology overview, cost basis approaches, integrated energy systems, nuclear industry growth challenges, the costs and benefits of nuclear power, new reactor planning and management, and government policy for cost reduction.

42. In April 2024, the Agency published *Approaches to Cost-Benefit Analysis of New Nuclear Power Projects* (IAEA Nuclear Energy Series No. NG-T-4.8), which suggests an approach for conducting a cost–benefit analysis for a nuclear newbuild project as part of a feasibility study.

43. The first meeting of the Technical Working Group on Fuel Cycle Facilities will be held in Vienna, in August 2024. It is aimed at sharing information on operational aspects of nuclear fuel cycle facilities from milling to fuel fabrication, through conversion, enrichment, and reconversion, as well as nuclear R&D related fuel cycle facilities (such as research laboratories and post irradiation examination facilities).

44. Two meetings of APReSC were held, at which the outline for online training of new peer review and advisory services team members was finalized. Additionally, APReSC reviewed and took stock of the implementation of key performance indicators in regards of peer review missions in 2023. APReSC also approved two new advisory services: Stakeholder Engagement Advisory Service for Nuclear Power Programmes, and Integrated Nuclear Education Advisory Services.



IAEA Communication, Cooperation with Other Agencies and Stakeholder Involvement

A. Background

1. In resolution GC(67)/RES/10.B.2, the General Conference welcomed the Secretariat's efforts to introduce mechanisms for Member States to participate in the preparation of Nuclear Energy Series publications and the sharing of information on drafts under preparation, and further encouraged the Secretariat to continue consolidating the drafting and review of Nuclear Energy Series publications to establish a single, systematic, and transparent process and to report to the Member States on this matter. The General Conference also encouraged the Secretariat to continue to develop Nuclear Energy Series documents as a more integrated, comprehensive and clearly organized set of publications to be maintained up to date by clearly marking which publications are current and which have been superseded, in order to enhance accessibility and navigation between these documents. Further, the General Conference welcomed the development of the IAEA website in all official languages of the Agency and encouraged the Secretariat to include more content relevant to policymakers and experts involved in Agency activities, such as organizational charts and activities of expert groups, and to make access to Agency guidance documents and IAEA Technical Documents easier.

2. The General Conference also requested the Secretariat to continue cooperation with international initiatives such as UN-Energy and Sustainable Energy for All, stressing the importance of ongoing, transparent communications about the risks and benefits of nuclear power in operating and embarking countries; encouraged the strengthening of mutual cooperation between Member States by exchanging information on relevant experiences and good practices with respect to nuclear power programmes, through international organizations such as the IAEA, the Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) (OECD/NEA), the International Framework for Nuclear Energy Cooperation (IFNEC), the World Nuclear Association (WNA) and the World Association of Nuclear Operators (WANO); encouraged the Secretariat to cooperate with national and international industrial organizations for standardization, such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), with regard to their development of appropriate engineering and industry codes and standards in order to better respond to the needs of the Member States; and recommended that the Secretariat continue to explore opportunities for synergy between the Agency's activities (including the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)) and those pursued under other international initiatives in areas relating to international cooperation in peaceful uses of nuclear energy, safety, proliferation resistance and security issues and, in particular, supports collaboration among INPRO, the GIF, IFNEC, the Sustainable Nuclear technology Platform (SNETP), and ITER with regard to innovative and advanced nuclear energy systems.

3. The General Conference encouraged the Secretariat to continuously assist Member States in enhancing public awareness and understanding of peaceful uses of nuclear energy, including by publishing reports as well as by organizing schools on stakeholder engagement, and establishing a stakeholder engagement advisory service and conferences, technical meetings and workshops, among other mechanisms.

4. The General Conference, in resolution GC(67)/RES/10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

5. A technical meeting held in December 2023 with the participation of 30 Member States discussed the development of an Agency publication on strengthening resilience in the nuclear organization.

6. The Agency and WANO continued, through regular meetings, to build synergy to optimize Agency services to ensure maximum added value to the Member States during commissioning and subsequent operations. The Agency and WANO also continued cooperating through WANO's Industry Working Groups on Human and Organizational Performance and Equipment Reliability. The Agency and WANO also collaborated through the OECD/NEA Working Group on Human and Organisational Factors, both in virtual and in-person plenary meetings. The Agency provided presentations on applied, cooperative efforts to develop critical human and organizational performance capabilities (such as leadership/management and resilience skills).

7. The Agency and Association of Southeast Asian Nations continued cooperating through the Nuclear Energy Cooperation Sub-sector Network, sharing information on nuclear infrastructure and Agency support tools.

8. The Agency increased its cooperation with the African Commission on Nuclear Energy (AFCONE) to support capacity building in the area of nuclear power infrastructure development, nuclear safety and security, and nuclear applications under the MoU signed by the Agency and AFCONE in September 2022. In the framework of the MoU A mid-term action plan for the period 2024–2025 was issued in February 2024.

9. The Agency and Arab Atomic Energy Agency (AAEA) continued cooperating in the areas of nuclear power infrastructure development, nuclear safety and security, and nuclear applications through the MoU between the IAEA and AAEA, signed in June 2022.

10. The Agency continued to collaborate with OECD/NEA in the area of economics and climate change mitigation, participating in the NEA Working Party on Nuclear Energy Economics, as well as participating as an observer in the GIF Economic Modelling Working Group.

11. The 59th Meeting of the Joint OECD/NEA–IAEA Uranium Group was organized at the OECD/NEA's headquarters, in Paris in February 2024. It was attended by 36 experts from 29 countries, who made country presentations on uranium- and nuclear-related topics and provided suggestions and proposals for *Uranium 2024: Resources, Production and Demand* (Red Book 2024) and for possible future Agency Technical Meetings on various unconventional uranium deposit types.

12. The Agency held several meetings in 2023 and 2024 with Members States and the ITER Organization to finalize a draft document provisionally entitled *Legal and Institutional Aspects of Prospective Deployment of Fusion Plants (INPRO Fusion Study)*. An Agency publication on this topic is forthcoming.

13. The Agency engages with the GIF as an observer in the Proliferation Resistance and Physical Protection Working Group. The team from the two Organizations completed a joint IAEA–GIF paper entitled *GIF Proliferation Resistance and Physical Protection (PR&PP) Working Group Activities on Generation IV Nuclear Energy Systems*, for presentation at Global 2024.

14. The Technical Meeting on Local Stakeholder Engagement in Radioactive Waste Management, held in Vienna in October 2023, brought together over 100 virtual and in-person participants from 50 Member States, including countries with operating NPPs, as well as newcomers and non-power countries. The meeting captured the experiences of local communities hosting radioactive waste management facilities, which will be reflected in an Agency publication.

15. The Agency continues its leadership and is working closely with, the Global Partnership of Municipalities with Nuclear Facilities, established in 2022, in organizing and facilitating Member States becoming a member of this association. In March 2024, representatives of the Global Partnership and the Agency attended the Nuclear Energy Summit in Brussels and presented the perspectives of local communities hosting nuclear facilities.

16. The Technical Meeting on Stakeholder Involvement and Public Communication, held in Abu Dhabi in April 2024, was attended by 79 participants from 35 Member States. The meeting provided practical guidance and offered a forum to share experiences and lessons learned in stakeholder engagement for countries with new and expanding nuclear power programmes.

17. In February 2024, the Agency conducted the Workshop on Stakeholder Involvement and Nuclear Power Communication in Kilifi, Kenya, in support of the country’s efforts to develop effective communication with the local community near the proposed site of the future NPP. The Workshop promoted an open debate among representatives of Kenya’s Nuclear Power and Energy Agency, local authorities and the local community.



FIG. B.1. Participants in the Workshop on Stakeholder Involvement and Nuclear Power Communication held in Kilifi, Kenya, held in February 2024, which included representatives from the Nuclear Power and Energy Agency, the Kenya Nuclear Regulatory Authority and the local community. (Photo: NuPEA)

18. In August 2024, the Agency will conduct the Interregional Training Course on Nuclear Communication and Public Information Centres in Pretoria. The course will cover a range of topics relevant to communicating about nuclear energy and designing, implementing, and operating public information centres.

19. Panel sessions highlighting stakeholder engagement were held during the second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero, held in October 2023; the International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Meeting the Moment, held in June 2024; and the International Conference on Nuclear Knowledge Management and Human Resources Development, held in July 2024.

20. The Agency launched 'NuclearXchange', a community of practice in a collaborative virtual space on the LinkedIn platform, which brings together professionals who contribute to shaping and practising stakeholder engagement and nuclear communication within the nuclear energy sector.

Nuclear Fuel Cycle and Waste Management

A. Background

1. In resolution GC(67)/RES/10.B.3, the General Conference recognized the importance of assisting Member States interested in uranium production to improve and maintain safe and sustainable activities through appropriate technology, infrastructure and stakeholder engagement, including indigenous engagement where Member States deem it appropriate, and the development of skilled human resources; and encouraged interested Member States to use the IAEA's Integrated Uranium Production Cycle Review mission in this field, which is based on the analysis and promotion of practical know-how and innovative knowledge regarding environmental aspects of uranium exploration, mining and site remediation.

2. The General Conference also encouraged the Secretariat to assist interested Member States in analysing the technical challenges that may hinder the sustainable operation of nuclear fuel cycle facilities, such as ageing management issues.

3. Furthermore, the General Conference requested the Secretariat to continue and strengthen its efforts relating to the fuel cycle, spent fuel, and radioactive waste management, and to assist Member States to develop and implement adequate programmes, in accordance with relevant safety standards and security guidance. It also encouraged the Secretariat to promote information sharing to better integrate approaches to the back end of the fuel cycle that impact processing, transport, storage and recycling of spent fuel and radioactive waste management, for example through the coordination of research projects, and to provide more information on all stages of radioactive waste management, including waste pre-disposal management and disposal, thereby assisting Member States, including those embarking on nuclear power programmes, to develop and implement adequate disposal programmes in accordance with relevant safety standards and security guidance.

4. In the same resolution, the General Conference requested the Agency to formulate guidance documents on decommissioning and action plans to support decommissioning, with a view to promoting the safe, secure, efficient, and sustainable execution of these activities, and to facilitate the systematic review of these guidance documents based on recent developments, as appropriate. It also encouraged the Agency to further strengthen its activities in the area of environmental remediation, in close collaboration between the Department of Nuclear Energy and the Department of Nuclear Safety and Security. In the same resolution, it also encouraged the Secretariat to further promote the Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) peer review service and requested the Secretariat to enhance the effectiveness and efficiency of this service, including combined and back-to-back Integrated Regulatory Review Service (IRRS)–ARTEMIS missions, through cooperation and coordination between the Department of Nuclear Energy and the Department of Nuclear Safety and Security.

5. The General Conference also encouraged the Agency to further strengthen its activities in support of the effective management of disused sealed radioactive sources (DSRS) through, inter alia, the DSRS Technical Centre peer review mission and cooperative efforts to strengthen supporting information on the borehole disposal of DSRS, with a view to enhancing safety and security of DSRS in the long term.

6. In the same resolution, the General Conference encouraged Member States and the Agency to ensure appropriate decommissioning, radioactive waste and spent fuel management plans for all NPPs, including small and advanced modular reactors, so that these considerations are built into the earliest stages of development, taking into account lessons learned from legacy nuclear power activities.

7. The General Conference, in resolution GC(67)/RES/10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

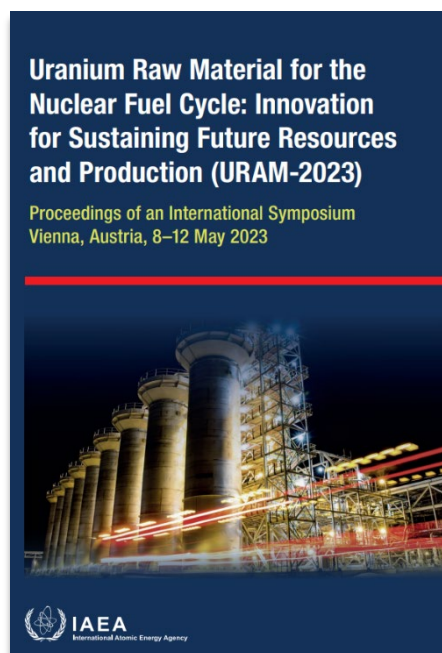
B. Progress Since the 67th Regular Session of the General Conference

8. The Joint Technical Meeting of the Uranium Mining and Remediation Exchange Group and the International Working Forum on Regulatory Supervision of Legacy Sites was held in San Rafael, Argentina, in October 2023. It was attended by 17 experts from 9 countries, who discussed the regulatory and technical aspects of the remediation of uranium mines and processing sites, and legacy sites. They also visited the National Atomic Energy Commission (CNEA)'s San Rafael Uranium Mine and Milling Complex and the Malargüe Site Environmental Remediation Project for Uranium Mining to witness current and past remediation projects.



Fig: B.1. Site visit as part of the CNEA remediation project at the Malargüe Site, Argentina, October 2023. (Source: IAEA)

9. The publication *Global Inventories of Secondary Uranium Supplies* (IAEA-TECDOC-2030), published in November 2023, represents a comprehensive evaluation of publicly available information on front end uranic inventories, while considering the approach of end users towards the reliability of their once-through supply chain.



10. In March 2024, the Agency published *Uranium Raw Material for the Nuclear Fuel Cycle: Innovation for Sustaining Future Resources and Production (URAM-2023): Proceedings of an International Symposium Held in Vienna, Austria, 8–12 May 2023*, as a Proceedings Series publication.

11. A Technical Meeting on the Modernization and Refurbishing of Instrumentation and Control Systems of Nuclear Fuel Cycle Facilities will be held in Vienna in July 2024. The aim of the event is to share experiences related to the life management of instrumentation and control (I&C) systems at nuclear fuel cycle facilities for improving their long term operation, in order to develop an IAEA Technical Document.

12. The 22nd Meeting of the Technical Working Group on Fuel Performance and Technology (TWG-FPT) was held in Vienna in April 2024 and was attended by 19 experts who discussed global trends and the Agency's activities in fuel engineering. Members of the TWG-FPT recommended

establishing Task Forces on light water reactor fuel, heavy water reactor fuel; fast reactor (FR) (lead cooled and sodium cooled FR) fuel; AI and machine learning in nuclear fuel engineering; fuel manufacturing and quality assurance; and MSR fuel. TWG-FPT members also provided recommendations on IAEA activities to be undertaken in the current and future biennia with specific recommendations on water cooled SMR fuel, advance technology fuel, FR fuel and MSR fuel.

13. A Technical Meeting on the Challenges and Opportunities in Reprocessed Uranium Fuels: Fabrication and Performance Assessment was held in Vienna in November 2023. It was attended by 49 experts from 16 Member States who discussed: national policies related to reprocessed uranium (RepU); current and future inventories of RepU; loading into reactor cores and the behaviour of RepU fuel; the management of spent enriched reprocessed uranium fuel; the recycling contribution of RepU recycling to the SDGs; the market and economics of RepU; and strengthening the proliferation resistance of uranium by using RepU. Participants made recommendations for future Agency activities in these areas.

14. An International Workshop on the Chemistry of Fuel Cycles for Molten Salt Reactor Technologies was held in Vienna in October 2023, jointly with the OECD/NEA. It was attended by 46 experts from 17 Member States and 2 International Organizations who discussed four main thematic areas related to the chemistry of MSRs. Gaps, opportunities and needs in these areas were identified and developers from 4 companies shared their experience and expectations. Participants requested the Agency and the NEA to develop a nuclear fuel cycle taxonomy for MSRs linked to that described in the recently published Status of Molten Salt Reactor Technology (IAEA Technical Reports Series No. 489).



Fig. B.2. Participants in the Workshop on the Chemistry of Fuel Cycles for Molten Salt Reactor Technologies, held in October 2023. (Source: IAEA)

15. In January 2024, the Agency published the third edition of the *Guidebook on Spent Fuel Storage Options and Systems* (IAEA Technical Reports Series No. 240), providing guidance on spent fuel storage options, describing the history and observed trends of spent fuel storage technologies, and gathering operational experiences and lessons learned.

16. A side event on the establishment and operation of the IAEA Low Enriched Uranium Bank (LEU Bank) was co-organized with Kazakhstan on the margins of the 67th General Conference, held in Vienna in September 2023. Additionally, a report on “Operation of the IAEA Low Enriched Uranium (LEU) Bank for the Supply of LEU to Member States” was published in May 2024 in document GOV/INF/2024/6.



Fig. B.3. Participants in the side event on the IAEA LEU Bank at the 67th General Conference, held in September 2023. (Source: IAEA)

17. An Integrated Uranium Production Cycle Review Mission was organized in Uganda in May 2024, with a team of five experts from five countries who conducted a review of Ugandan uranium exploration and mining regulations based on the Milestones Approach. The experts completed a final report that summarized their direct observations. Overall, and within the final report, the experts made 44 recommendations, 42 suggestions and identified 4 areas of good practice.



Fig: B.4. IAEA experts and participants from Uganda's Ministry of Energy and Mineral Development assessing a uranium occurrence in the Sembabule District during an Integrated Uranium Production Cycle Review Mission in Uganda. (Source: Uganda Ministry of Energy and Mineral Development)

18. The International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Meeting the Moment was held in Vienna in June 2024. It was attended by more than 250 experts (and 200 more registered to follow the conference online) from about 50 Countries and four International Organizations, who discussed various aspects of the backend of the nuclear fuel cycle (BEFC) activities (such as spent fuel storage, recycling, transport and disposal), acknowledging the global efforts in developing and implementing technical solutions for the BEFC and the need to continue moving ahead to make these technologies a reality, and stressing importance of knowledge management and future generations of professionals in sustaining the nuclear power industry.



Fig. B.5. Director General presenting awards to the winners of the Young Generation Event of the Conference. (Source: IAEA)

19. The Technical Meeting on the Characterization of Radioactive Waste, held in Vienna in November 2023, was attended by over 120 participants from 55 Member States. The event provided an excellent forum for the exchange of information and discussions on good practices, latest developments, challenges and future directions in the area of radioactive waste characterization and provided information on state-of-the-art methods and technologies.

20. A Webinar on Nuclear Fuel Cycle Scenario Simulation, attended by 253 attendees from 62 Member States and international organizations, was held in October 2023. Six panellists from France, Japan, Spain and the Agency gave presentations on fuel cycle modelling systems, notably the Nuclear Fuel Cycle Simulation System, a computer simulation system maintained by the Agency that uses simplified approaches to calculate nuclear fuel cycle requirements.

21. The publication *Decontamination Methodologies and Approaches* (IAEA Nuclear Energy Series No. NW-T-1.38), issued in December 2023, helps in the planning for the nuclear and radiological decontamination projects and provides guidance on the selection of the approach.

