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Atoms for Peace and Development

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

Report by the Director General

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Item 17 of the Conference's provisional agenda
(GC(67)/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(66)/RES/9.A.1, GC(66)/RES/9.A.2, GC(66)/RES/9.A.3, GC(66)/RES/9.A.4 and GC(66)/RES/9.A.7, this document contains progress reports on

- Part A: Non-Power Nuclear Applications
  - General (Annex 1)
  - Support to the African Union's Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) (Annex 2)
  - Renovation of the Agency's Nuclear Applications Laboratories at Seibersdorf (Annex 3)
  - Zoonotic Disease Integrated Action (ZODIAC) Project (Annex 4)
  - Plan for Producing Potable Water Economically Using Small and Medium Sized Nuclear Reactors (Annex 5)

- Part B: Nuclear Power Applications
  - Introduction (Annex 6)
  - IAEA Communication, Cooperation with Other Agencies and Stakeholder Involvement (Annex 7)
  - Nuclear Fuel Cycle and Waste Management (Annex 8)
  - Research Reactors (Annex 9)

- Operating Nuclear Power Plants (Annex 10)
- Agency Activities in the Development of Innovative Nuclear Power Technology (Annex 11)
- Approaches to Supporting Nuclear Power Infrastructure Development (Annex 12)
- Small and Medium Sized or Modular Reactors (Annex 13)

Further information on the Agency's activities related to nuclear science, technology and applications can be found in the *Nuclear Technology Review 2023* (document GC(67)/INF/4); the *IAEA Annual Report 2022* (GC(67)/2), in particular the section on nuclear technology; and the *Technical Cooperation Report for 2022* (GC(67)/INF/5).

Recommended Action

- It is recommended that the Board of Governors take note of this report and authorize the Director General to submit the report to the General Conference at its 67th regular session.

General
Non-power applications

A. Background

1. In resolution GC(66)/RES/9.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 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-seventh (2023) 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 66th Regular Session of the General Conference

3. In the field of nutrition, the Agency developed new publications on energy expenditure, building on its Doubly Labelled Water Database, to help enhance the understanding of energy metabolism and how to plan interventions to prevent and manage obesity. In addition, a new Agency database on breast milk intake was launched in August 2022, which aims to provide unique insights regarding breastfeeding behaviours such as why exclusive breastfeeding is not the current global norm. A coordinated research project (CRP) was completed that developed and validated a novel, minimally invasive technique to assess protein digestibility and utilization from plant-based diets, as they are consumed by vulnerable populations, in regions habitually relying on plant-based diets. The Agency continued to support quality assurance measures for the assessment of body composition and breast milk intake through conducting an interlaboratory study where participating laboratories can demonstrate their technical competences in the analysis of deuterium enrichment.

4. The Agency continued working towards increasing the capacity of Member States for worldwide harmonization of dosimetry in radiation medicine and radiation protection through the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories (SSDL Network). Two guidance documents were published to assist Member States exploring the possibility of establishing a secondary standards

dosimetry laboratory, and to assist those needing to maintain and further develop their capabilities. The SSDL Network hosted a Technical Meeting on Development and Trends in Secondary Standards Dosimetry Laboratories (SSDLs) and Quality Management Systems (QMS), which was attended by 120 participants from 77 Member States. The focus of the meeting was on newly published international standards and guidance documents covering various technical areas of radiation dosimetry.

5. The Agency continued its efforts to promote the education and training of medical physicists, supporting the Abdus Salam International Centre for Theoretical Physics (ICTP) Master of Advanced Studies in Medical Physics, and collaborating with ICTP and other partners. A training activity on comprehensive clinical audits in diagnostic radiology under the Quality Assurance Audit for Diagnostic Radiology Improvement and Learning was organized as a joint event with the Argonne National Laboratory in Houston, United States of America. Two joint Agency–ICTP workshops on radiotherapy dosimetry audits and medical physics aspects in brachytherapy took place in Trieste, Italy. The Agency's Dosimetry Laboratory in Seibersdorf hosted 24 medical physicists and radiation metrologists working at SSDLs from 14 Member States for practical training in brachytherapy.

6. The Agency continued working towards achieving international harmonization in quality assurance in radiotherapy. An update of the Agency's guidelines for the Quality Assurance Team for Radiation Oncology (QUATRO) was published with the endorsement of the European Federation of Organisations for Medical Physics, the European Society for Radiotherapy and Oncology, and the International Organization for Medical Physics. Following a training course held in English, a course on the QUATRO methodology was held in Spanish for professionals from the Latin America and the Caribbean region. Practical experiments and exercises were performed using the linear accelerator facility of the Agency's Dosimetry Laboratory.

7. With regard to quality assurance in diagnostic and interventional radiology, the Agency published a handbook containing harmonized quality control procedures for diagnostic radiology equipment, taking into consideration the latest developments in the field.

8. A set of new e-learning courses with several modules in radiobiology for radiation oncologists was developed for the Human Health Campus. Radiobiology knowledge is a key prerequisite for radiation oncology practice. These new e-learning radiobiology modules will be hosted on the Agency's open learning management system and accessible for all Member States.