22. A webinar entitled “Developing Waste Acceptance Criteria for All Stages of the Waste Lifecycle”, held in March 2024, had by far the highest number of participants, with 444 participants from 74 Member States.

23. The Technical Meeting on the Development of Strategies for Terminating Safeguards on Radioactive Waste was held in Vienna in October 2023, with a focus discussion on disposal facilities containing materials subject to safeguards control. A follow-up webinar held in November 2023 was attended by 288 participants from 63 Member States.

24. The Technical Meeting of the International Low Level Waste Disposal Network (DISPONET) on Recent Experiences, Good Practices and Lessons Learned in the Disposal of Low Level Waste was held in Manchester, UK, in October 2023. Participants benefited from a technical visit to the low level waste repository at the Drigg site in the UK. A Technical Meeting on Site Selection Criteria for Informing the Site Selection of Geological Disposal Facilities, held in Vienna in November 2023 and attended by 34 participants from 27 Member States, looked at wider criteria including socioeconomic and environmental impact assessment.

25. In terms of support for the development of deep geological repositories, the Agency organized a Technical Meeting on Landmark Experiments at Underground Research Facilities, held in Vienna in October 2023. In September 2023, the Agency organized a webinar entitled “Roadmap for

Implementing a Deep Geological Repository Programme”, which was attended by 218 participants. A Workshop on Planning and Implementing Construction of Underground Research Facilities and Deep Geological Repositories will be held at the Beijing Research Institute of Uranium Geology in Beishan, China, in July 2024.



Fig. B.6. Participants in the DISPONET meeting, held in October 2023 in Manchester, UK. The event included a technical visit to the low level waste repository at the Drigg site. (Source: IAEA)

26. The new CRP entitled “Deep Borehole Disposal Options” held its first Research Coordination Meeting in June 2024, with over 40 participants. The purpose of the CRP is to launch a research project that focuses on progressing the knowledge base to support informed decision making and planning for next steps.

27. In September 2023, the Agency launched a new CRP entitled “Geopolymers as an Immobilization Matrix for Radioactive Waste”, aimed at establishing standardized testing protocols for geopolymers as an immobilization matrix for radioactive waste. The first Research Coordination Meeting under this project will be held in September 2024.

28. The *Proceedings of the International Conference on Radioactive Waste Management: Solutions for a Sustainable Future* was published in December 2023. The full proceedings showcase the effective, safe and secure implementation of radioactive waste management solutions in Member States for the continued use of nuclear technologies and nuclear energy production, and for a sustainable future.

29. The Agency conducted a review to increase the functionality of the Spent Fuel and Radioactive Waste Information System (SRIS) as the primary resource database on radioactive waste management, promote the harmonization of dataset input and increasing the use of these datasets. A Technical Meeting will be held in a virtual format in July 2024 to deliberate on the input data and highlight the synergy between SRIS and other Agency tools and databases.

30. A virtual Training Workshop on the Spent Fuel and Radioactive Waste Inventory Tool was held in Vienna in July 2024 to demonstrate the functionalities, utility and benefits of using the Spent Fuel and Radioactive Waste Inventory Tool (SWIFT) to establish and maintain a comprehensive inventory of radioactive waste, including spent fuel DSRS declared as waste. Participants will have opportunities to explore and understand its value and hear the views of current users.

31. Proper information management is crucial in facilitating systematic reviews of decommissioning guidance and experience. Over the years, various databases have been developed within the Agency and other international domains to preserve decommissioning information and knowledge. The Agency collaborated with the European Commission and the OECD/NEA to adopt a common taxonomy for decommissioning knowledge management. This collaboration resulted in the issuance of a joint publication entitled *A Taxonomy for the Decommissioning of Nuclear Facilities* (IAEA-TECDOC-2029), published in December 2023, which aims to facilitate the interlinking of relevant knowledge management systems developed by different organizations. To increase the impact of this publication, the Agency is continuing its work with the European Commission to establish internationally recognized semantic web standards using the Simple Knowledge Organization System. These standards will enable information to be accessed and shared in both machine and human-readable formats, enhancing the accessibility and usability of decommissioning knowledge across international boundaries.



32. To ensure that Member States are equipped with essential knowledge for nuclear decommissioning, the Agency runs a decommissioning school to facilitate effective knowledge transfer and experience sharing. An International Workshop on Training and Educational Needs to Implement Decommissioning Projects was conducted in Ulsan, Republic of Korea, in November 2023, and included a site visit to the Korea Radioactive Waste Agency (KORAD) disposal facility.



Fig. B.7. A visit to the KORAD disposal facility during an International Workshop on Training and Educational Needs to Implement Decommissioning Projects, held in the Republic of Korea in November 2023. (Source: IAEA)

33. In May 2023, the Agency published *Determination of Environmental Remediation End States* (IAEA Nuclear Energy Series No. NW-G-3.2), which provides practical technical and organizational guidance to promote the safe, efficient and cost-effective decommissioning of radioactively contaminated sites.

34. The Agency issued publications to further strengthen activities in environmental remediation: *Ten Years of Remediation Efforts in Japan: Outcomes of the Four IAEA–MOE Expert Meetings on Environmental Recovery of Off-Site Areas Affected by the Fukushima Daiichi Accident* (IAEA-TECDOC-2020), which captures the findings and information obtained during the discussions on the decontamination process; waste management; monitoring; stakeholder issues; knowledge management; remediation, recovery and regulatory issues. It also published *Technical Aspects Related to the Design and Construction of Engineered Containment Barriers for Environmental Remediation* (Technical Reports Series No. 493), which provides an introduction to the design and construction of different containment barriers for low level radioactive waste generated from remediation activities.

35. Recognizing the challenges in remediating historic waste trench sites, the June 2024 meeting of the Legacy Trench Site Community of Practice, facilitated by the Agency, focused on the characterization and assessment of sites.

36. In April 2024, the Agency organized a Workshop on Techniques and Technologies Used for the Characterization of Radioactively Contaminated Land. Thirty-one international delegates learned about systematic planning, site investigation techniques, characterization data assessment and visualization.

37. The ARTEMIS Peer Review mission to Belgium, conducted in December 2023, concluded that Belgium has implemented good decommissioning practices and established a robust infrastructure for managing its radioactive waste and spent fuel.

38. The ARTEMIS Mission to Slovakia, conducted in February 2023, recognized Slovakia's strong commitment to ensuring the safe implementation of radioactive waste and spent fuel management activities, in accordance with applicable legal and regulatory systems, international conventions and Agency safety standards. The Agency's team of experts commended Slovakia for its decommissioning activities while noting opportunities to enhance preparations for geological disposal.

39. The ARTEMIS mission to Greece, conducted in September 2023, focused on the national radioactive waste management framework. The mission concluded that Greece has established a good basis to ensure and enhance the safety of radioactive waste management. The Agency's team of experts acknowledged the efforts of the host team to support the review. Recommendations included improving stakeholder involvement and ensuring that there were adequate human resources for the continued safe management of spent fuel and radioactive waste.

40. The Global Radium-226 Management Initiative continues to garner attention among Member States, with 59 entities registered as source owners and 13 registered as the recipients of radium sources. Six transfers of radium sources are currently in the pipeline.

41. A Technical Meeting on Lessons Learned from Removals of Category 1 and 2 Disused Sealed Radioactive Sources and Strategies to Improve Removal of Unique Devices was held in a virtual format in December 2023. The most notable issues with Category 1 and 2 removals pertained to logistics, which can be time-consuming to arrange and may pose challenges that are difficult to predict. The meeting was attended by 96 participants from 49 Member States.

42. Continuing the work undertaken at a Technical Meeting on Decommissioning Fusion Reactors, held at the ITER Cadarache facility in February 2023 to discuss the decommissioning aspects of fusion reactors, the Agency held a second Technical Meeting with the identical title in February 2024 to review the ongoing regulatory frameworks developed by Member States for the operation and decommissioning of fusion reactors. A publication summarizing the key findings is anticipated in 2025.

43. The decommissioning of nuclear fuel cycle facilities poses myriad challenges on account of the various stages and processes involved in the nuclear fuel cycles within these facilities. The Agency initiated an exploration of this complex subject at a Technical Meeting held in Cherbourg, France in June 2023. The work has progressed into 2024, with a technical report currently being prepared to consolidate findings and recommendations.

44. The Agency is developing a Strategic Roadmap for the Decommissioning of Graphite Reactors. The roadmap aims to outline the essential considerations for defining strategy, sequencing activities, and identifying major tasks involved in the decommissioning of graphite moderated reactors. It also highlights the linkages between these major tasks. The project's steering group continued refining the roadmap in April 2024.

45. Research and development on accelerator-driven systems (ADSs) is being conducted at numerous research facilities globally, many of which are focusing on closing nuclear fuel cycles and transmuting minor actinides. To ensure appropriate decommissioning of these research facilities, the Agency began examining the decommissioning aspects of ADSs in 2024 along with the anticipated challenges, through dedicated meetings including an upcoming Technical Meeting on ADS applications and the use of LEU, to be held in September 2024.

46. In anticipation of future decommissioning needs for various SMR designs, the Agency convened multiple meetings to delve into the decommissioning aspects associated with different SMR technologies. A publication detailing these discussions and findings is anticipated in 2025.

47. The need for safe and efficient decommissioning highlighted the importance of supply chain and technology innovations, as discussed at the International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future, held in Vienna in May 2023. As a follow-up, the Agency is organizing a workshop to be held in July 2024 that will bring together over 40 participants from 20 Member States and the European Demolition Association to share relevant experiences and lessons learned in this critical area.

48. In late 2023, the Agency initiated a new CRP entitled “R&D to Advance Decommissioning of Legacy Reactors”, aimed at supporting Member States to undertake proper decommissioning efforts. The first Research Coordination Meeting, held in May 2024, was attended by participants from seven organizations and four observer Member States, and research proposals and future studies were discussed and planned.

49. The repurposing of nuclear sites and stakeholder engagement will be the main topics of a Technical Meeting to be held in August 2024. It is planned that participants will discuss their views on the sustainable development of nuclear sites, giving consideration to wider technical, economic societal and environmental aspects.

50. In January 2024, the Agency published *Addressing Challenges in Managing Radioactive Waste from Past Activities* (IAEA-TECDOC-2039), highlighting the challenges in managing legacy waste and providing guidance on strategies to address those challenges.

Research Reactors

A. Background

1. In resolution GC(67)/RES/10.B.4, the General Conference requested the Secretariat to continue assisting interested Member States in their efforts to utilize existing research reactors for nuclear science and technology, including nuclear power applications, with a view to strengthening infrastructure, including safety and security, and fostering science, technology, engineering and capacity building.
2. In the same resolution, the General Conference encouraged the Secretariat to continue to foster regional and international collaboration and networking that expands access to research reactors, such as international user communities. It also encouraged the Secretariat to inform Member States considering the development or installation of their first research reactor of the issues related to utilization, cost effectiveness, environmental protection, safety and security, nuclear liability, proliferation resistance, the application of comprehensive safeguards, and radioactive waste management associated with such reactors, and, on request, to assist Member States pursuing new reactor projects following the Agency's *Specific Considerations and Milestones for a Research Reactor Project* (IAEA Nuclear Energy Series No. NP-T-5.1), including systematic, comprehensive and appropriately graded infrastructure development.
3. The General Conference also urged the Secretariat to continue to provide guidance on all aspects of the research reactor life cycle, including the development of ageing management programmes at all research reactors, to ensure continuous improvements in safety and reliability, sustainable long term operation, the sustainability of fuel supply, exploration of efficient and effective disposition options for spent fuel and radioactive waste management, and the development of a knowledgeable customer capability in Member States decommissioning research reactors.
4. Furthermore, the General Conference encouraged the Secretariat to further strengthen its efforts to support capacity building based on research reactors.
5. Finally, the General Conference called on the Secretariat to continue to support international programmes working to minimize the civilian use of high enriched uranium (HEU), for example through the development and qualification of LEU high density fuel for research reactors, where such minimization is technically and economically feasible.
6. The General Conference requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

7. The Agency initiated revision of *Utilization Related Design Features of Research Reactors: A Compendium* (Technical Reports Series No. 455). The revised publication will include a monographic part providing comprehensive information on the subject and is intended to be used by designers,

operators and end users of research reactors and experimental facilities in new or refurbished reactors. A Technical Meeting to discuss the draft publication is scheduled for July 2024.

8. A Training Workshop on the Assessment of the National Nuclear Infrastructure to Support a New Research Reactor Project, held in Vienna in October 2023, was attended by 47 participants from 18 Member States. The workshop provided Member States with practical information relating to the establishment of infrastructure for a new research reactor, the application of *Specific Considerations in the Assessment of the Status of the National Nuclear Infrastructure for a New Research Reactor Programme* (IAEA Nuclear Energy Series No. NR-T-5.9), relevant Agency safety standards and other related Agency publications. The workshop also provided a forum for participants to share and discuss experiences, challenges and lessons learned in the development and implementation of new research reactor projects.

9. To assist Member States in planning human resources for research reactor programmes, the Agency held the Technical Meeting on Human Resource Development Modelling for Research Reactors in Vienna in November 2023. Fifteen participants representing 12 Member States were provided with practical information on the use of the Agency's Human Resource Modelling Tool for New Research Reactor Programmes and discussed experiences, challenges and lessons learned in developing human resources. The meeting also gathered inputs from Member States for further improvement of the computer model and to determine the scope of a planned Agency publication on the topic.

10. In February 2024, the Agency published *Project Management in Construction of Research Reactors* (IAEA Nuclear Energy Series No. NR-G-5.3), which is based on proven practices in a number of Member States and provides guidance on project management during the construction of a research reactor facility, from the preparatory phase to turnover for commissioning. It also includes experience gained and lessons learned from project management for significant modifications of research reactors.

11. The Technical Meeting on Integrated Management Systems for Research Reactors, held in Daejeon, Republic of Korea, in September 2023, provided 46 participants from 25 Member States with practical information on the establishment, implementation and continuous improvement of management systems for research reactors based on Agency safety standards and served as a forum to discuss related issues, including the use of a graded approach in the application of the requirements for management systems.

12. In December 2023, the first-of-a-kind Regional Training Course on Ageing Management of Research Reactors was conducted in Pelindaba, South Africa. Eighteen participants from eight African countries currently operating research reactors received training in the operation, maintenance and ageing management of research reactors in order to further improve their reliability, performance, and safety.

13. A Technical Meeting on HEU/LEU Conversion, Operation and Utilization of MNSR and SLOWPOKE Research Reactors will be held in Vienna in August 2024 to allow operators of these similar facilities to compare various aspects of their activities and share insights on the optimization of their research reactors.

14. In 2024, the Agency initiated a new CRP entitled "Development of Time Limited Ageing Analyses to Support Continued Safe Operation of Research Reactors", which is intended to develop a methodology to identify, validate and build time limited ageing analyses applicable to research reactors.

15. In December 2023, an Integrated Nuclear Infrastructure Review for Research Reactors (INIR-RR) mission was conducted in Kenya to assist the country in determining status of the national infrastructure necessary to support the first research reactor programme and to identify further development needs.

The mission provided recommendations and suggestions that can be used by the Government and other relevant organizations in Kenya to address areas needing further action.

16. The follow-up INIR-RR mission to Bangkok, conducted in April 2024, assessed the level of implementation of recommendations and suggestions of the INIR-RR mission conducted in 2021, identified good practices and discussed areas of further work.

17. An Operation and Maintenance Assessment for Research Reactors (OMARR) mission to the IEA-R1 research reactor in São Paulo, Brazil was conducted in February 2024. The mission followed the pre-OMARR mission conducted in October 2023 and provided recommendations and suggestions on improving operational and maintenance practices for the continued reliable and safe operation of the reactor.



Fig. B.1. An IAEA team conducting an OMARR mission at the IEA-R1 research reactor in São Paulo, Brazil, in February 2024. (Source: IAEA)

18. As part of efforts to assist Member States in the safe and reliable operation of their research reactors, a mission to support technical inspection of the ETRR-1 research reactor in Inshas, Egypt, was conducted in June 2024. The mission provided a thorough assessment of the structures, systems and components of the facility.

19. An OMARR follow-up mission and a mission to support in-service inspection at the RECH-1 research reactor in Santiago are planned for July 2024 to review improvements in operational practices and assist in assessing the technical condition of the facility.

20. In 2024, the Agency redesignated the Korea Atomic Energy Research Institute as an International Centre based on Research Reactors (ICERR) in the areas “Hands-on Training” and “Joint R&D Projects” for the next five years.

21. An Integrated Research Reactor Utilization Review mission was conducted at the research reactor at McMaster University, Canada, in January 2024. The mission examined how McMaster University could better utilize the research reactor in several areas such as radioisotope production and neutron-based sciences, and education and training opportunities that integrate the reactor with all McMaster faculties and could help prepare Canada’s future nuclear workforce.

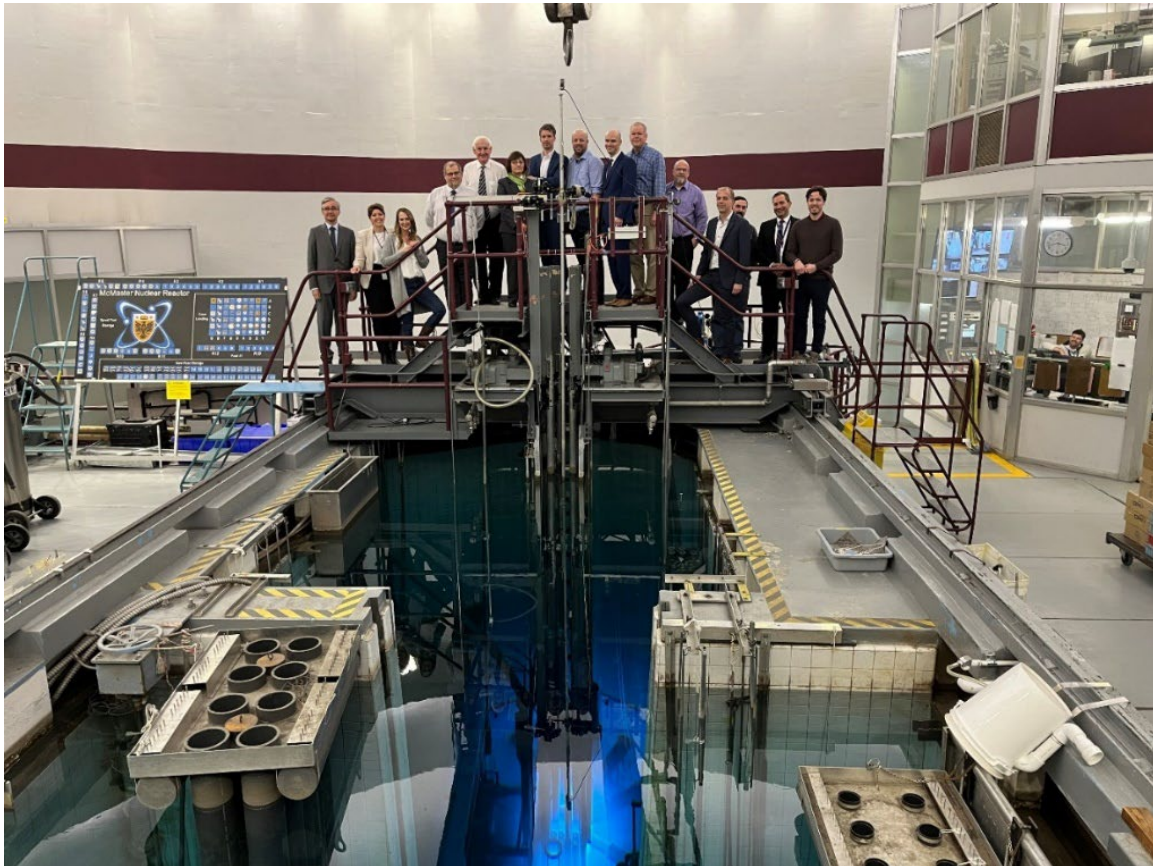


Fig. B.2. An IAEA team together with McMaster nuclear reactor staff taking part in the IRRUR mission. (Source: McMaster University, Canada)

22. The IAEA Expert Mission on Stakeholder Analysis and Functional Specifications for a Multi-Purpose Research Reactor (MPRR) was conducted at the King Abdulaziz City for Atomic and Renewable Energy in Riyadh in December 2023.