9. Monthly virtual tumour board meetings were held for radiation oncology professionals in Africa and in the Asia and the Pacific regions. Cancer professionals presented, discussed and reviewed challenging cancer cases to help improve the quality of cancer care in Member States. The meetings were attended on average by at least 50 participants from 44 Member States and 111 institutions.

10. The Agency continued to provide technical support to the first wave of Member States participating in the Rays of Hope (RoH) initiative. Tailored plans were developed to support the needs of Benin, Chad, the Democratic Republic of the Congo, Kenya, Malawi, the Niger and Senegal. In the reporting period, the Agency streamlined the application process and defined specific requirements for anchor centres, which have been made available to Member States on the Agency's website. A total of 36 Member States have expressed interest in joining RoH. Letters of interest to become anchor centres were received from over ten countries and are at different stages of the evaluation process.

11. In December 2022, the Agency partnered with 11 of the largest professional societies in cancer care, with the aim of strengthening the Agency's support to its Member States, particularly in the areas of capacity building in radiation oncology, medical physics and diagnostic imaging. This partnership will inform the Rays of Hope Initiative.

FIG. B.1. Roundtable Event on Partnerships in Global Cancer Care. Practical Arrangements Signing Ceremony between the International Atomic Energy Agency signed by Director General Rafael Mariano Grossi, and the 11 partner groups in the area of radiation oncology, imaging, and medical physics held at the Agency headquarters in Vienna, Austria, 6 December 2022. (Source: IAEA)

12. The Agency, through the IAEA Marine Environment Laboratories, continued to coordinate closely with United Nations agencies as a member of the UN-Oceans mechanisms and the United Nations Environment Management Group contributing to the preparatory work for a legally binding instrument to end plastic pollution and to the elaboration of a common approach towards a pollution-free planet.

13. The Agency continued to implement the Nuclear Technology for Controlling Plastic Pollution (NUTEC Plastics) to help its Member States integrate nuclear science and its related techniques into their efforts to address the challenges of plastic pollution. This includes the development of harmonized protocols to identify microplastics in environmental samples and analytical techniques that are in line with best practices and state-of-the-art science, and support for training scientists and technicians in their use.

14. Under NUTEC Plastics, the Agency continued to support 64 Member States in monitoring microplastic density in coastal areas. The Agency signed two Memoranda of Understanding, with Argentina and Cuba, to set forth frameworks for scientific cooperation, and to gather data on the type and distribution of microplastics in the Caribbean and Antarctic regions. Furthermore, the Agency collaborated with Latin American and Caribbean Member States institutions, through the Research Network of Marine-Coastal Stressors in Latin America and the Caribbean, to develop harmonized sampling protocols to guide the collection and analysis of samples for the monitoring of microplastics in coastal areas.

FIG. B.2. Director General Rafael Mariano Grossi opens the side event dedicated to informing about the developments and progress of the NUTEC Plastics project at the IAEA 66th General Conference. IAEA, Vienna, Austria, 28 September 2022. (Source: IAEA)

15. The Agency, through its Ocean Acidification International Coordination Centre (OA-ICC) continued to support Member States in their efforts to tackle ocean acidification. In the reporting period, the OA-ICC organized and supported a total of 12 events including technical and consultancy meetings, as well as training courses and side events within the framework of high-level United Nations conferences. More than 50 early-career scientists, representing more than 30 Member States, have benefited from robust capacity building exercises involving hands-on experimental work with the use of nuclear and isotopic techniques. The OA-ICC had a robust presence at the 27th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27), with three side events addressing regional aspects of ocean acidification research, policy and governance, as well as cross-sectoral and interdisciplinary approaches to climate change adaptation and mitigation, including nature-based solutions for ocean-climate action.

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

17. The Agency continues to support regional seas programmes such as the United Nations Environment Programme's Mediterranean Action Plan, the Convention for the Protection of the Marine Environment of the North-East Atlantic and 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 for the analysis of contaminants in marine matrices.

18. In the reporting period, two new reference materials for trace elements and persistent organic pollutants were established to support reliable and highly accurate monitoring of contaminants in the marine environment and in seafood.

19. The Agency's Terrestrial Environmental Radiochemistry Laboratory in Seibersdorf and its Radiometrics Laboratory in Monaco were both accredited as producers of selected certified reference materials for activity concentration measurements of radionuclides, thereby further underpinning the international recognition of the quality, competency and reliability of the reference materials provided to Member States. Proficiency testing and interlaboratory comparisons play a very important role in obtaining high quality data in analytical measurements.

20. The Agency issued a publication entitled *Artificial Intelligence for Accelerating Nuclear Applications, Science and Technology*, which provides a review of current artificial intelligence (AI) activities in the nuclear field, highlights the Agency's role in their implementation, outlines challenges and identifies priorities for future AI activities. In 2022, the Agency continued working with the High-Level Committee on Programmes Inter-Agency Working Group on Artificial Intelligence on the adoption of principles for the ethical use of AI in the United Nations system. It also continued its partnership with the AI for Good platform and contributed to the 2022 International Telecommunication Union report *United Nations Activities on Artificial Intelligence (AI)*, which featured new Agency AI initiatives in the areas of radiotherapy, the marine environment, radioactive contamination in agriculture, climate change impact assessment and fusion science. All these activities were included in AI for Atoms, a new Agency knowledge-sharing platform for partnerships in AI applications in the nuclear field.

21. The Agency continued to support capacity building, emergency interventions and South–South cooperation through the Veterinary Diagnostic Laboratory Network, a scientific and technical network of national veterinary laboratories from 46 African and 19 Asian countries, as well as recently initiated networks in 17 countries in Latin America and the Caribbean, and 27 countries in Eastern Europe. The support is complementary to that provided through the Zoonotic Disease Integrated Action (ZODIAC) project.

22. The Agency supported the development of a standard workflow for service-based whole genome sequencing, including metagenomics, in Albania, Argentina, Azerbaijan, Bosnia and Herzegovina, Brazil, Croatia, Cyprus, Georgia, Greece, Indonesia, Latvia, Lithuania, Montenegro, Morocco, Mozambique, Namibia, Portugal, Romania, Senegal, Serbia, Slovakia, Türkiye and Uzbekistan to enable Member States to apply next generation sequencing molecular characterization technologies for efficient disease diagnosis and surveillance.

23. The Agency continued its efforts to improve the capacities of Member States for producing irradiated vaccines for the control of animal diseases. A workshop was held in November 2022, including contributions from pharmaceutical industry representatives, on possibilities, approaches and challenges for scaled-up production of irradiated vaccines. Approximately 50 scientists from Member States participated in the event, with presentations given by world leading experts in vaccinology.

24. The Agency continued its efforts to support the national animal breeding programmes of various Member States, particularly in implementing advanced nuclear and related technologies for selection and multiplication of high-producing livestock. The Agency supported more than 25 countries in applying modern genomic and reproductive biotechnologies through various technical cooperation projects to sustainably improve meat, milk and egg production. Research was supported through CRPs in ten countries (Argentina, Bangladesh, Burkina Faso, China, India, Kenya, Pakistan, Peru, South Africa and Sri Lanka) for development of DNA-based genomic tools to identify livestock with superior genetic merit.

25. 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. Rapid, field-deployable methods for verifying rice origin and authenticating

commodities such as coffee, organic orange juice and strawberries to combat food fraud, and for the detection of heavy metals, aflatoxins and pesticides, were developed.

26. The Agency supported adoption of integrated soil–crop–livestock production systems/models in 14 African countries (Algeria, Djibouti, Egypt, Eswatini, Ethiopia, Ghana, Kenya, Libya, Mauritania, Mauritius, Morocco, Nigeria, Rwanda and South Africa) for sustainable agricultural productivity.

27. Antimicrobial resistance (AMR) is a critical global problem that affects humans, animals and the environment, and one that most clearly illustrates the need for a One Health approach. During the reporting period, the Agency launched a dialogue in the H20 Digital Dialogue Series, which brings together partners of the G20 Health and Development Partnership and senior ministers, policymakers and representatives of multilateral organizations, to offer concrete solutions to addressing the short- and long-term challenges of AMR and other health emergencies.

28. The Agency, through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, launched a new CRP entitled "Innovative Nuclear and Related Molecular Approaches for Detection and Characterization of Antimicrobial Resistance in Animal Production Environment". This CRP will target three major animal production systems, namely pig, chicken and cattle and help develop inter alia validated/harmonized protocols for sampling and analysis of farm environment samples, distribution characteristics of drug resistance among infectious agents affecting livestock, and strategies/guidelines on optimal husbandry practices that improve biosecurity and mitigate AMR in animal farm premises.

29. The Agency developed standardized sampling and isotopic analytical protocols for tracing the fate of antimicrobials in soils and crops using a synthesized antibiotic commonly used to treat infections in animals as part of a CRP entitled "Isotopic Techniques to Assess the Fate of Antimicrobials and Implications for Antimicrobial Resistance in Agricultural Systems".

30. The Agency supported the release of 16 new and improved crop varieties in six Member States during the year: Bangladesh (one mung bean variety and one rice variety), China (one wheat variety), India (two rice varieties and one groundnut variety), the Lao People's Democratic Republic (two rice varieties), Namibia (five sorghum varieties) and Yemen (three wheat varieties).

31. The Agency supported the training of Member State scientists in food safety and authenticity through the development of e-learning courses on analytical methods to detect and control organic contaminants in food; on a chemometrics add-in for Microsoft Excel; and on elemental analysis for isotope ratio mass spectrometry. Laboratory networks for food safety were further strengthened through Agency support for over 217 food safety and control institutions in Africa (102 institutes in 21 countries), Asia (46 institutes in 29 countries) and Latin America and the Caribbean (69 institutes in 21 countries).

32. The Agency helped strengthen food safety and control systems in Member States through the development, at its Seibersdorf laboratories, of 22 analytical method protocols and 24 standard operating procedures for food testing methods for 12 different commodities.