23. The Agency continued expansion of the Internet Reactor Laboratory project, with new guest agreements signed in February 2024 with Armenia and Ethiopia. Several African countries expressed interest in joining the project.

24. The first Regional Research Reactor School in the Spanish language was conducted for Latin America in Argentina in November 2023, with 10 participants from 4 countries. The event assisted Member States in building nuclear competence and provided hands-on training for young professionals in the operation of research reactors. The Regional Research Reactor School conducted in Russia in May June 2024 was attended by 14 participants from 12 Member States, and provided information on

research reactor operation, safety, security, design features and the role of research reactors in the development of nuclear science and technology.

25. In collaboration with the Eastern European Research Reactor Initiative (EERRI), the Agency conducted the 18th EERRI Research Reactor Training Course at three research reactors in Austria, Czechia and Slovenia between September and November 2023. Eight young professionals from seven Member States received extensive six-week training in research reactor physics, operation, maintenance, and utilization.



Fig. B.3. Participants in the 18th EERRI Research Reactor Training Course in the reactor hall, Ljubljana, November 2023. (Source: IAEA)

26. In March 2024, the Agency held a Technical Meeting on Experience in Removal of High Enriched Uranium from Research Reactors in Budapest to review a publication under preparation to capture experience and lessons learned by efforts over the past 20 years to repatriate HEU to its country of origin under various take-back programmes. The objective of the publication is to provide information to facilitate the future transport of spent nuclear fuel from research reactors without the support and guidance of take-back programmes. The event was attended by 47 participants representing 19 Member States.

Operating Nuclear Power Plants

A. Background

1. In resolution GC(67)/RES/10.B.5, the General Conference requested the Secretariat to promote collaboration among interested Member States for strengthening excellence for the safe, secure, efficient and sustainable operation of NPPs, and to continue its support for this work through experience sharing and the identification and promotion of best practices, taking into account quality assurance and control activities related to nuclear construction, component manufacturing and modifications, with respect to fitness for service issues and independent nuclear training accreditation.
2. In the same resolution, the General Conference requested the Secretariat to continue its support to interested Member States, in particular through strengthening their knowledge, experience and capacity in the management of ageing plants and plant life management.
3. The General Conference also encouraged the Secretariat to support interested Member States in their activities to improve the safe, secure and economical operation of existing NPPs throughout their operational lifetime; and to share best practices and lessons learned with respect to procurement, engineering, and related issues in the delivery of large, capital-intensive nuclear engineering projects, to promote and disseminate them through publications, training courses and web-based tools with respect to supply chain management, and to identify opportunities that may exist to enhance supply chain resilience;
4. The General Conference encouraged the Secretariat to analyse the status and future challenges of human resources in the nuclear power industry, to support interested Member States in their activities to utilize NPPs for non-electrical applications, including gathering and quantifying data, and to identify best practices and lessons learned.
5. The General Conference, in resolution GC(67)/RES/10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

6. The revised publication *Quality and Reliability Aspects in Nuclear Power Reactor Fuel Engineering — Guidance and Best Practices to Improve Nuclear Fuel Reliability and Performance in Water Cooled Reactors* (Nuclear Energy Series No. NF-G-2.1 (Rev. 1)), published in February 2024 with a significantly expanded scope compared to the previous edition, supports nuclear fuel designers, manufacturers, reactor operators, and fuel engineers and managers in fuel design and design changes, fuel manufacturing, qualification, in-reactor operation and on-site services to achieve excellence in fuel reliability and performance and the safe operation of nuclear fuel under all applicable plant states.

7. The Agency organized the first meeting of the second term of the Technical Working Group on Nuclear Power Plant Operations, held in Vienna in April 2024. The event brought together 22 experts from 14 Member States and 4 international organizations to share experience related to the global fleet of operating NPPs, to consider recent, relevant Agency Member State support, and to develop actionable recommendations for the Agency's consideration.

8. The Nuclear Harmonization and Standardization Initiative (NHSI) Industry Track's Topical Group 2: Common Approaches to Codes and Standards has worked to identify similarities and differences in different codes and standards and oversight regimes, the reasons for them and common practices that can be adopted to improve the situation. This contributes to harmonization for current reactors and those planned for the near future, including SMRs. A paper was issued in June on the role of other than nuclear regulations on nuclear projects' delays and costs. Another paper on challenges and potential solutions with long lead items - like pressure vessels – is planned to be issued by the IAEA General Conference in September 2024.

9. The Agency established the CONNECT Management, Supply Chain and Quality Network of Excellence web-based platform by expanding the scope of the former Management System Network of Excellence while hosting NHSI Topical Group 2 shared activities and issued two newsletters to its members with relevant deliverables and meetings.

10. The Agency created a database on nuclear equipment qualification standards as a part of this Management, Supply Chain and Quality Network of Excellence. The database contains a high-level description providing an overview of the scope of the identified standards and a link to the pages of the relevant standards development organization.

11. The Steering Committee of the International Network on Life Management of Nuclear Power Plants (LMNPP Network) was officially formed in November 2023 at the first Steering Committee meeting, and consists of representatives from 27 Member States and 8 cooperation organizations. Eight working groups were established and 10 events (including Consultancy Meetings, Technical Meetings and workshops etc.) were successfully held under the auspices of the LMNPP Network in 2023. Cooperative events with Member States were implemented under the umbrella of the LMNPP Network, including a workshop on the effectiveness of ageing management programmes in NPPs with the Nuclear Research and Consultancy Group in the Kingdom of the Netherlands. Cooperation with other organizations, such as the Electric Power Research Institute (EPRI), WANO, OECD/NEA, WNA, the Pressurized Water Reactor Owners Group, SNETP, the European Commission's Joint Research Committee and the Nuclear Energy Institute (NEI), was strengthened by sharing, participating in and co-organizing the activities.



Fig. B.1. A Technical Meeting on Good Practices in and Lessons Learned from the Long Term Operation of Nuclear Power Plants (LMNPP Network) in November 2023. (Source: KHNP)

12. The outputs from the working groups are strengthening Member States' knowledge, experience and capacity in the management of ageing and plant life management. For example, the draft of an Agency publication provisionally entitled *Good Practices and Lessons Learned from Long Term Operation of Nuclear Power Plants*, aimed at sharing good practices and operating experience in important aspects of long term operation, was finalized by Working Group 1.

13. In June 2024, under the auspices of Working Group 6 of the LMNPP Network, the Agency held a Technical Meeting on the On-Site Technical Adaptation of Nuclear Power Plants to Environmental Changes. The event brought together 50 participants from 27 Member States and 2 international organizations to share approaches and examples of performance-related technical solutions that enhance plant resilience to production losses caused by environmental changes and climate variability, and to identify recommendations to be considered by operators for further adapting their NPPs in that respect. The outcomes of the meeting were used to improve an Agency publication under development on the adaptation of operating NPPs to climate and environmental variability to enhance resilience to production losses.

14. Under the auspices of the Agency's Power Reactor Information System (PRIS), the Agency published the 43rd edition of *Nuclear Power Reactors in the World* (2023 edition, Reference Data Series No. 2). It presents the most recent reactor data available to the Agency. It contains summarized information as of the end of 2022 on power reactors that are operating, under construction and shut down, as well as performance data on reactors operating in Member States.

15. The Agency held a Technical Meeting on Developments of the Power Reactor Information System in Vienna in December 2023. The event brought together 32 experts from 18 Member States and 2 international organizations to discuss the main issues and achievements to date in relation to the PRIS database, as well as future development priorities; to provide an overview of recent changes to the system, including the new reporting software; to present key areas of and latest trends in nuclear power development and performance in Member States; and to discuss how PRIS should reflect those trends.

16. The Agency published the 54th edition of *Operating Experience with Nuclear Power Stations in Member States*. The report contains information on electricity production and the overall performance of individual plants during 2022.

17. The Agency issued the 2023 edition of the *Country Nuclear Power Profiles*. This publication provides a high-level overview of programmes in participating Member States. Currently, it contains historical country information for 50 countries, including 31 currently operating NPPs, and 20 with past or planned nuclear power programmes. Statistical data on nuclear plant operations, energy and electricity use are drawn from national contributions and PRIS, the Agency's Energy and Economic Data Bank and the World Bank's World Development Indicators.

18. Under the auspices of the International Network on Innovation to Support Operating Nuclear Power Plants (ISOP), the Agency held a Technical Meeting on Deployment of Artificial Intelligence Solutions for the Nuclear Power Industry: Considerations and Guidance in March 2024. The event was hosted in the USA by the United States Nuclear Regulatory Commission. Organizers convened 153 diverse experts from operators, regulators, national laboratories, independent research organizations, academia and commercial companies in 29 Member States and 4 international organizations to share experience related to the deployment of AI at operating NPPs and to finalize a new IAEA Technical Document provisionally entitled *Deployment of Artificial Intelligence Solutions for the Nuclear Power Industry: Considerations and Guidance* to set out the implementation considerations for Member States interested in the deployment of AI in NPPs.

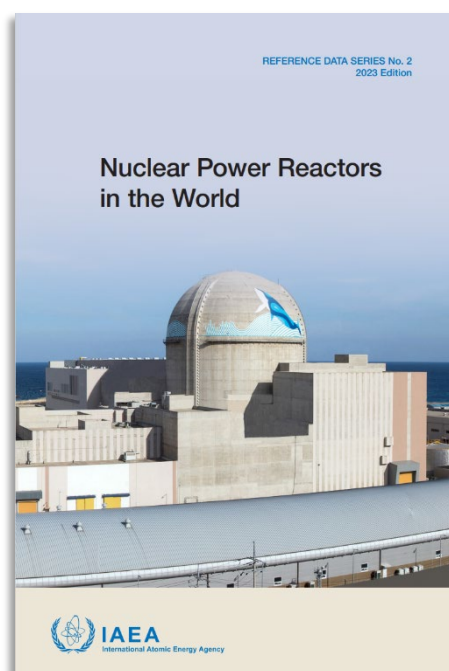
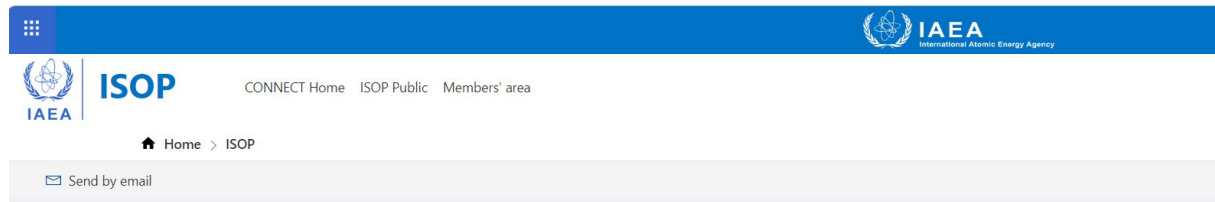




Fig. B.2. A Technical Meeting on Deployment of Artificial Intelligence Solutions for the Nuclear Power Industry: Considerations and Guidance, hosted by the United States Nuclear Regulatory Commission in the USA in March 2024. (Source: NRC)

19. Under the auspices of ISOP, the Agency implemented a Workshop on Innovative Technical Solutions to Improve Performance While Minimizing Costs at Operating Nuclear Power Plants in October 2023. The event was hosted by the INL in the USA and brought together 97 diverse experts from operators, regulators, national laboratories, independent research organizations, academia and commercial companies in 15 Member States and 3 international organizations. Participants shared examples and experience related to deployed innovation that maintained or improved nuclear safety and security while improving performance, reducing cost and/or increasing revenue. The scope of the workshop included technical and process innovation as well as innovation linked to the nuclear power sector supply chain.



Welcome to ISOP

The International Network on Innovation to Support Operating Nuclear Power Plants

This network has been established to increase **collaboration and experience sharing** in the field of innovation for the nuclear industry. It also aims to support the Global Forum initiative (see About ISOP below) to support innovation deployment within the nuclear industry. The scope of the network activities includes **all types of innovations** that could serve the purpose of the **nuclear industry sustainability**. It should include activities related to **technologies, processes, frameworks** including **regulatory aspects** and **collaboration, culture & leadership**.

20. Under the auspices of ISOP, in July 2024 the Agency will hold a Technical Meeting on Innovation at Operating Nuclear Power Plants jointly with the Global Forum for Nuclear Innovation Network, EPRI, OECD/NEA and the UK’s National Nuclear Laboratory. Simultaneous events will be hosted by EPRI and NextEra Energy in the USA, with the aim of equipping participating experts with tools to help drive innovation and continuous improvement across the nuclear power industrial sector.

21. The Agency conducted a Technical Meeting on Innovation, Advances and Developments in the Water Chemistry of Pressurized Water Reactors in Vienna in April 2024. Fifty-four experts from 25 Member States and 1 international organization gathered to share the latest insights into innovations and review an IAEA Technical Document under development on innovation, advances and developments in the water chemistry of pressurized water reactors that also covers the water chemistry of water-water energetic reactors.

22. The Agency publication *Member States’ Experiences and Insights from Maintaining Safety, Security and Reliable Nuclear Industry Operations During the Covid-19 Pandemic* (Technical Reports Series No. 491) shares information about the experience of managing and regulating facilities and activities during the COVID-19 pandemic and assisting Member States in considering further actions to improve their preparedness and response in relation to a pandemic and similar challenges in the future. The effective sharing of operating and regulatory experience is intended to have a positive influence on the response to, and recovery from, such global events.

23. The Agency published *Integrated Life Cycle Risk Management for New Nuclear Power Plants* (IAEA Nuclear Energy Series No. NR-T-2.15), which is designed to enhance stakeholders’ understanding of the fundamental processes, procedures and methods for integrated risk management. Practical guidelines are provided and best practices shared. The importance of having appropriate risk management policies is emphasized, especially when considering the various contractual and organizational arrangements in different construction entities, operating organizations and Member States.

24. In July 2024, the Agency will organize a Technical Meeting on Commercial Equipment in Nuclear Applications and Non-Nuclear Standards for Safety Instrumentation and Control Systems. The event is aimed at sharing operating experiences and good practices regarding the use of commercial equipment in nuclear applications and non-nuclear standards for safety instrumentation and control systems.

25. The Agency held a Technical Meeting on the Harmonization and Use of Industrial Codes and Standards for Small Modular Reactors in Vienna in December 2023, which was attended by 104 participants from 24 Member States. The outcomes helped to steer the work of the NHI Industry Track's Topical Group 2: Common Approaches on Codes and Standards, especially in areas related to using industrial grade components in safety systems, approval practices for mechanical long lead items, the importance of non-nuclear codes and standards, and high-level comparison of mechanical codes and standards.

26. The publication *Assessment of Post-irradiation Examination Techniques for Advanced Reactor Fuel and Materials: Report of a Technical Meeting* (IAEA-TECDOC-2035), exploring the use of existing and new post-irradiation examination techniques for the study of next-generation fuel types, was published in December 2023.

27. The Agency held the Technical Meeting on Advances in High Temperature Processes for Hydrogen Production with Nuclear Energy in a hybrid format at the Vienna International Centre (VIC) in September 2023. It was attended by 35 participants from 16 Member States and 2 international organizations. Participants exchanged information on the most recent developments in high temperature nuclear hydrogen production projects worldwide and discussed the true potential for coupling those technologies with various types of nuclear plants.

28. The Technical Working Group on Nuclear Desalination (TWG-ND) continues to fulfil its function as a forum for advice on and review of the Agency's nuclear desalination and integrated water resources management activities. The ninth meeting of the TWG-ND was held in a hybrid format at the VIC in October 2023. Fifteen participants from 14 Member States attended the event. Members of the TWG-ND confirmed the recommendations and conclusions of the previous TWG-ND meeting and provided new recommendations for planning Agency activities in the area of water desalination and integrated water management.

29. In the area of non-electric applications through capacity building, the Agency, in cooperation with the Rosatom Technical Academy, organized an Interregional Training Course on Specific Design Considerations of Nuclear Cogeneration Projects using Small Modular Reactors (SMRs) and Microreactors (MRs) in Moscow in October 2023. The event was attended by 14 participants from 11 Member States. Experts provided a comprehensive overview of the use of nuclear energy beyond electricity production, for applications such as water desalination, hydrogen production or providing heat to support various industrial processes. The Interregional Training Course familiarized participants with the basics of technology and safety aspects of SMR and MR cogeneration and provided theoretical and practical introductory training in Agency tools (the Desalination Economic Evaluation Program and the Desalination Thermodynamic Optimization Program).

30. A Technical Meeting on Advances in Desalination Technologies and Uses for Optimal Coupling with Nuclear Plants, Including Small Modular Reactors, held at the VIC in December 2023, was attended by 16 participants from 12 Member States. Participants discussed recent advancements in the field of nuclear desalination, as well as plans for the deployment of nuclear desalination in their countries. In addition, participants attended a joint session with the concurrent Technical Meeting on Managing Naturally Occurring Radioactive Material Legacy Sites, where participants of both events discussed emerging opportunities for nuclear energy to be a key player in the emerging areas of zero liquid discharge and brine mining.