33. To enhance food security and income generation of African farmers, the Agency continued to support African local research institutes and farmer associations across Africa by sharing sustainable and efficient nutrient, water and soil management practices using climate-smart agriculture to improve cassava production. As a result, cassava yields in Burundi, the Central African Republic, Ghana, Nigeria and Rwanda doubled and even quadrupled from 10 tonnes per hectare to more than 40 tonnes per hectare in demonstration farms.

34. The Agency continued to support Member States in dealing with the impacts of climate change. In the Andes region of the Plurinational State of Bolivia, a cosmic ray neutron sensor, in combination with data from C-band Sentinel, is being used as part of an early warning system for drought and flooding

prediction for the cities of El Alto and La Paz. In addition, a real-time high-resolution soil moisture map can help identify areas of wetland ecosystems that are under stress to develop targeted conservation strategies, thus ensuring their long-term sustainability and resilience.

35. The Agency organized the International Symposium on Trends in Radiopharmaceuticals (ISTR-2023) in April 2023. The event brought together over 500 scientists and other professionals, representing 88 Member States, and more than 30 industries and three international organizations, to discuss recent updates and challenges in medical radioisotope production, and radiopharmaceuticals for diagnostic, therapeutic or theranostic uses. Side events organized during ISTR-2023 offered additional opportunities to participants, including young researchers and women in radiopharmaceuticals, to advance their understanding of, and collaboration and networking in, the field of radiopharmaceutical science.

36. The Agency, in partnership with the World Health Organization (WHO), launched new guidelines on meeting the current expectations and trends in good manufacturing practices specific to investigational radiopharmaceuticals used in clinical trials.

37. In the reporting period, the Agency issued two publications as part of the IAEA Radioisotopes and Radiopharmaceuticals Series entitled *Copper-64 Radiopharmaceuticals: Production, Quality Control and Clinical Applications* and *Guidance for Preclinical Studies with Radiopharmaceuticals*.

38. The Agency continued to strengthen its assistance to Member States to ensure better availability of safe radiopharmaceuticals and novel medical radioisotopes by cooperating closely with external partners and professional societies, such as the Euratom Supply Agency, URENCO, and research consortium initiatives for novel radioisotope and radiopharmaceutical development.

39. As part of a NUTEC Plastics-related CRP entitled “Recycling of Polymer Waste for Structural and Non-structural Materials by Using Ionizing Radiation” a guidelines document on integrating electron beam technology into the polymer recycling process was finalized for publishing. The document covers all aspects of integrating the technology into recycling facilities, and several promising case studies.

40. Two Excel-based tools were developed, for economic feasibility studies for setting up a recycling facility using electron beam technology and for technology readiness level progress assessment to be disseminated on the NUTEC Plastics portal.

41. The Agency continued to provide emergency support for natural disasters. In the reporting period, two dedicated task forces were convened to support Ecuador, the Syrian Arab Republic and Türkiye following earthquakes. It is expected that human and infrastructural capacities in using non-destructive testing to evaluate the integrity of civil structures and buildings will be developed in these countries to support disaster recovery activities.

42. With the aim of validating and enhancing the quality of environmental measurements in Member States’ laboratories, almost 2000 units of reference materials produced by the Agency were distributed to the laboratories of 60 Member States during the reporting period. Two new certified reference materials were released.

43. Proficiency testing exercises on the determination of anthropogenic and natural radionuclides in water, soil and simulated contaminated surface samples were launched at the beginning of 2023, and 440 laboratories registered to verify their technical competence. The Analytical Laboratories for the Measurement of Environmental Radioactivity grew during the reporting period and now comprises 195 laboratories in 90 countries.

44. The Agency continued to strengthen its relationships with the World Meteorological Organization and the International Bureau of Weights and Measures (BIPM) in the area of climate change with the

purpose of expanding the global isotopic monitoring of methane as an atmospheric greenhouse gas and testing capabilities for carbon dioxide isotope analysis of leading institutions. A pilot interlaboratory comparison study for evaluating stable isotope analysis in carbon dioxide was organized in collaboration with the BIPM (with 17 participants from 15 countries).

45. A Joint ICTP–IAEA Advanced Workshop on Future Trends in Multidisciplinary Ion Beam Analysis was held in Trieste, Italy, in October 2022, and was attended by 25 participants from 16 Member States.

46. In October 2022, the Agency held an Advanced Training Course on Characterization, Dating and Data Interpretation of Heritage Materials and Objects with Nuclear Analytical Techniques, which was attended by over 50 participants from 25 Member States.

47. The first Training Workshop on the Safe Operation and Applications of Neutron Generators was held in November 2022 in Seibersdorf, Austria, and was attended by ten participants from ten Member States.

48. A Training Workshop on the Operation and Maintenance of Electrostatic Accelerators and Associated Instrumentation was held at the IAEA Collaborating Centre iThemba Laboratory for Accelerator-Based Sciences in South Africa and was attended by ten participants from eight Member States.

49. In September 2022, a Regional Training Course on In-Situ Characterization of Contaminated Sites with Practical Field Applications was held in Pecs, Hungary, and was attended by 40 participants from 17 Member States.

50. In 2022, two Integrated Research Reactor Utilization Review missions were implemented, in Peru and South Africa.

51. In November 2022, the Agency, in cooperation with the Egyptian Atomic Energy Authority, organized the tenth African Conference on Research Reactor Safety, Operation and Utilization, which was held under the theme “Strengthening the Capacity for Research Reactor Safety and Applications in Africa” and was attended by 54 participants from 15 African Member States. The proceedings of the conference were published as a special issue of the *Arab Journal of Nuclear Sciences and Applications*.

52. In August 2022, the Agency organized the Eighth IAEA DEMO Programme Workshop, where experts discussed operational plasma transients, coolant technologies, the fusion fuel cycle and required materials research and development needed for future demonstration fusion power plants (DEMO) and pilot plants. The event was attended by 41 participants from 14 Member States and representatives from the ITER Organization and Fusion for Energy.

53. In October 2022, the first Technical Meeting on Plasma Physics and Technology Aspects of the Tritium Fuel Cycle for Fusion Energy was organized by the Agency. The topical area of focus was the complex interface of plasma physics and technology aspects of the fusion fuel cycle, from ITER to DEMO plants. The event was attended by 39 participants from 9 Member States, as well as representatives from the ITER Organization.

54. In December 2022, the Agency published its first ever *World Survey of Fusion Devices*. This publication provides a worldwide survey of public and private fusion devices with experimental and DEMO designs that are currently in operation, under construction or being planned. It provides details such as device name, status, ownership, host country and organization, with over 130 fusion devices featured.

55. In the reporting period the Agency continued to expand Member States’ participation in the area of fusion science and technology by organizing several schools, these include; in November 2022 the

Joint ICTP–IAEA College on Plasma Physics for Fusion Applications, which was held in Trieste, Italy, and attended by 36 participants from 17 Member States, in May 2023, a Joint ICTP–IAEA School on AI for Nuclear, Plasma and Fusion Science which was attended by 19 participants from 16 Member States, and in June 2023 the 12th ITER International School, organized in cooperation with the Agency in Aix-en-Provence, France which was attended by 157 participants from 29 Member States.

56. The Advanced Training Course on Characterization, Dating and Data Interpretation of Natural Heritage Materials and Objects with Accelerator-Based and Complementary Analytical Techniques was held virtually in October 2022 and was attended by 53 participants from 25 Member States.

57. In May 2023, the Agency and the United Nations Interregional Crime and Justice Research Institute held a joint informal briefing in Vienna and proposed a cooperation platform on using nuclear techniques to combat illicit trafficking in cultural goods to support Member States' efforts towards more effective crime prevention and control to fight illicit trafficking in cultural property.

58. In May 2023, a Joint ICTP–IAEA Advanced Workshop on Accelerator Mass Spectrometry Radiocarbon Dating for Heritage and Forensic Sciences was held in Trieste, Italy, and was attended by 23 participants from 16 Member States.

59. The Agency launched a CRP entitled "Sub-Cellular Imaging and Irradiation Using Accelerator-Based Techniques", which will result in the development of novel sub-cellular imaging and biological cell irradiation techniques in order to advance knowledge of, and capabilities in understanding, how biological cells respond to radiation towards more efficient and tailored particle therapy.

60. In October 2022, a Technical Meeting on Research Reactor Radioisotope Production took place in a hybrid format in Vienna and was attended by 19 participants representing 17 Member States.

61. In October 2022, the Agency published Muon Imaging: Present Status and Emerging Applications (IAEA-TECDOC-2012), which describes some of the main muon imaging techniques, the detector types involved, and a wide variety of applications that have been identified from the examination of modern and ancient built environments, volcanology and industry to nuclear security and safeguards.

62. In April 2023, the Agency published Specific Considerations and Guidance for the Establishment of Ionizing Radiation Facilities (IAEA Radiation Technology Series No. 7), which provides guidance for organizations and institutions working on ionizing radiation facility projects in order to enable them to undertake such projects in a well-organized manner.

63. In June 2023, the Agency issued the non-serial publication Advances in Boron Neutron Capture Therapy, which describes the latest developments in BNCT during the past two decades, with an emphasis on accelerator-based technology.

64. In July 2023, the Agency published Cold Neutron Sources: Practical Considerations and Modern Research (IAEA-TECDOC-2025), which details practical experience in the design and operation of cold neutron sources at research reactors and at accelerator-based neutron sources and provides an overview of some modern developments in cold moderators.

65. In July 2023, the Agency published Intercomparison of k0-NAA Software Packages (IAEA-TECDOC-2026), which assesses and establishes the magnitude of the impact on the final mass fractions determined by the different software packages considered.

66. In collaboration with the US Department of Energy and French Institute for Radiological Protection and Nuclear Safety (IRSN), the Agency developed the International Database of Reference Spectra for the Measurement of Uranium and Plutonium Isotopes.