31. The Agency continues to coordinate R&D in the field of non-electric applications. It held the first Research Coordination Meeting of the new CRP entitled “Role of Nuclear Cogeneration within the Context of Sustainable Development” in a hybrid format at the VIC in November 2023.

32. The Agency continues to be engaged with international organizations and consortiums working on non-electric applications. It participates in the European Union’s TANDEM project on SMRs for non-electric applications as an observer, and as a member of the four-person Scientific Advisory Committee. Further, it participates as an observer in the OECD/NEA Working group on Hydrogen Value Chain (H2-VAL) and attended the group’s first meeting in Paris in April 2024, presenting the work carried out by the Agency on nuclear hydrogen in support of the IAEA Member States, in order to liaise effectively with the working group and its members and observers.

Agency Activities in the Development of Innovative Nuclear Power Technology

A. Background

1. In resolution GC(67)/RES/10.B.6, the General Conference encouraged the Secretariat to consider further opportunities to develop and coordinate the services it provides on the relevant subjects, focusing on transition to sustainable nuclear energy systems using, inter alia, the analytical approaches, tools and services developed by INPRO. It also encouraged the Secretariat to consider further use of web-based tools for implementing the INPRO Collaborative Project: Analytical Framework for Analysis and Assessment of Transition Scenarios to Sustainable Nuclear Energy Systems, an approach for comparative evaluation of nuclear energy system options based on key indicators and multi-criteria decision analysis methods.

2. The General Conference encouraged the Secretariat to consider further use of web based tools for implementing the INPRO collaborative project entitled “Analytical Framework for Analysis and Assessment of Transition Scenarios to Sustainable Nuclear Energy Systems”, an approach for comparative evaluation of nuclear energy system options based on key indicators and multi-criteria decision analysis methods.

3. In the same resolution, the General Conference encouraged interested Member States and the Secretariat to apply the ROADMAPS templates for national case studies, including case studies based on cooperation among technology holder and technology user countries, and for national and regional long term energy planning to enhance sustainability of nuclear energy systems. It also requested the Secretariat to promote collaboration among interested Member States in developing innovative, globally sustainable nuclear energy systems and to support the establishment of effective collaboration mechanisms to exchange information on relevant experiences and good practices.

4. The General Conference requested the Secretariat to promote further application of multi-criteria decision analysis methods for comparative evaluation of plausible nuclear energy system options by interested INPRO Member States to support decision analysis and prioritization in national nuclear energy programmes. It encouraged the Secretariat to study cooperative approaches to the back end of the nuclear fuel cycle with a focus on the drivers and institutional, economic and legal impediments to ensure effective cooperation among countries towards the long term sustainable use of nuclear energy, and requested the Secretariat to facilitate discussion among developers of advanced reactors (e.g. SMRs, Generation IV reactors) on the challenges and technologies related to decommissioning and radioactive waste and spent fuel management at the earliest stage of their design thinking.

5. The General Conference requested the Secretariat to continue providing assistance on strategic planning for sustainable nuclear energy development and deployment, including through capacity building, INPRO Schools, and the establishment of an integrated service to advise interested Member States.

6. The General Conference also encouraged the Secretariat to continue, through activities on innovative nuclear technologies and their underlying science and technology, to exchange knowledge and experience in the area of innovative, globally sustainable nuclear energy systems.

7. In the same resolution, the General Conference called upon the Secretariat and Member States in a position to do so to investigate new reactor and fuel cycle technologies with improved utilization of natural resources, and proliferation resistance, including technologies for the recycling of spent fuel and its use in advanced reactors under appropriate controls and for the long term disposition of remaining waste materials, taking into account economic, safety, and security factors.

8. The General Conference recommended that the Secretariat continue to explore, in consultation with interested Member States, innovative nuclear technologies, including alternative fuel cycles, associated back-end management capabilities, innovative nuclear energy systems and fusion power plants, with a view to strengthening and fostering infrastructure, safety, security, science, technology, engineering and capacity building via the use of experimental facilities and material testing reactors, to facilitate licensing, construction, and operation of these technologies.

9. Lastly, the General Conference encouraged the Secretariat to study the legal and institutional aspects of fusion facilities deployment and to work on identification and development of the basic framework to support the pre-feasibility study of a fusion demonstration plant, and to strengthen activities in the area of fusion technology development and deployment.

10. The General Conference, in resolution GC(67)/RES/10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

11. The 32nd Meeting of the INPRO Steering Committee was held in Vienna in October–November 2023. INPRO members discussed progress, the initiation of new INPRO collaborative projects, the draft INPRO Strategic Plan for 2024–2029 and the endorsement of the 2024-25 INPRO Subprogramme Plan. The meeting was attended by 37 participants from 20 Member States, as well as observers from AFCONE and the Regional Network for Education and Training in Nuclear Technology (STAR-NET).



*Fig. B.1. Participants in the 32nd INPRO Steering Committee meeting, October 2023.
(Source: IAEA)*

12. The Agency completed successfully the CRP entitled “Advancing the State-of-Practice in Uncertainty and Sensitivity Methodologies for Severe Accident Analysis in Water-Cooled Reactors”, which resulted in five publications addressing all reactor lines, including *Advancing the State of the Practice in Uncertainty and Sensitivity Methodologies for Severe Accident Analysis in Water Cooled Reactors of PWR and SMR Types* (IAEA-TECDOC-2031), which addresses specific reactor lines and provides descriptions by contributing institutions of the uncertainty and sensitivity methods they utilize for severe accidents analysis in large pressurized water reactors and in integral pressurized water (iPWR)-type SMRs; and *Advancing the State of the Practice in Uncertainty and Sensitivity Methodologies for Severe Accident Analysis in Water Cooled Reactors in the QUENCH-06 Experiment* (IAEA-TECDOC-2045), which contains contributions describing uncertainty and sensitivity assessment methods applied in simulating the QUENCH-06 experiment.



Fig. B.2. Participants and IAEA staff at the fifth Research Coordination Meeting summarizing the final results towards completion of the CRP entitled “Advancing the State-of-Practice in Uncertainty and Sensitivity Methodologies for Severe Accident Analysis in Water-Cooled Reactors”. (Source: IAEA)

13. The Agency redesignated the Swiss Federal Institute of Technology Lausanne as an IAEA Collaborating Centre to support Member States in the area of advanced reactor experiments and high-fidelity multi-physics nuclear simulation techniques for open-source code development and validation.

14. The Agency also redesignated the Pakistan Institute of Engineering & Applied Sciences as an IAEA Collaborating Centre to support the Agency and Member States in research, development and capacity building activities for the multidisciplinary application of advanced and innovative nuclear technologies.



Fig. B.3. On the margins of the 67th General Conference in 2023, the Agency redesignated the Pakistan Institute of Engineering & Applied Sciences as an IAEA Collaborating Centre.

(Source: IAEA)

15. The Agency designated the Center for Science of Information at Purdue University, USA, as an IAEA Collaborating Centre to support the Agency and Member States in relevant activities on AI for nuclear power.

16. The Agency continues supporting the AAEA in the area of nuclear power capacity building and in May 2024 conducted the first training courses on advanced reactor technologies with hands-on learning using the Agency's nuclear power basic principle simulators. The training helped develop the required technical proficiency of the ten selected participants (to be trained as future trainers) by familiarizing them with Agency learning tools, in particular the iPWR simulator in preparation for the in-person training to be delivered later in 2024.

17. In May 2023, the Agency conducted a Webinar on Thorium-based Advanced Reactor Design Concepts where four external experts provided up-to-date information on the viability of novel engineering solutions using thorium as a fuel in water cooled reactors (WCRs) and MSRs. The webinar was attended by over 360 participants.

18. In June 2023, the Agency conducted the Joint 26th Meeting of the Technical Working Group on Advanced Technologies for Light Water Reactors (TWG-LWR) and the 22nd Meeting of the Technical Working Group on Advanced Technologies for Heavy Water Reactors (TWG-HWR), providing a global forum for exchanging information on national programmes and advice to the Agency on its activities in technology development for WCRs. The meeting addressed all agenda items and included 19 high-level presentations delivered by TWG-HWR and TWG-LWR members, including 15 Member States. Members of both groups acknowledged the Agency's efforts towards international collaboration and proposed possible future R&D topics and activities.

19. Member States are applying Roadmaps for a Transition to Globally Sustainable Nuclear Energy Systems (ROADMAPS) templates in national case studies under the ongoing INPRO collaborative projects entitled "ASENES pilot study on "Sustainable deployment scenarios for small modular reactors (SMRs)" (ASENES SMR) and "Potential of Innovative Nuclear Installations to Support Multi-Recycling of Fuel in a Nuclear Energy System" (STEP FORWARD). Jordan, Kenya and the Russian Federation incorporated ROADMAPS results in their case studies for planning the life cycle of their nuclear energy system.

20. The Agency conducted a Webinar-Workshop on Developing Roadmaps for Long Term Planning Towards Sustainable Nuclear Energy in February 2024, as part of the INPRO advisory service requested by Indonesia. The event facilitated the establishment of a national implementation strategy for nuclear power development. Twenty-eight Indonesian experts attended the event (remotely).

21. The Agency conducted a Hybrid-Technical Meeting of the ASENES Pilot Study on "Potential of Innovative Nuclear Installations to Support Multi-Recycling of Fuel in a Nuclear Energy System" (STEP FORWARD) in Vienna in December 2023 as part of the ASENES service. The meeting was held in a hybrid format with 28 participants from 15 Member States. New case studies were proposed by 3 Member States.



*Fig. B.4. Participants in the INPRO Technical Meeting ASENES STEP FORWARD, December 2023.
(Source: IAEA)*

22. Bangladesh, Egypt, Jordan, Indonesia, Kenya, the Republic of Korea, Mexico, Pakistan, Thailand, and the Russian Federation are applying the INPRO approach in 13 case studies under INPRO collaborative projects to perform a comparative evaluation of different types fuel cycles with SMR technologies, taking into account fuel supply and waste management as key indicators, and a comparative analysis of minor actinides transmutation efficiency and different maturity levels of infrastructure, to support sustainable nuclear fuel cycle.

23. The Agency continued the modernization of the ARIS database and made updates to SMR and microreactor design descriptions.



24. In June 2024, the Agency submitted its 2024 progress report on its ‘Energy Compact’ under SDG 7 (affordable and clean energy). This will contribute to the Energy Compacts Annual Progress Report 2024, to be released during the United Nations General Assembly High-level Week in September 2024.

25. The Agency is performing a review of Indonesia’s NESA SMR report, submitted in December 2023. The NESA covers all INPRO sustainability areas (economics, infrastructure, waste management, proliferation resistance, physical protection, environment and the safety).

26. In July 2024, the Agency will hold a joint ICTP–IAEA INPRO School on Strategic Planning for Sustainable Nuclear Energy Development with the objective of familiarizing participants with the basic concepts, methodology and tools for performing modelling, analysis, and sustainability assessments of nuclear energy systems.

27. In October 2023, the Agency held an Interregional Training Course on Application of INPRO Nuclear Energy System(s) Assessment Methodology for Sustainability Assessment of Small Modular Reactors (SMRs) and Microreactors (MRs) in Saint Petersburg, Russian Federation. The event was attended by 21 participants from 15 Member States.

28. In June 2024, the Agency held a Regional INPRO School on Strategic Planning for Sustainable Nuclear Energy in Uzbekistan. The training helped develop and strengthen competencies for long term strategic planning of sustainable nuclear energy systems at the national, regional, and global levels. The event was attended by 27 participants from 7 Member States.

29. At the request of the China Nuclear Energy Association, the Agency held the pilot INPRO service providing National Training on INPRO Methods and Tools for Sustainability Assessment of Nuclear Energy Systems in Vienna in November 2023. China requested INPRO to guide them in assessing the sustainability of the high temperature gas-cooled microreactor design. INPRO worked with eight Chinese participants.

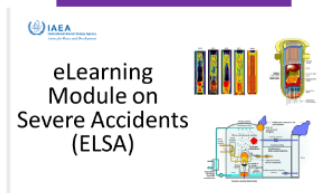


*Fig. B.5. Participants in the INPRO pilot service providing National Training with China.
(Source: IAEA)*

30. In April 2024, the Agency conducted an Assist Visit to Beijing to advise on the application of INPRO methodology for NESAs and on sustainability, specifically for their microreactor.

31. The Agency is developing e-learning Materials on post-irradiation examination. As part of this initiative, 17 e-learning modules on nuclear fuel were published in 2023.

32. The Agency developed e-learning modules on all reactor lines and recently added a module on thorium-based reactor designs. Most of the modules are translated into all or most of the official languages of the United Nations.



eLearning Module on Severe Accidents

This eLearning module provides knowledge about the complex physics of severe accidents in water cooled

[Click to enter this course](#)



Nuclear Reactor Technology Assessment for Near Term Deployment

This module describes Nuclear Reactor Technology Assessment for Near Term Deployment, and includes :

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33. The Agency launched the Hub for On-line Nuclear Power Plant Part-Task Simulators (HOPS) platform with four educational part-task basic principle simulators, and published training course series (manuals), including exercises and installation instructions, to support education and training within national nuclear power programmes in Member States with online, graphically interfaced NPP part-task simulators.

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Hub for On-line Nuclear Power Plant Part-Task Simulators (HOPS)

HOPS has been established in order to support the education and training within the national nuclear power programmes of the IAEA Member States with the help of graphically interfaced nuclear power plant part-task simulators available on the HOPS online platform. In particular, HOPS provides:

- A collection of nuclear power plant part-task simulators that are developed by IAEA Member States with detailed descriptions on their applications and use;
- Support to organizations and/or Member States requiring assistance in their nuclear power education and training programmes by making the relevant skills and knowledge available as well as transferring knowledge on educational and training approaches for the use of the part-task nuclear power plant simulators from Member States with well-established educational and training programmes in the nuclear field;
- An expanded range of training and demonstration activities on nuclear power plant fundamentals with part-task nuclear power plant simulators, such as operational performance of systems and subsystems and their roles in the overall operation of a nuclear power plant.

34. The Agency conducted the Hybrid National Training Course on Reactor Technology Assessment, in March 2023, Cairo, attended by 25 participants. This training course provided skills in applying the Agency's reactor technology assessment methodology and the IT Toolkit using information about SMR designs from the Advanced Nuclear Power Reactors (ARIS) database.

35. The Agency conducted the Interregional Workshop on Advances in Design of Generation-IV Small and Medium Sized or Modular Reactors, hosted by the China Institute of Atomic Energy in Beijing in June 2024. The event discussed the innovative designs of small and medium sized or modular reactors (SMRs) within the framework of the six concepts outlined by the Generation IV International Forum (GIF).

36. The Agency conducted a Technical Meeting on Compatibility Between Coolants and Materials for Fusion Facilities and Advanced Fission Reactors in October–November 2023 to share information on recent Member State and Agency initiatives relating to fusion development and deployment and to address general issues of heat and mass transfer problems specific to advanced fission and fusion reactors.

37. The Agency has established an online portal for Open-source Nuclear Codes for Reactor Analysis (ONCORE) for the development and application of open-source software to support research, education and training in the field of nuclear science and engineering.

38. The Agency has developed an e-learning course entitled “Multi-physics modelling and simulation of nuclear reactors using OpenFOAM” that includes six online lectures and supplementary materials. OpenFOAM is an industrial-level, open-source toolbox for computational fluid dynamics computations and a library for the finite-volume discretization and parallel solution of partial differential equations.



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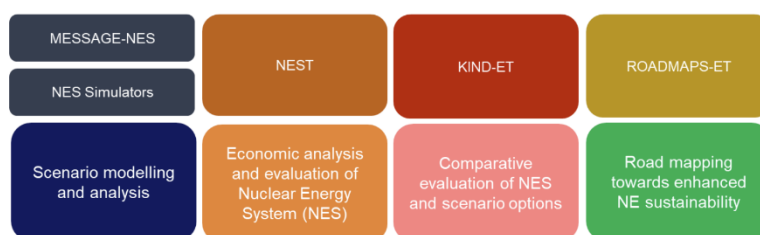


INPRO Methods and Tools for Modelling and Analysis of Nuclear Energy Systems

This course provides users with INPRO methods and tools for modelling and analysis of nuclear energy systems (NESs) to Member States to enhance national capability on strategic planning for sustainable development of nuclear energy systems.

The course materials can be used for familiarisation with INPRO methods and tools for INPRO Schools and trainings, and for conducting studies within INPRO collaborative projects.

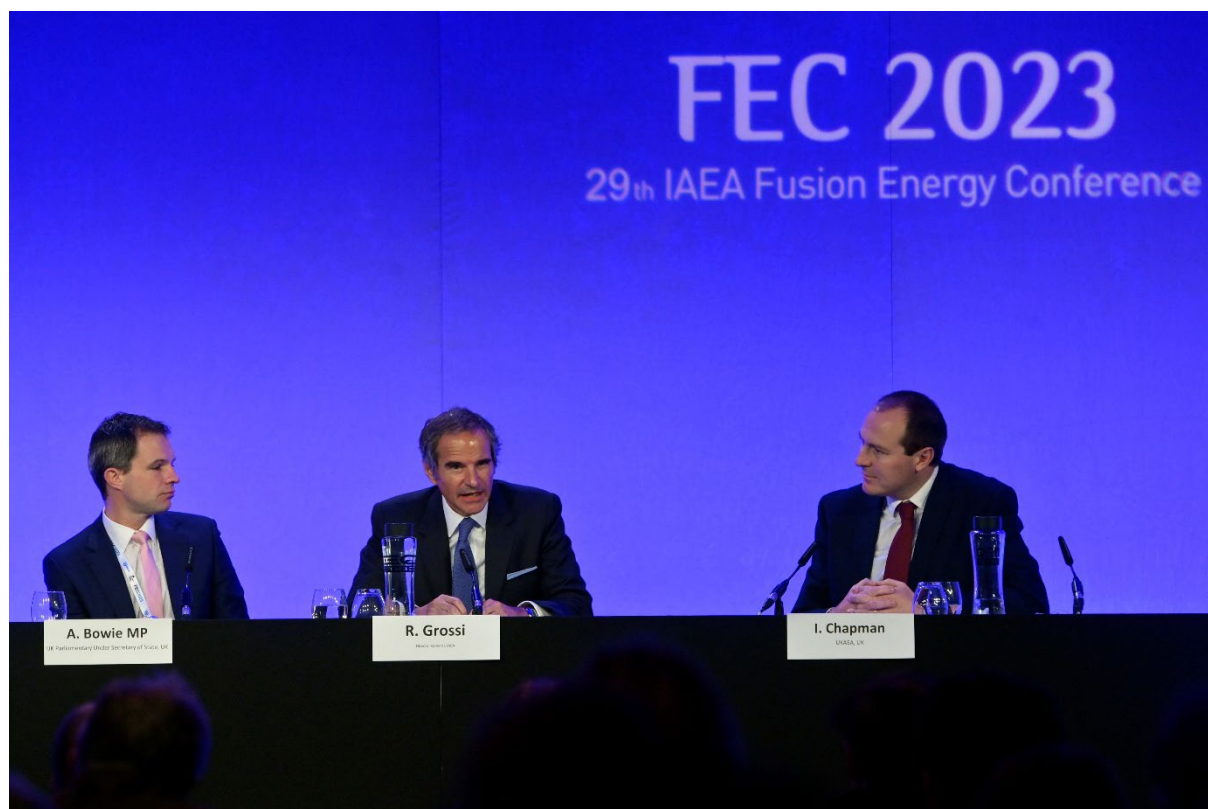
Please contact [INPRO Team](#) if you have any questions or feedback.