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

A. Background

1. In resolution GC(66)/RES/9/A.2, the General Conference recognized that tsetse flies and the trypanosomosis problem which they cause constitute one of the greatest constraints on the African continent's socio-economic 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 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 selected operational SIT field projects and to strengthen its support for R&D and technology transfer to African Member States in order to complement their efforts to create and subsequently expand tsetse-free zones.

3. The General Conference 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-seventh (2023) regular session.

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

B.1. Strengthening Collaboration with AU-PATTEC

4. The Agency has continued its collaboration with AU-PATTEC on its goal to eliminate tsetse flies and trypanosomosis through the creation of sustainable tsetse and trypanosomosis (T&T) free areas. In response to a request from Member States, a task force meeting was organized, and the Agency is supporting 20 Member States (Angola, Burkina Faso, Cameroon, Chad, Cote D'Ivoire, Djibouti, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Mali, Mozambique, Nigeria, Senegal, South Africa, Sudan, Uganda, Tanzania, Zambia, and Zimbabwe) with the aim of exploring mechanisms to strengthen AU-PATTEC activities such as, inter alia, engaging the African Union Commission to operationalize the AU-PATTEC Coordination Office, and supporting the development of bankable documents to mobilise resources for tsetse and trypanosomosis field programmes.

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 sterile insect technique (SIT) into area-wide integrated pest management (AW-IPM) through regional

project RAF/5/087 “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, procurement of equipment and materials, training courses and workshops, fellowships and scientific visits through relevant technical cooperation projects, and research that was conducted at the Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria. In addition, experts from affected Member States continued to participate in the coordinated research project entitled “Improvement of Colony Management in Insect Mass-rearing for SIT Applications”, which includes a research group on tsetse flies.

6. The Agency’s support strengthened Member States’ capacities, 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.

7. Research activities at the IPCL continued to focus on improving sterile male quality by refining feeding, sterilization and quality control protocols and understanding the impact of pathogenic viruses and symbiotic bacteria on the productivity and performance of tsetse colonies.

8. Species-specific sorting protocols have been developed for the Near Infrared Pupae Sex Sorter for four tsetse species that are targets for the SIT. Sex sorter units are in operation in insectaries that produce tsetse pupae for the AW-IPM campaign currently under way in the Niayes region of Senegal, to the north-east of Dakar.

FIG. B.1. A fellow from the United Republic of Tanzania receives training in utilizing the Near Infrared Pupae Sex Sorter for the sex sorting of 24-day old tsetse pupae. (Source: IAEA)

9. The Agency supports the European Commission-funded Horizon 2020 project “Controlling and Progressively Minimizing the Burden of Animal Trypanosomosis” (COMBAT) by being part of the project’s external advisory board. COMBAT’s main objectives are to advance knowledge on African

trypanosomosis (AT), to improve control of and develop information systems for AT and tsetse, to evaluate the burden and improve strategies for AT control, and to increase the capacities and awareness of COMBAT partners and AT stakeholders.

10. The Agency continued to develop new isotope and nuclear techniques for making banana and coffee production systems more climate-change resilient. Experiments in the Seibersdorf laboratories greenhouses helped scientists understand how drought stress affects banana plants by looking at mother and next generation daughter plants as they exist in field conditions. Both the yield from the mother plants, as well as the potential yield from the next generation plants, will be impacted by drought stress when a sucker is present. To sustain yields under suboptimal conditions, farmers might consider reducing the number of suckers or delaying sucker selection until conditions are more favourable. These findings were obtained through labelling with enriched stable isotope carbon-13 techniques. The methods employed can be transferred to other plants, which could lead to improvements in the resilience and sustainability of perennial farming systems. This research is financed by the Belgian Government through the Agency's Peaceful Uses Initiative project "Enhancing Climate Change Adaptation and Disease Resilience in Banana–Coffee Cropping Systems in East Africa", which is being conducted in close scientific collaboration with the International Institute of Tropical Agriculture.

11. Knowledge about radiocaesium dynamics is important for the remediation of radioactive contamination in agriculture. However, the methods to obtain this knowledge are often impractical because they are time-consuming and expensive to analyse. The Agency is developing rapid and cost-effective tools for predicting radiocaesium dynamics and uptake using mid-infrared spectroscopy (MIRS). One of radiocaesium-related parameters, exchangeable caesium-137 or total caesium-137 in soil, was accurately predicted using MIRS. The investigative effort will continue in 2023, with more parameters to be investigated and more data added to the dataset, which is expected to improve the accuracy of predictions.

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

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

13. Under regional project RAF/5/087, 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 Democratic Republic of 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 one regional training course to train participants from 17 Member States on technical aspects of field baseline data collection procedures, and data management applied in field programmes targeting tsetse flies. Moreover, a technical task force meeting was implemented to support Member States in strategies and provide a road map to overcome challenges, bottlenecks and key knowledge gaps in T&T management at the regional level using SIT. The Agency also supplied materials and equipment to continue enhancing the capacities of Member States in the region for their fight against tsetse flies and trypanosomosis.