39. The Agency developed an e-learning courses on INPRO methods and tools for strategic planning for sustainable nuclear energy that provides users with tools to enhance national capabilities in strategic planning for sustainable development of nuclear energy systems.

40. The Agency held a Technical Meeting on the INPRO collaborative project entitled “Case Study on Nuclear Hydrogen Systems: Drivers and Institutional, Economic and Legal Impediments (INPROHydrogen Study)” in May 2024. The event was attended by 37 participants from 17 Member States.

41. The 29th IAEA Fusion Energy Conference was held in London in October 2023, hosted by the UK through the United Kingdom Atomic Energy Authority. The event attracted over 2000 participants (about 1000 in person) from more than 80 countries. For an entire week, fusion scientists, engineers, policymakers, regulators and entrepreneurs gathered in London to review recent developments and chart a course to a future of fusion energy. The conference was organized around 23 technical sessions with over 100 talks and more than 800 poster presentations. During the conference, the Director General introduced the first-ever *IAEA World Fusion Outlook*, a global reference for authoritative information on the latest developments in fusion energy, and announced the inaugural meeting of the World Fusion Energy Group, to be held in 2024.



*Fig. B.6. 29th IAEA Fusion Energy Conference High Level Panel in London, 16 October 2023.
(Source: IAEA)*

42. The Third Research Coordination Meeting on Pathways to Energy from Inertial Fusion: Materials Research and Technology Development was held in a virtual format from 12 to 15 December 2023 with 28 participants from 17 Member States. The event reviewed and summarized the ongoing activities of the CRP with the same title and initiated the drafting of the associated Agency publication.

43. The Agency published *Considerations of Technology Readiness Levels for Fusion Technology Components* (IAEA-TECDOC-2047) in March 2024. The publication addresses the growing need for the use of technology readiness levels in fusion programmes, and it is expected that their use will continue to increase in the future. This publication is intended for technologists, researchers, university professors and students, regulatory experts, nuclear engineers, and fusion plant planners.

44. The Agency published *Plasma Physics and Technology Aspects of the Deuterium–Tritium Fuel Cycle for Fusion Energy* (IAEA-TECDOC-2049) in March 2024. In addition to the overview of plasma physics and technology aspects of the deuterium–tritium (D–T) fuel cycle in magnetic fusion devices, this publication provides requirements for all the important areas in all stages of the lifetime of fusion fuel cycle facilities to protect workers, the public and the environment from harmful effects of ionizing radiation and for the safety of facilities and activities that give rise to radiation risks.

Approaches to Supporting Nuclear Power Infrastructure Development

A. Background

1. In resolution GC(67)/RES/10.B.7, the General Conference encouraged the Secretariat to pursue its activities in the area of nuclear infrastructure development provided to Member States embarking on or expanding nuclear power programmes, and emphasized the necessity for Member States to ensure the development of the appropriate legal and regulatory frameworks, which are necessary for the safe introduction of nuclear power.
2. The General Conference also requested the Secretariat to continue to incorporate lessons learned from INIR missions and to enhance the effectiveness of such INIR activities, including based on the IAEA Technical Document on 10 years of INIR missions (IAEA-TECDOC-1947); urged Member States to develop and keep updated action plans to address the recommendations and suggestions provided by the INIR missions; to participate in the development of their Member State-specific IWPs, to implement these IWPs to plan and integrate the IAEA support; to use the Country Nuclear Infrastructure Profiles (CNIPs) as a tool for monitoring and reporting progress; and to make use of INIR follow-up missions for each phase of the programme to assess progress and determine whether recommendations and suggestions were successfully implemented.
3. The General Conference encouraged the Secretariat to be prepared to perform INIR missions in all United Nations official languages; to allow the highest level of information exchange during the missions; and to expand the panel of related experts, especially in countries using one of these languages other than English as a working language, while ensuring that the use of such experts does not constitute a conflict of interest or convey commercial advantage.
4. In the same resolution, the General Conference requested the Secretariat to continue to update the nuclear infrastructure bibliography, as useful tools to help Member States plan technical cooperation and other assistance for the development of their national nuclear power programmes such as training needs for capacity building.
5. The General Conference encouraged the Secretariat to facilitate, where possible, international coordination, including through consultations with Member States that are providing financial support for nuclear infrastructure development activities, to improve efficiency and reduce overlap and duplication of multilateral and bilateral assistance to Member States, provided it avoids all conflicts of interest and excludes areas which are commercially sensitive.
6. The General Conference also encouraged the Agency to review and adapt the evaluation methodology, taking into account the work being coordinated and carried out under the Agency-wide SMR Platform and the activities being undertaken under the SMR Regulators' Forum and the NHSI.
7. In the same resolution, the General Conference encouraged the Agency to continue to organize workshops on management systems and the leadership roles and responsibilities of senior management in the context of a new nuclear power programme.
8. Lastly, the General Conference encouraged the Secretariat to finalize the reactor technology assessment methodology to incorporate the lessons learned in seven years of its application with

embarking countries, and to expand the methodology to be relevant to advanced reactor technology, including SMRs, and non-electric applications.

9. The General Conference, in resolution GC(67)/RES/10.B.9, requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors as appropriate and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

10. The Secretariat continued its efforts in providing integrated Agency assistance to Member States embarking on or expanding nuclear power programmes based on *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1, Rev. 1). This support is coordinated through the interdepartmental Nuclear Power Support Group, which provides policy and direction at Divisional Director level as well as the Infrastructure Coordination Group, which provides direction at the Section Head level.

11. In addition, Member State-specific core teams include representatives from all relevant Departments (Nuclear Energy, Nuclear Safety and Security, Safeguards, and Technical Cooperation) and the Office of Legal Affairs. The core teams participated in bilateral meetings with 11 Member States (Bangladesh, Egypt, Ghana, Jordan, Kenya, Nigeria, Poland, Saudi Arabia and Sri Lanka) to develop or update their national IWPs and CNIPs to plan and tailor Agency assistance to the current needs of each Member State and to monitor the progress of national infrastructure development following an INIR mission.

12. The Secretariat continued to learn lessons from the conduct of self-evaluation report support missions, pre-INIR, INIR and INIR follow-up missions, which are taken into consideration during the conduct of further missions, in the development of new and the revision of existing publications and in the overall support provided to Member States to enhance their effectiveness.

13. A registry containing all recommendations and suggestions made during previous missions is maintained and updated regularly, supporting the development of tools, publications, workshops and trainings related to nuclear infrastructure for new and expanding Member States.

14. The Secretariat continued to perform INIR missions and, when appropriate, accept documentation in a mixture of English and one of the official languages of the United Nations to facilitate the highest level of information exchange. While self-evaluation reports are expected to be submitted in English, supporting documents can be provided in other official languages. The main INIR mission report is published in English.

15. Through regular training of external experts and relevant Agency staff, the continued sustainability of the INIR service and the availability of a broad pool of experts is being ensured. The Secretariat continued to ensure that the use of external experts for INIR missions did not constitute a conflict of interest or provided a commercial advantage.

16. Supported by external experts, the Secretariat continued to undertake regular systematic reviews of the Nuclear Infrastructure Bibliography to identify areas not covered by existing Agency publications and those in need of revision. The most recent meeting was held in June 2024. The regularly updated Nuclear Infrastructure Bibliography is published on the Agency website, structured according to the 19

infrastructure issues of the Milestones Approach, and has proven to be a useful tool for supporting embarking countries in building competence.

17. To the extent possible, and when permitted by the Member State, the Secretariat continued to facilitate the incorporation of multilateral and bilateral assistance into the IWP. Member States are encouraged to share information about activities related to infrastructure development carried out in cooperation with other international organizations, donors and the vendor in the interest of maximizing the benefit of Agency support and avoiding overlap with third party support.

18. The Agency reviewed the conditions contained in the publication *Evaluation of the Status of National Nuclear Infrastructure Development Methodology (Rev.2)* for potential considerations related to SMRs and developed additional guidance in this regard. The additional guidance was used for the INIR Phase 1 mission to Estonia in October 2023. The feedback from the missions focusing on SMRs will be incorporated into the Evaluation Methodology in the next revision.

19. The Agency continued to deliver Interregional Nuclear Infrastructure Training (INIT) courses, through interregional TC projects, to increase awareness and understanding of the Milestones Approach. To continue delivering assistance to Member States in nuclear infrastructure development, a new interregional project, TC project INT2024, “Supporting Member States Introducing or Expanding Nuclear Power Programmes to Develop a National Infrastructure for a Safe, Secure and Peaceful Nuclear Power Programme”, which commenced in January 2024 in continuity of TC project INT2021, “Supporting Member States Considering or Planning to Introduce or Expand Nuclear Power Programmes in Developing the Sustainable National Infrastructure Required for a Safe, Secure and Peaceful Nuclear Power Programme”, which ended in December 2023. Under TC project INT2021, trainings were provided to 162 participants from 38 Member States through 13 interregional training courses. Under TC project, INT2024, approximately 20 interregional training courses will be provided to participants from around 40 Member States annually.

20. Within the framework of the ongoing PUI project entitled “Supporting the Development of Management Systems and Nuclear Safety Culture in Countries Introducing Nuclear Power Programmes” (Phase 2) the Agency continued to offer tailored assistance in the area of management systems in the form of workshops, expert missions, consultancy meetings and scientific visits through IWP meetings with Member States embarking on new or expanding existing nuclear power programmes. Activities under this project supported the development and review of management system documentation in key organizations and enhanced the senior managers’ understanding of the role of management systems to help ensure safety, security, effectiveness and sustainability.

21. The coordination and sequencing of Agency services and assistance for Member States embarking on a nuclear power programme or expanding such programmes is typically addressed in the Integrated Work Plan (IWP) and mid-term IWP meetings between Member States and Agency cross-departmental core teams. Eleven IWP or mid-term IWP meetings have been conducted since the last General Conference.

22. Three publications were issued: *Enhancing National Safeguards Infrastructure to Support the Introduction of Nuclear Power* (IAEA Nuclear Energy Series No. NG-T-3.25), *Managing Human Resources in the Field of Nuclear Energy* (IAEA Nuclear Energy Series No. NG-G-2.1). A revised version of *Environmental Protection in New Nuclear Power Programmes* (IAEA Nuclear Energy Series No. NG-T-3.11 (Rev.1)) was also issued.

23. The Agency conducted a Technical Meeting on Management Systems to Support New Nuclear Power Programmes in June 2024 to discuss lessons learned and good practices related to the establishment and assessment of management systems to support new nuclear power programmes.

24. The Agency conducted seven expert review missions on management systems to Member States embarking on new nuclear power programmes, namely in Poland in September and November 2023, Egypt and Kenya in September 2023, Jordan in November 2023, Nigeria in February 2024 and Ghana in July 2024. A workshop will be held in Bangladesh in August 2024. Reports containing findings and suggestions are provided to Member States after the expert review missions.



*Fig. B.1. Expert review mission on management systems in Kenya, September 2023.
(Source: NuPEA, Kenya).*

Small and Medium Sized or Modular Reactors — Development and Deployment

A. Background

1. In resolution GC(67)/RES/10.B.8, the General Conference encouraged the Secretariat to continue its efforts to facilitate support to Member States in a consistent and coordinated manner, including through the tools and activities developed in the framework of the SMR Platform.
2. The General Conference requested that the Secretariat ensure coordination between the SMR Platform and the NHSI and report back to Member States in this regard. It also requested the Agency to further elaborate its strategic vision, programmatic objectives and expected outcomes from the NHSI.
3. The General Conference also encouraged the Secretariat to take into account Member States' expertise on SMR-related issues, to consider how to best to engage Member States across all relevant initiatives in this regard, and to take note of relevant initiatives across other international organizations.
4. In the same resolution, the General Conference encouraged the Secretariat to continue taking appropriate measures to assist Member States, particularly embarking countries, engaged in the process of preparatory actions with regard to demonstration projects and encouraging the development of safe, secure, economically viable SMRs with proliferation resistance and comprehensive strategies for decommissioning and radioactive waste and spent fuel management.
5. The General Conference called upon the Secretariat to continue to promote effective international exchange of information on options with regard to SMRs available internationally by organizing technical meetings and workshops, as appropriate, and to produce relevant status and technical reports. It also invited the Secretariat and Member States that are in a position to offer SMRs to foster international cooperation in undertaking studies of the social and economic impacts of SMR deployment in embarking countries, their potential integration with renewables, and their non-electric applications.
6. The General Conference encouraged the Secretariat to continue consultations and interactions with interested Member States, the competent organizations of the United Nations system, financial institutions, regional development bodies, and other relevant organizations regarding advice on the development and deployment of SMRs.
7. In the same resolution, the General Conference encouraged the Secretariat to continue working on defining indicators of safety performance, operability, maintainability, and constructability so as to assist countries in assessing advances in SMR technologies and developing guidance for SMR technology implementation. It also encouraged the Secretariat to continue providing guidance for technology development and deployment, safety, security, economics, licensing, and regulatory reviews of SMRs of various designs and to foster collaboration among interested Member States working to license and deploy SMRs.
8. Finally, the General Conference encouraged the Secretariat to continue developing generic user requirements and criteria, sharing information on codes and standards, and experiments and validation of simulation computer codes for SMRs, as well as accelerating the implementation of a nuclear infrastructure for SMRs in the framework of the workstreams of the NHSI and in cooperation with Member States and relevant stakeholders. It also invited the Director General to raise appropriate funding from extrabudgetary sources in order to support the activities under the SMR Platform and to

contribute to the implementation of Agency activities relating to the sharing of experience and lessons learned from the development and deployment of SMRs.

9. The General Conference further requested the Director General to continue to report on: the activities coordinated and carried out by the SMR Platform, and progress made on the NHSI; and progress made in the research, development, demonstration and deployment of SMRs in interested Member States intending to introduce them to the Board of Governors, as appropriate, and to the General Conference at its sixty-eighth (2024) regular session.

B. Progress Since the 67th Regular Session of the General Conference

10. In November 2023, the Agency, through the SMR Platform, organized the first International Symposium on the Deployment of Floating Nuclear Power Plants — Benefits and Challenges. The event was attended by 161 participants from 45 Member States and 6 invited organizations. The event reviewed past and present experiences in deploying floating nuclear power plants (FNPPs), including an overview of current development activities; discussed the life cycle of FNPPs with a focus on shipyard production and deployment scenarios; explored and discuss the feasibility of FNPP deployment; and examined legal aspects.



*Fig. B.1. The Director General and co-chairs delivering opening statements to the first International Symposium on the Deployment of Floating Nuclear Power Plants — Benefits and Challenges.
(Source: IAEA)*

11. Through NHSI, the Agency is bringing together decision makers from governments, regulators, designers, technology holders, operators, non-traditional end users, and other international organizations to collaborate under one framework.

11.1. In September 2023, the NHSI Industry Track Topical Group 2 issued a paper entitled “Why Serially Manufactured Industrial Products are Crucial for Reliable Deployment Of Small Modular Reactors”. The paper proposes using serially manufactured or ‘off-the-shelf’ commercially available parts rather than bespoke designs to speed up procurement, reduce production delays and costs and ensure reliable supply chains compliant with safety requirements.

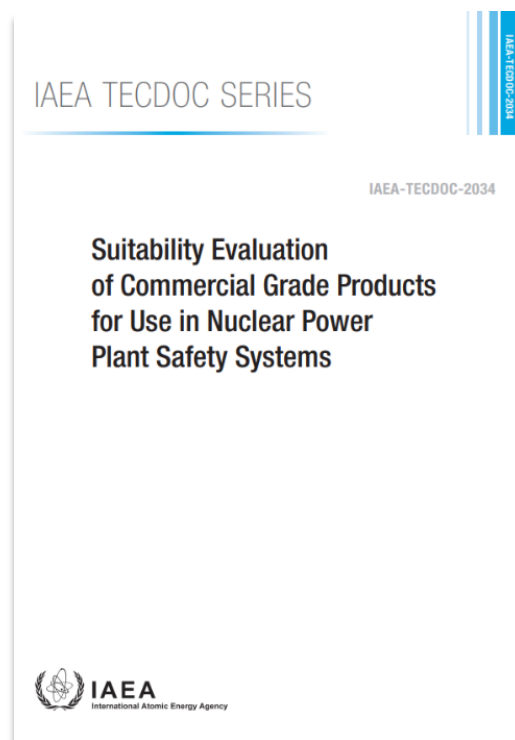
11.2. In December 2023, Topical Group 2 also released *Suitability Evaluation of Commercial Grade Products for Use in Nuclear Power Plant Safety Systems* (IAEA-TECDOC-2034), which provides practical guidance based on previous good practices and is to be used in conjunction with publications in the IAEA Safety Standards Series and other publications dealing with management systems, project management, supply chain management and quality.

11.3. In February 2024, the NHSI Industry Track Topical Group 4 hosted a technical meeting to share and collect Member States’ comments on the proposed final draft of the IAEA Technical Document provisionally entitled *Considerations to Facilitate the Accelerated Deployment of Small Modular Reactors*. Comments raised during this meeting will be addressed via consultancy meetings in the latter part of the second quarter and in the third quarter, and the publication process is expected to begin in late 2024.

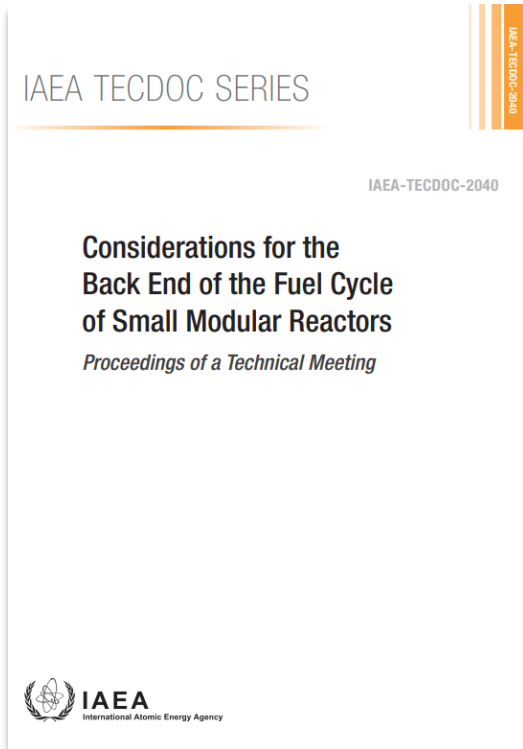
11.4. In May 2024, the NHSI Industry Track Topical Group 1 hosted a technical meeting to share and receive comments on its final draft document on high level user requirements for SMRs. The draft document includes a comprehensive list of conditions that a future owner operator expects a design to comply with, aims to help technology holders develop designs in line with the needs of future users, and may serve as a basis for bid invitation specifications.