14. 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 using an AW-IPM approach with an SIT component. The last wild flies were trapped more than 12 months ago, and, therefore, the tsetse fly population is considered to have been eradicated. This has been confirmed by an analysis of the disease incidence in resident

cattle, i.e. transmission of animal trypanosomosis has stopped. Sterile male releases have continued, including with sterile male flies derived from weekly shipments from the IPCL. Senegal continues to import more productive cattle into the area.

FIG. B.2. Intensive cattle farming has been made possible thanks to the eradication of tsetse flies in the Niayes region of Senegal. (Source: IAEA)

15. In Burkina Faso, the Agency continued to provide technical support to the country through fellowship training and enhancing the capacity building for tsetse suppression in the field, large-scale rearing of tsetse flies and molecular biology techniques for the detection of trypanosome infection in wild tsetse populations. This has resulted in the continued production of sterile males of *Glossina palpalis gambiensis* for release as part of the SIT project in Senegal.

16. In Chad, pre-operational activities have continued in the Mandoul area, one of the country's few remaining active foci of sleeping sickness. Equipment was supplied for ongoing suppression activities, resulting in an extremely low density of tsetse flies and the lowest number of cases of sleeping sickness in this focus, which consists of areas for which historical records of disease transmission are available. Training activities on the maintenance of tsetse colonies, the sorting and sterilization of tsetse pupae and the long-distance shipment of sterile pupae continued. Through the technical cooperation programme, the Agency continued to provide technical support to Chad to enhance capacity building through fellowship training and providing equipment for suppression activities in the field and establishing a tsetse handling centre. The Agency also supported Chad through determining the genetic relationship between *Glossina fuscipes* tsetse flies in the Mandoul area and those reared in the IPCL, which has resulted in the possibility of using the reared flies for producing sterile males to be released in the Mandoul area.

FIG. B.3. Glossina fuscipes fuscipes, the vector of sleeping sickness in the Mandoul area of Chad. (Source: IAEA)

17. In Ethiopia, South Africa and the United Republic of Tanzania, the Agency continued to provide technical support through fellowship training, scientific visits and enhancing capacity building by supplying tsetse mass rearing equipment.

18. African trypanosomosis affecting livestock continues to pose a significant constraint on development in much of sub-Saharan Africa, especially in rural areas. Where technically feasible, 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 trypanosomosis, but also of human trypanosomosis (sleeping sickness) where it occurs. The benefits achieved, such as the improved ability to rear livestock for milk, meat and animal traction for ploughing to grow crops, will substantially improve the livelihoods of rural populations. The Agency continues to assist in building capacity in this area for the benefit of Member States in sub-Saharan Africa.

19. The constraints on successful and more widespread application of SIT in suitable areas continue to be the shortage of mass-rearing capacity in Africa and of appropriate management structures for mass-rearing and area-wide pest control operations.

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, the Director General announced during the March 2020 Board of Governors meeting plans to build a second new Flexible Modular Laboratory (FML-2) building, which will house the three above-mentioned laboratories. The Dosimetry Laboratory will be refurbished 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 'ReNuAL 2', during a technical briefing on 3 September 2020. 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 Sustainable Development Goals.

5. The General Conference, in resolution GC(66)/RES/9, 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-seventh (2023) regular session.

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

B.1. Implementation Status

6. Design planning for the three main elements of ReNuAL 2 (i.e., the FML-2 building, the greenhouses and the refurbishment of the Dosimetry Laboratory) was concluded with the assistance of an external architectural firm in May 2021. An open bidding process was launched in November 2021 for the construction of the new laboratories building, the refurbishment of the Dosimetry Laboratory, and the construction of foundations for the new greenhouses. A contract was signed in mid-September 2022 for the construction of the FML-2 building and greenhouses foundation. A ground-breaking event to mark the launch of construction was held on 3 October 2022. The refurbishment of the Dosimetry Laboratory was included in the same contract, with a guaranteed "not to exceed" price ceiling. Following extensive value engineering and negotiation, a Notice to Proceed was issued to the contractor on 10 March 2023 to move forward with refurbishment of the Dosimetry Laboratory. Separate tender processes were launched in March 2023 and April 2023, respectively, for procurement of laboratory greenhouses (apart from their foundation, which is included in the FML-2 building contract) and outfitting of the new FML-2 building; both procurement processes were ongoing as of the beginning of the third quarter of 2023.

FIG. B.1. Member State representatives join the Director General for the ReNuAL 2 ground-breaking event on 3 October 2022. (Source: IAEA)

7. Construction works on both the new FML-2 laboratories building and the refurbishment of the Dosimetry Laboratory were well underway as of the beginning of the third quarter of 2023. The FML-2 building infrastructure, foundation and ground floor walls had been completed and work had begun on the second storey of the four-storey building, with the project on track to complete the building frame on schedule by the fourth quarter of 2023. Construction works on the Dosimetry Laboratory are phased to minimize interference with the ongoing operations of the Laboratory. Refurbishment commenced in mid-April with the clearance of laboratory space, dismounting and demolition works. Subsequently, the suspended ceiling in the corridors was dismounted, and preparatory electrical and heating, ventilation and air conditioning installation works were initiated in the basement. The areas designated for the next

phase of the Dosimetry Laboratory refurbishment will be cleared by the end of July, with construction slated to commence in August, followed by installation works starting in September. Construction works on the Dosimetry Laboratory are expected to be completed by the end of the first quarter of 2024.