11.5. In June 2024, the NHSI Industry Track Topical Group 3 hosted the first Network for Experiments and Code Validation Sharing (NEXSHARE) Workshop in Vienna. The workshop provided a platform to identify opportunities for collaborations between entities operating experimental facilities, technology holders and technical support organizations (TSOs). A corresponding CONNECT Network has been established to support the NEXSHARE platform.

12. The Agency is peer reviewing case study reports as part of the ASENES pilot study “Sustainable Deployment Scenarios for Small Modular Reactors” that promotes the use of INPRO tools for modelling and analysis of nuclear energy system and scenario options involving SMRs. During the reporting period, five case studies were produced by four Member States, (Indonesia, Kenya, Mexico and the Russian Federation (two case studies)).



13. The new CRP entitled “Challenges, Gaps and Opportunities for Managing Spent Fuel from Small Modular Reactors” was launched in November 2023 and is open for research agreement/contract



proposals. The objective of the CRP is to identify, for the different SMR technologies in development worldwide, generic key parameters/criteria to design the back end programmes of different fuel cycle options.

14. *Considerations for the Back End of the Fuel Cycle of Small Modular Reactors: Proceedings of a Technical Meeting* (IAEA-TECDOC-2040), published in December 2023 identifies the opportunities and challenges faced at all stages (e.g. storage, transportation, reprocessing, recycling and disposal) in managing spent fuels from different SMR technologies, gaps in existing infrastructure and the knowledge required to ensure an integrated approach to the overall spent fuel management strategy, as well as potential ways to move forward in addressing them in the short, medium and long term.

15. The conditions contained in the Evaluation Methodology, with additional considerations related to SMRs, were used for the INIR Mission to Estonia – which is only considering SMR technology - in October 2023.

16. In 2023, the Agency initiated a full scope NESA with Viet Nam and Seaborg Technologies on the compact molten salt reactor design using the INPRO methodology. INPRO continues to support Viet Nam and Seaborg Technologies on the NESA self-assessment, specifically addressing sustainability in the following areas: infrastructure, proliferation resistance, and economics for completion in 2024.

17. An Interregional Workshop on Technology Development and Applications of SMRs and an Interregional Workshop on Generic User Requirements and Criteria for SMRs (NHSI Industry Track Topical Group 1) were held in China in September 2023. The events, which were attended by 237 participants from 52 Member States, allowed for the sharing of information about the development of specific SMR technologies for various applications, including updates about the technology readiness level of SMR designs; and provided information on safety and security aspects for SMRs and on practices and experience in licensing SMR designs and how the Agency can support Member States in these areas.



Fig. B.2. A visit to a NPP construction site held on the margins of the combined Interregional Workshops on Technology Development and Applications and the Generic User Requirements and Criteria for SMRs, held in China in September 2023. (Source: IAEA)

18. The Agency conducted the Interregional Training Course on the IAEA Reactor Technology Assessment for Small Modular Reactors in Copenhagen in August 2023, which helped raise awareness, improve knowledge and strengthen capacity building in embarking countries in relation to the reactor technology assessment applied to SMRs. The course was attended by 30 participants from 24 Member States.



FIG. B.3. The Interregional Training Course on the IAEA Reactor Technology Assessment for Small Modular Reactors, held in Copenhagen in August 2023, in the Niels Bohr classroom where he used to teach students. (Source: IAEA)

19. The Agency has started preparations for the first ever International Conference on Small Modular Reactors and their Applications, to be held in Vienna in October 2024. The purpose of the conference is to provide a platform to take stock of progress and discuss the opportunities, challenges and enabling conditions for the accelerated development and safe and secure deployment of SMRs. The conference has attracted 420 submissions of abstracts and papers. The conference, which will be opened by the Director General, will feature keynote speeches, plenary panels, parallel sessions for 17 technical tracks, an ‘industry night’ and exhibitions.

20. The publication *Status of Molten Salt Reactor Technology* (IAEA Technical Report Series No. 489), published in November 2023, provides a summary of the current knowledge on the status of research, technological developments, reactor designs and experiments in advanced reactors fuelled and/or cooled by molten salt.

21. A Workshop on Core and Plant Simulation with an Emphasis on Fuel Behaviour in Light Water Reactor Based Small Modular Reactors was conducted in Vienna in February 2024. It was attended by 96 experts who exchanged information on multi-physics and multi-scale simulations of SMR cores (loaded with or without ATF fuels), using different computation approaches (neutronics, thermal-hydraulics and thermo-mechanics), to compare SMR fuel behaviour simulation. They also discussed the outcomes of the Euratom Horizon 2020-funded McSAFER project on high performance advanced methods and experimental investigations for the safety evaluation of generic SMRs. Acknowledging the impressive results of the Euratom Horizon 2020-funded McSAFER project, participants recommended that the Agency develop a publication and initiate activities in benchmarking simulations of light water reactor based SMRs.

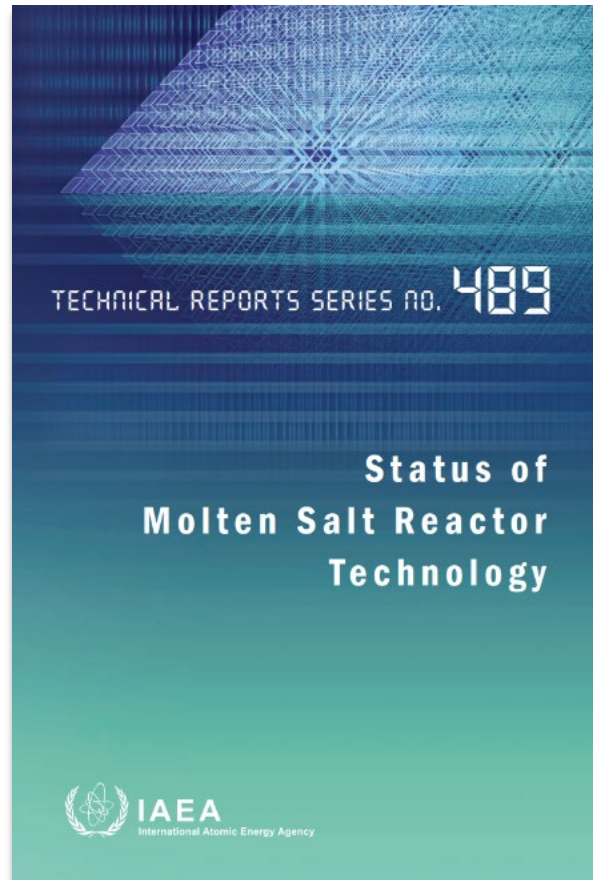


Fig. B.4. Participants in the Workshop on Core and Plant Simulation with an Emphasis on Fuel Behaviour in Light Water Reactor Based Small Modular Reactors, held in February 2024.

(Source: IAEA)

22. In May 2024, the Agency held the 22nd INPRO Dialogue Forum on Successful Development and Sustainable Deployment of SMRs at the Jeju International Convention Center in the Republic of Korea. The event was attended by 172 participants from 32 Member States and 1 international organization.



*Fig. B.5. Participants in the 22nd INPRO Dialogue Forum, held at the Jeju International Convention Center, Republic of Korea, in May 2024.
 (Source: Korea Nuclear International Cooperation Foundation)*

23. In March 2024, the Agency initiated a collaborative project to develop the terms of reference for FRAMES, which is a tool for assessing and analysing energy systems that integrate nuclear with other energy sources, in particular renewables. Thirty-two participants from 17 Member States and 2 international organizations took part.

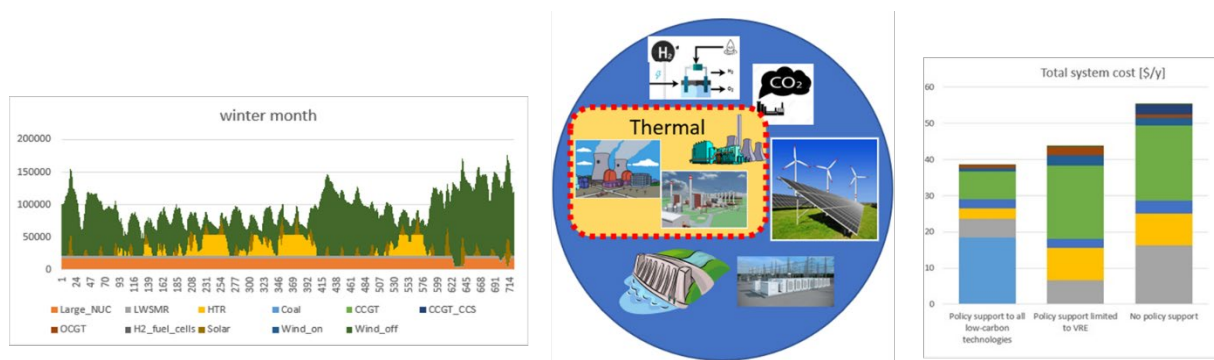


Fig. B.6. FRAMES output showing intermittent energy output and total system cost, for energy systems combining renewables with nuclear power. (Source: IAEA)

24. Under the framework of the SMR Platform, the Agency, at the request of Jordan, conducted an expert mission on Using Small Modular Reactors Including Economic Analysis for Electric Power Generation and Nuclear Desalination. As an outcome of the expert mission, the Agency produced a

report entitled “Final IAEA Expert Mission Report” providing suggestions on how to advance the country’s nuclear power programme towards the goal of deploying an SMR for desalination of seawater, which delivered to the Jordan Atomic Energy Commission in October 2023. Through this expert mission, the SMR platform leveraged Agency-wide expertise in all the areas necessary to advance country’s power programme.

25. Upon request of the Mongolia’s Nuclear Energy Commission, in February 2024 the SMR Platform organized a joint Webinar on SMR technologies and nuclear perspectives for Mongolia, delivering information on the Agency’s activities in the area of SMRs, including various services to support Member States in SMR deployment. The webinar was attended by 53 representatives of various Mongolian stakeholders. As a result, Mongolia joined the interregional TC project INT2023 entitled “Supporting Member States’ Capacity Building on Small Modular Reactors and Micro-reactors and their Technology and Applications as a Contribution of Nuclear Power to the Mitigation of Climate Change”.



Fig. B.7. Participants in the expert mission “Using Small Modular Reactors Including Economic Analysis for Electric Power Generation, and Nuclear Desalination”. (Source: IAEA)

Nuclear Knowledge Management

A. Background

1. In resolutions GC(66)/RES/9.C and GC(67)/RES/10.C, the General Conference commended the Director General and the Secretariat for their significant, interdepartmental efforts in addressing issues of preservation and enhancement of nuclear knowledge, and the Secretariat for its support to Member States in applying a comprehensive methodology and guidance for managing nuclear knowledge, including through the Knowledge Management Assist Visit (KMAV) programme and seminars in Member States, and for fostering nuclear knowledge management (NKM) as a vital component of an integrated management system. It encouraged the Director General and the Secretariat to continue to strengthen their current and planned efforts in this area in a holistic, interdepartmental manner, while consulting and engaging Member States and other relevant international organizations, and to further increase the level of awareness of efforts in managing nuclear knowledge.
2. The General Conference requested the Secretariat to continue to gather, and make available to Member States, nuclear data, information and knowledge resources on the peaceful use of nuclear energy, including the International Nuclear Information System (INIS) and other valuable databases as well as the IAEA Library and the International Nuclear Library Network. The General Conference called on the Secretariat to continue to focus, in particular, on activities aimed at helping interested Member States assess their human resource needs and to identify ways to address those needs, inter alia by encouraging the development of new tools and opportunities to gain practical experience through fellowships.
3. The General Conference invited the Secretariat, in consultation with Member States, to further develop and disseminate guidance and methodologies for planning, designing, implementing and evaluating NKM programmes and practices. It requested that the Secretariat continue to develop activities, tools and services in the areas of knowledge management and human resources development (HRD) in an integrated manner. It also requested the Secretariat to promote gender equality and diversity in the context of NKM activities.
4. The General Conference requested the Secretariat to ensure effective coordination among the Agency's Major Programmes, given the cross-cutting, interdepartmental nature of knowledge management issues and activities. It encouraged the Secretariat to continue to facilitate the establishment of and maintain effective human resource and knowledge management networks in developing countries, and where appropriate in collaboration with other United Nations organizations and with the support of existing such networks in developed countries.
5. The General Conference requested the Director General to take into account the continuing high level of interest of Member States in the range of issues associated with NKM when preparing and carrying out the Agency's programme.
6. Furthermore, in resolutions GC(66)/RES/9.C and GC(67)/RES/10.C the General Conference requested the Director General to report on progress made in the implementation of this resolution to the Board of Governors and to the General Conference at its sixty-eighth (2024) session under an appropriate agenda item. This Annex has been prepared in response to that request.

B. Strengthening Nuclear Knowledge Management

7. The Agency has merged two Technical Working Groups (on NKM and HRD) to provide a more efficient, cost-effective service with a broader and more connected range of support activities in line with the current practices in Member States. The first meeting of a new Technical Working Group on Managing Human Resources and Knowledge (TWG-MHRK) was held in May 2023. Eighteen members of a new working group were endorsed. Eight members of the Working Group participated in person; the remainder participated virtually. Two international organizations — the European Nuclear Engineering Network and the OECD — participated in the meeting. The discussions covered NKM topics such as knowledge loss risk management, monitoring implementation of knowledge management programme, nuclear education and networks. The membership of the TWG-MHRK has broad regional representation.

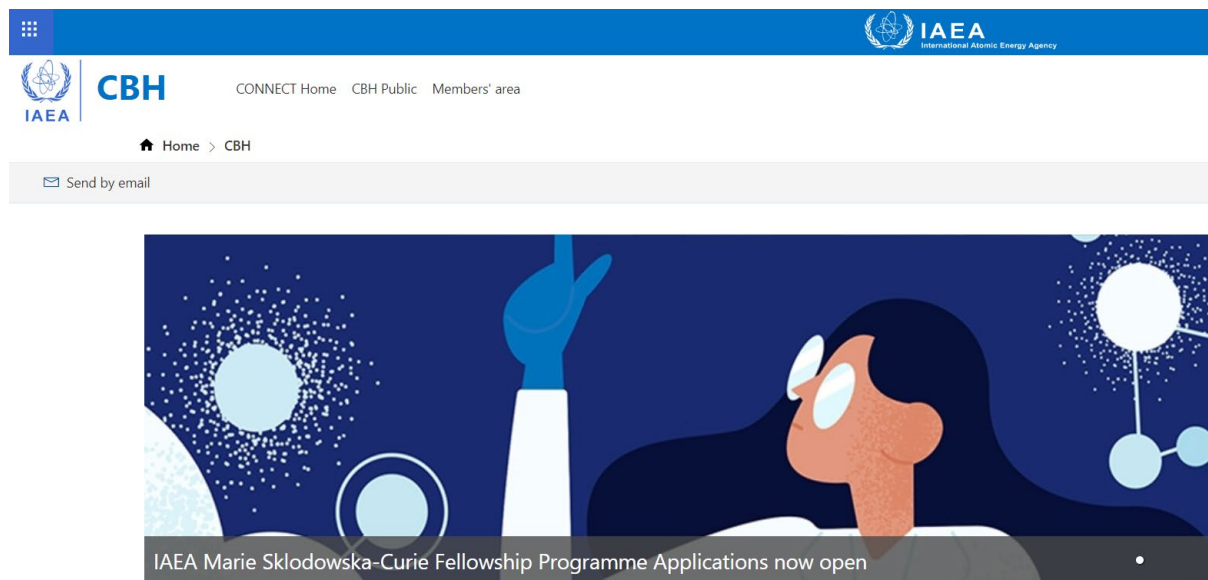
8. A Workshop on the Development of Technical Support Organization (TSO) for nuclear power programme/project was conducted in Riyadh in January 2024, supporting planning and activities to build capacity for a future TSO. A Combined review and assessment of the “Polskie Elektrownie Jądrowe staffing plan and human resources development plan for the Polish Nuclear Power Programme” was conducted in Poland in May 2024, to support next phases of the national programme according to IAEA milestones approach.

9. The Agency held the International Conference on Nuclear Knowledge Management and Human Resources Development: Challenges and Opportunities in Vienna in July 2024. The event reviewed developments in the global situation relating to NKM and HRD. The conference also considered current and future challenges and opportunities and provided participants with visibility regarding practical solutions that they can use at organizational, national and international levels to develop and maintain the human resources needed to support safe and sustainable nuclear power programmes. Finally, the event reviewed global developments in HRD and NKM, offering practical solutions for various levels.



Fig. B.1. Opening of the International Conference on Nuclear Knowledge Management and Human Resources Development: Challenges and Opportunities in Vienna in July 2024. (Source: IAEA)

10. The Nuclear Energy Capacity Building Hub was launched in 2023 to provide Member States with technical information in the areas of stakeholder engagement, leadership and human resource development, training and qualification and relevant areas of management to support the development of nuclear new build projects and sustain established nuclear power projects and programmes. It includes detailed information on the systematic approach to training methodology, a database of human resource activities and processes for gender quality, and leadership development programme guidelines.



Welcome to the IAEA Nuclear Energy Capacity Building Hub

The Nuclear Energy Capacity Building Hub (CBH) is a new digital platform that offers easy access for IAEA Member States to the latest information on IAEA activities, guidance documents and examples of good practices in all areas of human resource development for nuclear power programmes, including:

11. The Agency-facilitated International Nuclear Management Academy (INMA) supports universities to establish and deliver master's degree programmes focusing on technology management for the nuclear sector, including nuclear power programmes, nuclear applications, and radiological technologies. It provides guidance for master's degree programmes that have a particular focus on the advanced aspects of management and leadership required by the nuclear sector.

12. The Agency conducted seven INMA missions, including an INMA Assist Visit in March 2023 and an INMA Assessment Visit in February 2024 to Sofia University "St. Kliment Ohridski" in Bulgaria; an INMA Assessment Visit to the Korea Electric Power Corporation (KEPCO) International Nuclear Graduate School in the Republic of Korea in May 2023; an INMA Assessment Visit to the University of Idaho in the USA in June 2023; an INMA Assist Visit to Ontario Tech University in Canada in July 2023; an INMA Assessment Visit to Harbin Engineering University in China; and an INMA Assist Visit to Yerevan State University in Armenia in June 2024. The following three universities were awarded full INMA membership in September 2023: the University of West Bohemia, Czechia; the KEPCO International Nuclear Graduate School (KINGS), Republic of Korea; and the University of Idaho, USA.

13. The INMA missions provided insight from international experts and recommendations for consideration by the requesting organization as part of their efforts to further strengthen of their masters' degree programmes.

14. The Nuclear Knowledge Management Hub (NKMH) was extensively updated during 2022 and recommissioned in spring 2023. It provides Member States with easy access to the latest information on NKM guidance and services to support Member States in their nuclear programmes. This includes

publications and reports; an overview of missions, schools and upcoming Agency activities; presentations from Agency meetings, expert workshops and training events; examples of NKM good practices, shared experiences and lessons learned from nuclear organizations; and e-learning courses and training materials.

15. The NKMH has over 600 registered users and its collaborative project spaces are starting to be actively used, an example being the regional TC project for Europe entitled “Enhancing the Capacities of Educational Institutions for the Sustainable Use of Nuclear Technologies”, which involves over 90 representatives from 33 Member States in which counterparts are collaborating on the development and sharing of materials within the NKMH.

C. Building Capacity and Implementing Nuclear Knowledge Management

16. The seventh Russian Federation–IAEA Advanced Nuclear Energy Management School was held in Saint Petersburg, Russian Federation, in June 2023. The event was organized in cooperation with the State Atomic Energy Corporation “Rosatom” through the Rosatom Technical Academy. The event, which had a specialized curriculum, was aimed at middle-level managers and decision makers in the nuclear sector, with a view to enhancing the managerial and technical competencies essential for establishing or expanding national nuclear energy programmes. The School brought together 27 managers and leaders from 15 Member States.

17. The third United States of America–IAEA Nuclear Energy Management School was held at the Oak Ridge National Laboratory, Tennessee, USA, in July 2023. The event, funded by the US Department of Energy, was aimed at young professionals in the nuclear sector from African countries, with a view to enhancing the managerial and technical competencies essential for establishing national nuclear energy programmes. The School brought together 27 managers and leaders from 18 Member States.

18. In July 2023, the 13th ICTP–IAEA NEM School was held in person. The School brought together 26 managers from 21 Member States. This international NEM School has been organized yearly by the Agency, in cooperation with the ICTP, since 2010. The two-week event was focused on broadening young professionals’ understanding of current issues in the nuclear industry, building awareness of recent developments in nuclear energy, and sharing international perspectives on issues related to the peaceful use of nuclear technology.

19. The 11th Japan–IAEA NEM School was held in Tokyo and Fukushima, Japan, in August–September 2023. In cooperation with the Agency, the School was organized by the Japan Atomic Industrial Forum International Cooperation Center, the Japan Atomic Energy Agency, the Japan Atomic Industrial Forum, the Japan Nuclear Human Resource Development Network and the University of Tokyo. The School was intended to support 29 young professionals in the nuclear sector from 14 Member States in enhancing managerial and technical competencies that are essential for maintaining national nuclear energy programmes. The School’s programme included technical tours to nuclear facilities, including Fukushima Daiichi NPPs, to provide attendees with a unique insight into the implementation of nuclear energy programmes.

20. The third China–IAEA NEM School was held in person in October–November 2023 with the support of China’s Nuclear Industry Management College. The curriculum and content of the School were adapted to the needs of the participants and host organization. The two-week event was intended

for young professionals involved in national nuclear programmes. It was attended by 39 participants from academia, national regulatory bodies, relevant ministries and the nuclear energy industry in 23 Members States.

21. The fourth AFRA Network for Education in Science and Technology (AFRA-NEST)–IAEA Nuclear Energy Management School was held in Pretoria in November 2023. The School was supported by the South African Nuclear Energy Corporation and the Department of Mineral Resources and Energy. The School’s programme included technical tours to Koeberg NPP and the iThemba Laboratory for Accelerator-Based Sciences. The School was attended by 30 participants from 14 Member States.

22. In April 2023, the second United States of America–IAEA NKM School was held at College Station, Texas, USA. The School was designed for young nuclear professionals and provided education on the development and implementation of knowledge management programmes in their organizations. The School was attended by 20 young professionals from 11 Members States.

23. The fourth Russian Federation–IAEA NKM School was held in August 2023 in Moscow. The School was organized by the Agency in cooperation with Rosatom through the Rosatom Technical Academy. This one-week event offered specialized training to professionals who have a role, or may have a role in the near future, in the development or implementation of NKM projects in their organizations. The School was attended by 25 participants from 13 Member States.



Fig. C.1. In cooperation with Rosatom, the Agency organized an NKM School in Moscow in August 2023. (Source: IAEA)

24. The eighteenth Joint ICTP–IAEA NKM School was held in October in Trieste, Italy. The School was attended by 25 participants from 13 Member States. This international NKM School has been organized yearly by the Agency in cooperation with the ICTP. The one-week event was focused on broadening young professionals’ understanding of current issues in the nuclear industry, building

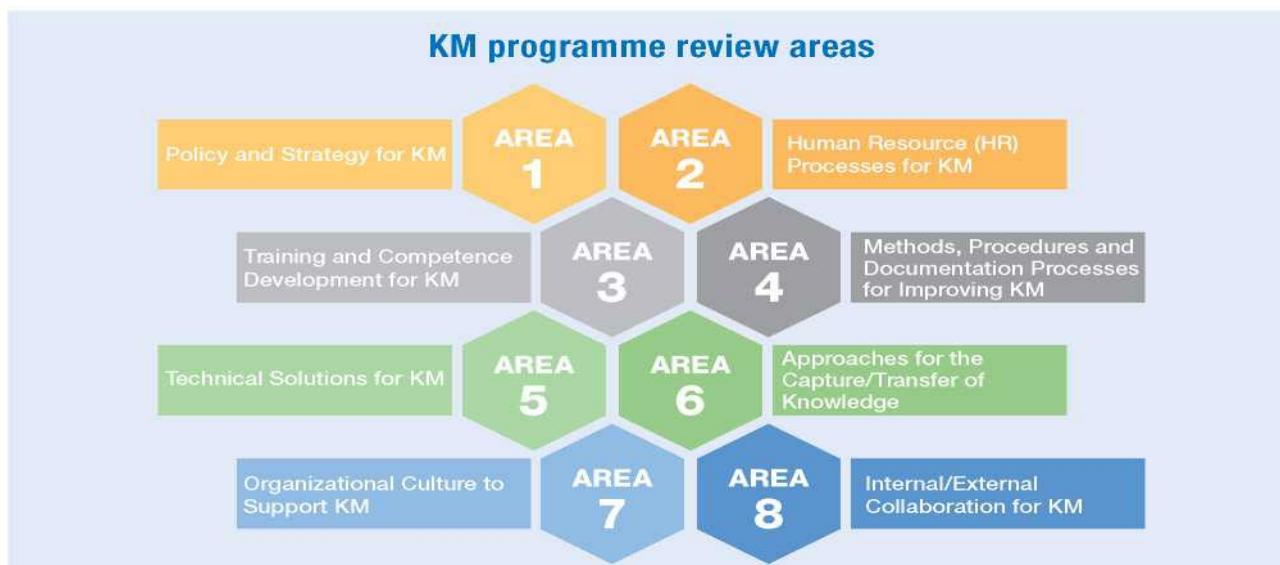
awareness of recent developments in nuclear energy, and sharing international perspectives on issues related to the peaceful use of nuclear technology.

25. The first national Australia–IAEA NKM School was held in Adelaide, Australia, in March 2024. The School was hosted by the Centre for Radiation Research Education and Innovation at the University of Adelaide. 22 Australian participants attended this one-week event.

26. The KMAV programme continues to assist Member States in capturing, maintaining, preserving and transferring the explicit and tacit knowledge within nuclear organizations through the application of pragmatic knowledge management methodologies encompassing people, processes and technology, with the aim of contributing to their organizational objectives. KMAV missions include the use of the Agency's knowledge management maturity self-assessment model, training of experts in Member States, and guidance on the preparation of new NKM documents.

27. A total of 14 KMAV missions were conducted in Member States: a KMAV Level 1 mission to Nigeria in September 2022, to address national-level NKM education and training issues; a KMAV Level 3 mission to the National Research and Innovation Agency in Indonesia in September 2022, to help address specific knowledge management challenges faced by the new national nuclear organization; a KMAV Level 1 mission to Tunisia in September 2022, to address national-level NKM education and training issues; a KMAV Level 1 mission to South Africa in October 2022, to address national-level NKM education and training issues; a KMAV Level 1 mission to the Syrian Arab Republic in October 2022, to help develop activities to strengthen NKM; a KMAV Level 2 mission to the National Centre of Nuclear Science and Technology (CNSTN) in Tunisia in November 2022, to help the Centre develop a strategic NKM programme; a KMAV Level 1 mission to Georgia in March 2023, to address specific risks of knowledge loss and strengthen knowledge management, competencies and HRD for the Department of Radioactive Waste Management at the Agency of Nuclear and Radiation Safety; a KMAV Level 1 mission to the Nuclear Power Corporation of India Limited in India in April 2023, to address NKM issues and support the development of strategic NKM activities; a KMAV Level 2 Mission to the Nuclear Power Plants Authority in Egypt in May 2023, to support its initiative to establish a beneficial knowledge management programme for Egypt's first NPP project; a KMAV Level 2 mission in June 2023 to the Armenian NPP, to follow up on the development of a strategic knowledge management programme that would address Safety Aspects of Long Term Operation (SALTO) findings and recommendations for knowledge management, competence and HRD for the NPP's long term operation, a KMAV Level 3 mission to the National Centre for Nuclear Science and Technology (CNSTN) to support the development of the overall strategy for capacity building at the National Centre for Nuclear Science and Technology in Tunisia; and a KMAV Level 3 mission to the Swiss Federal Institute of Technology Lausanne in Switzerland, to gather and share best practices on the delivery of nuclear education programmes.

28. A KMAV Level 1 mission to the King Abdullah City for Atomic and Renewable Energy, Saudi Arabia, is planned for June 2024, and a KMAV Level 1 mission to Polskie Elektrownie Jądrowe in Poland is planned for September 2024.



29. An Agency Technical Meeting on the Implementation and Assessment of Knowledge Management Programmes was held in a virtual format in October 2022 to discuss approaches and share experiences on key aspects of NKM programmes in nuclear organizations. A full day was dedicated to national capacity building for nuclear science and technology educational providers. 75 counterparts from 57 nuclear organizations in 40 Member States participated in the meeting.

30. A virtual training workshop on the IAEA Methodology for Assessing the Knowledge Management Programmes of Nuclear Organizations and Education Providers was held in October 2022, with 76 participants from 34 Member States.

31. A Technical Meeting on Educational Networks was held in July 2023 to foster cooperation and the sharing of best practices between nuclear education networks, with a specific focus on best practices associated with outreach activities. The event attracted 49 participants from 34 Member States. Another event on this topic is planned for October 2024.

32. A Technical Meeting on the Implementation and Assessment of Knowledge Management Programmes was held in November 2023 to bring together knowledge management experts to discuss the implementation and assessment of knowledge management programmes, to share experiences and lessons learned, to collect feedback and to discuss future strategies to enhance knowledge management programmes. The meeting was attended by 66 participants from 28 Member States.

33. A Technical Meeting on Further Enhancing IAEA Nuclear Energy Management and Nuclear Knowledge Management Schools was held in November 2023, with 16 participants from 14 Member States.

34. A Technical Meeting on the International Nuclear Management Academy was held in a virtual format in December 2023 and brought together present and potential future INMA member universities to report on recent activities, share good practices and advise on future strategies for enhancing the INMA programme. It was attended by 26 participants from 14 Member States. The next meeting on this topic will be held in December 2024.

D. Applying Nuclear Knowledge Management to Development

35. The Agency provides human resource capacity building in Africa through long term training and other opportunities that can lead to professional certifications and postgraduate degrees. In September 2023, the winners of a competition for students from African countries on the benefits of nuclear science and technology were celebrated at a side event at the 67th General Conference. At the tenth session of the Africa Regional Forum on Sustainable Development, held in Addis Ababa from 23 to 25 April 2024, the Agency hosted a side event entitled “Building Human and Institutional Capacities in Africa in the Peaceful Use of Nuclear Science and Technology” with the support of the United Nations Economic Commission for Africa. The Agency also contributed to a high-level panel discussion entitled “Opportunities in Advanced Energy Technologies”. These side events focused on capacity building in the practical applications of nuclear science and technology in Africa with the aim of supporting climate change adaptation efforts. The Agency supported, jointly with the Argonne National Laboratory, a regional training course for teachers and educators from Africa that focused on introducing nuclear sciences in secondary schools using innovative approaches. The course was supported under the TC project entitled “Educating Secondary School Students and Science Teachers on Nuclear Science and Technology (AFRA). Seventeen teachers from 16 African countries participated in the training course.

36. In the Asia and the Pacific region, several Member States made progress on nuclear knowledge development and management, with Agency support. In 2022, the Agency facilitated support for HRD among countries in the Asia and the Pacific region and supported education for sustainability through training and education activities. The Asian Network for Education in Nuclear Technology (ANENT) celebrated its 20th anniversary at a side event at the 67th General Conference, showcasing progress and achievements over the past two decades. The International Nuclear Science and Technology Academy became fully operational in 2023 with the ambition of supporting nuclear science and technology educators in universities who can contribute to the safe, secure and peaceful use of nuclear science and technology around the world. Participants in regional TC project entitled “Supporting Nuclear Science and Technology Education at the Secondary and Tertiary Level” achieved significant milestones. A working document was launched, providing a comprehensive framework for introducing nuclear science and technology at secondary level. At a seminar held in Oman in October 2023, 80 participants and experts from 21 countries in the region met to share best practices, fostering collaboration and knowledge exchange on integrating nuclear science and technology into secondary level education. The scope of the initiative has expanded to include students with special needs and non-science students.



Fig. D.1. Engaged participants at the NST Education Seminar in Oman showcase diverse learning facilitation tools, such as interactive presentations, educational games, and assessment strategies, demonstrating their effective use in introducing Nuclear Science to classrooms and fostering active participation and critical thinking among learners. (Source: Ivan Lim/Philippines)

37. In Europe and Central Asia, the TC programme supports education and training in NKM. As part of the TC project entitled “Enhancing the Capacities of Educational Institutions for the Sustainable Use of Nuclear Technologies”, the Agency trained 59 participants through two regional workshops on nuclear and radiation education. In 2023, under the framework of the TC project entitled “Implementing an Integrated Approach for Capacity Building at the Nuclear Regulatory Agency”, Bulgarian experts benefited from scientific visits, hosted by regulatory authorities in Finland and Spain, on the organization and implementation of HRD systems, as well as introductions to various knowledge management systems and methodologies. These visits allowed Bulgarian experts to gain insights into human resources management and development, knowledge management practices, the organization of specialized training, the integrated management system of the organizations, and education and training systems.



Fig. D.2. Regional Workshop on Capacity Building for Nuclear Education and Training with a Focus on Outreach Activities to Secondary Schools in May 2024 at the Technical University of Sofia (Source: Technical University of Sofia)

38. The Agency is working to strengthen nuclear knowledge education, training and management in the Latin America and the Caribbean region. In November 2022, the Agency launched a new occupational radiation protection e-learning course. The course was developed in response to a request from the Member States of the Agency that are also members of the Caribbean Community and includes modules on ionizing radiation, radiological protection, radiation monitoring and occupational exposure control. It is widely accessible for basic training purposes and is now available via the Agency’s learning management platform. The Agency supported the organization of a workshop in Santiago where educators shared experiences, deepened their knowledge and reinforced educational practices on nuclear technology topics. In July 2023, Latin American representatives and members of the Latin American Network for Education in Nuclear Technology (LANENT) attended the Technical Meeting on Educational Networks in Vienna. At the event, the results of the TC project entitled “Furthering Knowledge Management Implementation in Nuclear Organizations and Strengthening Nuclear Education” were shared with 60 participants from 34 Member States, including representatives from nuclear education institutions and OECD/NEA.

E. Applying Nuclear Knowledge Management to Nuclear Safety, Security and Safeguards

39. The Agency has developed multiple tools to support the dissemination and application of knowledge related to nuclear safety and security within Member States. The Nuclear Safety and Security Online User Interface (NSS-OUI) provides users with easy access to Agency publications on nuclear safety and security, specifically the IAEA Safety Standards Series and Nuclear Security Series guidance publications. The interface provides direct access to the latest content of the publications, easy navigation between them, and enables users to provide feedback thereon. The electronic IAEA Nuclear Safety and Security Glossary - 2022 (Interim) Edition defines and explains technical terms used in IAEA safety standards and IAEA nuclear security guidance and other safety and security related IAEA publications, and provides information on their usage.

40. Three international training courses on the Agency's Safety Standards were held in Vienna in September 2022, May 2023, and May 2024 to raise awareness and enhance access to and use of the Agency's Safety Standards in Member States. In addition, a national training course was held in Sofia, Bulgaria in June 2023. The Agency has developed comprehensive e-learning modules covering all Safety Requirements publications, that are now available for Member States on the Agency-wide Cyber Learning Platform for Network Education and Training (CLP4NET).

41. The Agency held a Regional Workshop on the Development of Nuclear Safety Knowledge Management Programme for Regulatory Bodies in Vienna in September 2022. The event discussed the process for developing a competency model and framework for regulatory bodies for nuclear and radiation safety; formulate competency statements (knowledge, skills and attitudes) specifically for jobs involving technical functions of regulators for nuclear and radiation safety; and describe the process of using an assessment tool in establishing existing competencies and identifying gaps.

42. The Agency held the annual meetings of the Steering Committee on Regulatory Capacity Building and Knowledge Management in Vienna in December 2022 and December 2023 to exchange information on the current activities of the Secretariat and Member States in managing, developing, and strengthening regulatory competence. The Agency sought advice from Member States on the implementation of a strategic approach to capacity building activities in nuclear safety and provided a forum to exchange information on the status of the establishment of national strategies in this area.

43. The Annual Meeting of the Steering Committee on Education and Training in Radiation, Transport and Waste Safety was held in Vienna in December 2023 to provide advice to the Secretariat with respect to the implementation of the strategic approach to education and training in radiation protection, transport, and waste safety.

44. In September 2022, the Agency signed Practical Arrangements with the Malaysian Nuclear Agency and Brazil's National Nuclear Energy Commission on cooperation in the area of education and training related to radiation protection, transport and waste safety.

45. The Agency will hold a Regional Workshop on Nuclear Safety Knowledge Management Programmes for Regulatory Bodies in Kuala Lumpur in July–August 2024 to provide insights into specific aspects of knowledge management, assess achievements and areas for improvement, and formulate country-specific action plans to enhance knowledge management practices.

46. The Agency organised seven training courses as part of the IAEA International School on Nuclear and Radiological Leadership for Safety, in Cairo in October 2022; in Mexico City in November 2022; in Hiratsuka, Japan, in February–March 2023 and in March 2024; in Vienna in May and August 2023; and in Nice, France, in June 2023. In addition, five events were organised at the national level as part of

the IAEA School on Nuclear and Radiological Leadership for Safety in Buenos Aires in July 2023; in Abu Dhabi in November 2023; in Beijing in December 2023; and in Islamabad in December 2022 and June 2024. In December 2022, the Agency published a document entitled *IAEA School on Nuclear and Radiological Leadership for Safety: Standard Syllabus 2022* (IAEA Training Course Series No. 75).



Fig. E.1. Participants of the International School on Nuclear and Radiological Leadership for Safety and Security, held in Vienna in May 2023, visiting the IAEA Seibersdorf Laboratories. (Source: IAEA)

47. In October 2023, the Agency inaugurated the Nuclear Security Training and Demonstration Centre (NSTDC) at the Agency's laboratories in Seibersdorf, Austria. The centre is meant to enhance nuclear security capacity building by using advanced technology and expertise and to complement the training opportunities offered in Member States and Nuclear Security Support Centres. Equipped with specialized technical infrastructure and equipment, the centre offers training courses and workshops in the physical protection of nuclear and other radioactive material and associated facilities, and the detection and response to possible nuclear security incidents. In the first three months of operation, the NSTDC trained 346 participants through 14 events, with the future intention of providing training to 1000 participants per year.



Fig. E.2. Inauguration Ceremony of the Multipurpose Building for the Nuclear Security Training and Demonstration Centre. IAEA Seibersdorf, Austria. 3 October 2023. (Source: IAEA)

48. The Agency held a Regional School on Nuclear Security in Cape Town, South Africa, in November 2022 (with 30 participants from 14 English-speaking African countries). The Agency held International Schools on Nuclear Security, some of which were hosted jointly with the ICTP in March 2023 and April–May 2024 in Trieste, Italy, Schools for MSCFP fellows in Vienna in July–August 2023 and August 2024; and an International School on Nuclear Security in February–March 2024 in Havana.

49. During the reporting period, the Agency conducted two International Workshop on Human Resource Development (HRD) in Nuclear Security. One was held in the Republic of Moldova in November–December 2022 to assist Member States in implementing best practices and incorporating knowledge management aspects. The second one was held in November 2023 at the NSTDC, in conjunction with the Technical Meeting on the Management of Training on Nuclear Security by Training Organizations. Moreover, the Agency held a Regional Workshop and Technical Exchange on HRD for Nuclear Security Support Centres in the Asia and the Pacific Region in Beijing in October–November 2023.

50. During the 2022–2023 academic year, the Agency supported graduate education programmes in nuclear security by providing fellowships to seven students from seven Member States to attend the master’s degree programme in nuclear security at the University of National and World Economy in Bulgaria.

51. In April 2023, the Agency held a virtual International Workshop on Self-assessment of Emergency Arrangements and Use of the Emergency Preparedness and Response Information Management System (EPRIMS) to familiarize participants with and train them in the Agency’s EPRIMS system.

52. In November 2022, the Agency extended its cooperation on emergency preparedness and response (EPR) with the Response and Assistance Network -CBC in Japan.

53. The Agency held four National Workshops on SEED Capacity Building for Site Safety Evaluation and Review for New Nuclear Installation Programmes, in Kenya in August–September 2022; in Morocco in September 2022; in Nigeria in December 2022; and in Kazakhstan in May–June 2023.

54. The Agency continuously assists States in building their capacity to meet their safeguards obligations while raising awareness of the legal and technical aspects of safeguards implementation. In 2022 and 2023, activities included 75 interregional, regional and national training courses, technical visits, IAEA Safeguards and SSAC¹ Advisory Service (ISSAS) missions, virtual training events and other activities.

55. In 2023, the Agency concluded the pilot phase of COMPASS – the IAEA Comprehensive Capacity – Building Initiative for SSACs² and SSRAs³ –in the seven participating States. COMPASS will continue as part of the suite of safeguards assistance for States, with four States selected to participate in the 2024-2025 cycle.

56. During the reporting period, more than 850 participants from over 100 States were trained in safeguards-related topics. The online offering of safeguards related training material increased, with the Agency addressing in-demand topics such as nuclear trade export controls, design information activities, or nuclear material accountancy at facilities. The Agency continued to publish on safeguards matters, from scientific and technical guidance documents to general brochures and topical booklets. In 2023, the Agency published a digital edition of the IAEA Safeguards Glossary – 2022 Edition and launched translated versions of the Glossary at the 67th IAEA General Conference. The Glossary aims to facilitate the understanding of the specialised safeguards terminology within the international community.

57. The Agency’s 14th Symposium on International Safeguards, held in Vienna in October 2022, brought together nearly 1000 global stakeholders in support of IAEA safeguards, including Member State safeguards regulatory authorities, the research and development (R&D) community, industry and civil society. Entitled “Reflecting on the Past and Anticipating the Future”, the Symposium considered the evolution of safeguards to date; addressed contemporary challenges; anticipated and prepared for a changing landscape; leveraged innovations for safeguards applications; engaged youth; and expanded partnerships.

58. The Agency also continued to expand and promote the use of the State Declarations Portal (SDP), a web-based system that supports secure bi-directional communication between State or Regional Authorities and the Agency. As of April 2024, a total of 111 States, the European Commission, and the Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) were using the SDP.

59. The Department of Safeguards conducts an annual Safeguards Traineeship Programme for Young Graduates and Junior Professionals from developing Member States. Since 2021, the Department has expanded its training programme in this area, making efforts to ensure that its intake is as close to gender parity as possible, based on nominations. In 2023 and 2024, the programme comprised 50% women participants. An SSAC Professional Seminar was held in November 2022 to provide participants — 25% of whom were women — with the practical knowledge and skills required for the establishment and maintenance of SSACs.

¹ State System of Accounting for and Control of Nuclear Material

² SSAC stands for State's System of Accounting for and Control of Nuclear Material

³ SRA stands for a State or Regional Authority responsible for safeguards implementation

60. The Agency contributed to the development and implementation of the Specializing Master on Nuclear Safeguards organized by the Polytechnic University of Milan and the European Nuclear Education Network (ENEN), in collaboration with the European Union Joint Research Centre (JRC).

61. In line with the Agency Gender Equality policy, the Department of Safeguards is committed to supporting gender equality and is seeking to strengthen efforts to support both gender parity in its staff and gender mainstreaming consideration in relevant programmatic activities. In the reporting period, the Department conducted a variety of outreach activities aimed at attracting a diverse workforce by contributing to a wide range of events. Furthermore, the Department continued to support aspiring young safeguards professionals through junior professional officer positions, internships and internal mentorship opportunities.

F. Strengthening Networks Related to Nuclear Education and Training

62. The Agency held the Annual Meeting of the International Network for Nuclear Security Training and Support Centres (NSSC Network) in Vienna in February 2023 to advance the work of this collaborative network of training and support institutions that are involved in, or plan to be involved in, the provision of nuclear security training or nuclear security technical and scientific support services.

63. The Agency will hold the Annual Meeting of the International Nuclear Security Education Network (INSEN) in Vienna in July 2023 to review the INSEN action plan and discuss cooperation and collaboration with the NSSC Network.

64. Currently, LANENT comprises 75 institutions (62 full members, 14 collaborators and the Agency) from 18 Member States. The Agency provides support to LANENT through the TC project entitled “Furthering Knowledge Management Implementation in Nuclear Organizations and Strengthening Nuclear Education”. LANENT seeks to communicate the benefits of nuclear technology to the public, with the aim of stimulating interest in nuclear technology among younger generations. It has developed a multimedia educational programme, entitled ‘NUCLEANDO’, that equips primary and secondary school teachers with tools and resources, allowing them to introduce nuclear and isotopic sciences into their curricula in an engaging and innovative manner. A dedicated NUCLEANDO website has been created. Thirteen NUCLEANDO courses have been conducted in 10 Member States, 11 of which were held in a virtual format and 2 in person. 463 teachers have been trained, with an additional 1700 teachers trained post-project implementation, enabling the training of almost 250,000 students. The first NUCLEANDO regional course was established.

65. Currently, 21 Member States and 10 collaborating member organizations in the Asia and the Pacific region participate in the Asian Network for Education in Nuclear Technology (ANENT). The TC project entitled “Supporting Nuclear Science and Technology (NST) Education at the Secondary and Tertiary Level”, which started in 2022, expands the scope of collaboration to all regional partners in the educational network and secondary and tertiary level education. The ANENT web portal has been developed and consists of a learning management system. Twenty e-learning materials have been developed for universities. The ANENT Secondary Education portal was implemented in 2023 along with two modules of the e-learning programme for educators for secondary and tertiary education levels. The portal’s resources support capacity building and HRD in the Asia and the Pacific region, particularly in developing countries and countries with limited access to high quality educational resources in nuclear science and technology. ANENT’s online platforms have 611 users from 67 countries. The ANENT Webinar Series were organized in 2023-2024 as part of the ANENT’s commitment to sharing nuclear

knowledge in the region. The “Atomic melody” video competition for students was organized in 2024, providing an opportunity for the younger generation to produce creative musical videos reflecting the benefits and opportunities provided by nuclear technology.

66. AFRA-NEST is open to institutional membership within the African region and its membership has increased to 33 African Member States. The Agency provides support to AFRA-NEST through the TC project entitled “Supporting the Establishment of the Nuclear Education Science and Technology Network (AFRA)”. The main objective of AFRA-NEST is to facilitate activities and networking in higher education, training and research in nuclear science in the African Region. The AFRA website was established in 2023 under the aforementioned project. Enhancing awareness of education and training in nuclear science and technology, and of science teachers and training and the procurement of training kits in nuclear science and technology are focused activities under the TC project entitled “Educating Secondary Students and Training Science Teachers in Nuclear Science and Technology”.

67. STAR-NET, which includes 8 Member States through 14 universities, is open to institutional membership within the Eastern European region. Practical Arrangements between the Agency and STAR-NET on cooperation in nuclear education were signed in 2023. The STAR-NET learning management system, ‘STAR-NET LMS’ has 10 000 visits per year, 1600 registered users from 16 countries, 20 training courses, and 14 educational spaces to support internship programmes. The STAR-NET telegram channel regularly publishes information about the initiatives, resources and activities of STAR-NET and the Agency. STAR-NET collaborates with the Agency on the implementation of a regional TC project on nuclear education and has been actively involved in Agency activities.

68. INSTA, which has 21 Member States (42 organizations) is a regional educational initiative supported by the Agency under the TC project entitled “Supporting Nuclear Science and Technology Education at the Secondary and Tertiary Level”. INSTA’s mission is to contribute to global nuclear manpower development through regional and interregional collaborations to empower educators and advance nuclear science and technology education programmes at the secondary and tertiary level. A Working Document for the Nuclear Science and Technology Guidebook Series for Introducing Nuclear Science and Technology into Secondary-Level Education was launched during the 2023 Division for Asia and the Pacific National Liaison Officers meeting in March 2023. A study tour to the VIC for video competition winners was held in October 2023. The first IAEA–INSTA–ANENT E-Learning Programme for Educators started in April 2024.

69. The establishment of human resource and knowledge development networks provides a foundation for increasing the sustainability of the development of nuclear power programmes, nuclear science and technology applications, and the required safety infrastructure in many Members States. Close cooperation through an effective national human resource and knowledge development network, supported by an international network through the Agency, is beneficial in ensuring optimal utilization of the limited institutional, financial and other resources for supporting and sustaining national programmes in this regard.

70. Several Member States have recognized this issue and established national human resource and knowledge development stakeholder networks to bridge gaps that may exist between the roles and responsibilities of various stakeholders and to facilitate collaboration between them.

71. Thailand officially requested an Agency expert mission to Thailand in September 2021 to discuss the establishment of a national human resource and knowledge development network. In response, an expert mission was dispatched in March 2023. The mission provided practical guidance as well as recommendations and suggestions.

72. The IAEA CONNECT platform has established itself as the place to bring together professionals and experts from the Secretariat and Member States, serving more than 10 229 members from over 26 topical networks. Two new networks — NEXSHARE and GIF — joined in 2023. Two additional networks, yet to be named, are expected to join in 2024.

73. The IAEA CONNECT platform has recently undergone major system upgrades and a redesign to improve usability and the look and feel of the user experience. Automatic reading of the IAEA News web page at www.iaea.org and of Agency-wide Information System for Programme Support (AIPS) events information has been implemented for the benefit of users. A ‘Nuclear Wiki’ is available to IAEA CONNECT users, and contains technical articles developed and maintained by the Secretariat with the support of international experts. Several new topical areas were added or expanded recently, including INPRO methodologies for evaluation of sustainability, predisposal radioactive waste management, and environmental remediation.

74. As a fundamental element of the Agency’s strategic approaches to education and training, CLP4NET, the Agency’s standard delivery mechanism for e-learning, continued to experience significant growth during the reporting period as. By the end of April 2024, the number of registered users to CLP4NET had increased to over 88 000, and the number of courses had increased to 1035 (350 open courses, and 685 instructor-led courses). In addition to e-learning courses, in 2022 the Agency started to offer webinars through CLP4NET. One hundred and ninety-three webinars have now been made available on CLP4NET, with many more expected in the coming years.

75. A personalized dashboard showing course progress, upcoming courses, a calendar, timeline and recently visited courses (among other functionalities) has been made available on CLP4NET. The learning resources catalogue launched on the Agency’s website serves to increase the visibility and accessibility of the e-learning offerings available to Member States and is now also the central access point for all Agency webinars as well as course offerings. A new Agency e-learning governance framework to improve course quality and optimize resources while developing e-learning materials and products, and to control the life cycle of those outputs, is close to Agency-wide implementation. This new governance framework will help to ensure better control of e-learning projects and products and to maintain a high level of quality in the e-learning resources offered to Member States.

G. Nuclear Information

76. The Agency continues to maintain and expand INIS as a global repository of information on the peaceful uses of nuclear energy. Over 235 034 knowledge products were added to INIS in the reporting period, leading to a cumulative total of 4.79 million knowledge products. The repository continues to provide Member States with access to reliable information, and has recorded over 3 million individual users, 6 million searches and 14.8 million downloads in the portable document format (PDF). INIS can be searched in any of the following 10 languages: Arabic, Bulgarian, Chinese, English, French, German, Japanese, Persian, Russian and Spanish. Impressive progress has been made with regards to the replacement of INIS, which is expected to be completed by the beginning of 2025.

77. Metadata, including index terms, are critical to facilitate the retrievability of INIS content. To this end, an AI indexing tool called ‘NADIA’ was developed and deployed, resulting in fast and accurate indexing. The INIS Thesaurus, a ‘knowledge organization system’ containing over 31 000 descriptors, is maintained and kept up to date with new relevant terms by working with Member States and the INIS Thesaurus Advisory Group. The technical expertise INIS has developed in taxonomy development has resulted in significant contributions to projects such as the TC project entitled “Interregional Workshop

on the Development of Taxonomy for Small Modular Reactors (SMRs) and Micro-Reactors (MRs)", the Decommissioning Knowledge Integration System ('DECKING'), and Digital Technologies to Advance Decommissioning of Nuclear Facilities ('NET4D').

78. INIS has completed a project to digitize legacy Agency publications and conferences.

79. The Agency's Preprint Repository has continued to reduce the time it takes for Agency publications to be made available to the public. The repository was developed by the Nuclear Information Section in cooperation with the Publishing Section and uses the INIS process and infrastructure. All items placed on the preprint server are simultaneously made available through the INIS Repository, which contains over 136 preprints.

80. The 41st Meeting of INIS Liaison Officers was held in a virtual format in September 2022, with 93 representatives from 61 countries and 3 organizations in attendance. During the meeting, a guest speaker from the FAO presented recent advancements, and meeting participants voted on future initiatives and potential changes to INIS. The Agency hosted the 42nd Meeting of INIS Liaison Officers in July 2023, with 80 participants from 62 countries in attendance. The regional breakout sessions proved particularly valuable, facilitating discussions on local and regional concerns.

81. The Memorandum of Agreement between the Agency and the OECD/NEA regarding the provision of OECD/NEA Data Bank services to Agency Member States was concluded, and the appointment of a nuclear software specialist to the Data Bank was finalized.

82. On International Women's Day in March 2023, a ceremony was held to rename the IAEA Library as the IAEA Lise Meitner Library. Lise Meitner's great-niece, Ms Monica Frisch, was present to launch the new name together with the Deputy Director General of the Department of Nuclear Energy, Mr Mikhail Chudakov, and invited guests and staff members.



Fig. G.1. IAEA Director General Rafael Mariano Grossi welcoming Ms Monica Frisch, Lise Meitner's great-niece, on the occasion of the renaming the IAEA Library as the IAEA Lise Meitner Library on 8 March 2023. (Source: IAEA)

83. The IAEA Lise Meitner Library continued to provide access to nuclear information by connecting users to all available information resources. It continued to position itself as a hub for nuclear information that contains a wealth of information resources in electronic and printed formats. It provides access to 70 databases, 43 of which are open access. During the reporting period, it enhanced its basket of services to align with the changing needs of information seekers in Member States and the Agency.

84. More than 2500 books were borrowed by users, and electronic resources were accessed over 1 914 558 times. Through its interlibrary loan, document delivery and article delivery services, the IAEA Lise Meitner Library provided users with access to 1248 items not available in the collection. It held 37 training sessions, reaching more than 500 participants in person and virtually. It will continue to provide training to users to facilitate information literacy and promote the wealth of information it manages.

85. The IAEA Lise Meitner Library hosted various events to facilitate the sharing and exchange of information and resources and to promote the information services it provides. Together with the United Nations Library — Vienna, which serves the United Nations Office at Vienna and the United Nations Office on Drugs and Crime, and the United Nations Commission on International Trade Law (UNCITRAL) Law Library, the annual meeting of the United Nations Library and Information Network for Knowledge Sharing (UNLINKS) was held in a hybrid format in Vienna in October 2022, with 55 participants from United Nations.

86. Membership of the International Nuclear Library Network increased to 75 members from 43 Member States.

87. To better manage the IAEA Lise Meitner Library's information resources, a radio frequency identification system was installed so as to properly inventory the assets held and allow users to self-issue books.



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