FIG. B.2. The status of construction of the new laboratories building and greenhouse foundations as of February 2023. (Source: IAEA)

FIG. B.3. The status of construction of the new laboratories building and greenhouse foundations as of April 2023. (Source: IAEA)

FIG. B.4. The status of construction of the new laboratories building and greenhouse foundations as of late June 2023. (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 €470 000. Approximately €9.7 million of this project budget was made available to address the requirements of the four remaining laboratories in the ReNuAL 2 project phase, which includes the ongoing construction of a new building (FML-2), the construction of new greenhouses and the 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 already 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. On 6 September 2022, the Deputy Director General for Nuclear Sciences and Applications provided Member States an informal technical briefing to present revised ReNuAL 2 project cost projections and timelines based on the rapidly escalating prices and supply chain challenges encountered in the bidding process for construction of the FML-2 building, greenhouse foundations and 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 ReNuAL 2 phase could rise to €41 million or more. As of the beginning of the third quarter of 2023, the estimated total budget was €42.9 million, which includes cost elements identified as required to

complete the project, but not previously included in the project budget, such as transition, information technology infrastructure, photo voltaic and project energy costs.

10. As of the beginning of the third quarter of 2023, 34 Member States, one international organization and one private sector donor had announced extrabudgetary contributions for the ReNuAL 2 phase, totalling just over €27 million. An additional €4.3 million in funding was provided from the Major Capital Investment Fund. The Director General's proposed budget for 2024–2025 includes a request for €1.5 million for projected cost elements, identified as required to complete the project.

B.2.2. Funding Priorities

11. At the October 2022 ground-breaking event, and again at the November 2022 Board of Governors meeting, the Director General highlighted an urgent need for €5.5 million in extrabudgetary funding, which was the outstanding requirement for the estimated cost of €6 million cost for constructing the new laboratory greenhouses. At the March 2023 Board of Governors meeting, 12 Member States (Algeria, Australia, Germany, Jordan, the Republic of Korea, Kuwait, Malaysia, the Netherlands, Slovenia, the United Arab Emirates, the United Kingdom and the United States of America) responded by announcing a joint pledge of €5.5 million, allowing the Secretariat to launch a procurement process that month for the new greenhouses. In April 2023, the Secretariat launched a separate procurement process for the interior outfitting of the FML-2 laboratories building, for which almost all of the estimated cost of approximately €3 million had already been mobilized. With major construction works on the FML-2 building and Dosimetry Laboratory refurbishment already under contract and funded, the known remaining funding requirement for project construction, as of the beginning of the third quarter of 2023, was approximately €200 000 toward the estimated cost of the FML-2 building outfitting. Any actual outstanding funding requirement will be known only at the conclusion of the ongoing procurement processes for the greenhouses and the FML-2 outfitting.

B.2.3. Resource Mobilization Strategy

12. 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 are continually updated to account for progress in completing specific project elements, any changes in expected costs and expected resource requirements.

13. Laboratory tours remain invaluable to highlight the important work of the laboratories and play an essential role in fundraising efforts. The pace of laboratory visits continues to increase, after having been suspended and then resumed on a much more limited basis during 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 General Conference in 2022, and at the November 2022 and March and June 2023 Board of Governors meetings, provided valuable additional support to resource mobilization efforts. A centrepiece of these events is a donor display on which new contributors to ReNuAL 2 are recognized with a plaque. The donor display will be permanently installed in the lobby of the new FML-2 building upon its completion.

FIG. B.5. ReNuAL2 Side Event on the Margins of the March Board of Governors Meeting held at the Agency headquarters in Vienna, Austria, 7 March 2023. (Source: IAEA)

B.2.4. Resource Mobilization Efforts with Member States

14. The Secretariat continually engages in bilateral discussions with a wide 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 34 Member States so far announcing contributions to the ReNuAL 2 phase. (A total of 51 Member States had contributed to one or both phases of the ReNuAL initiative.) 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 Friends 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.

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

15. Contributors to the ReNuAL 2 phase of the initiative include one international organization (the Food and Agriculture Organization of the United Nations) and one private sector donor (URENCO). These successes, coupled with previous support by non-traditional donors during the first phase of ReNuAL, aligns 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".

C. Next Steps

16. Construction works on the FML-2 laboratories building and Dosimetry Laboratory refurbishment were well underway and on pace according to the revised timetable as of the beginning of the third quarter of 2023. Procurement processes for the new laboratory greenhouses and FML-2 building internal outfitting were ongoing. Upon the successful conclusion of these procurement processes, construction works will be launched on these project elements, with the expectation that all major construction on the ReNuAL 2 phase of the initiative will conclude by the end of 2024.

17. Resource mobilization efforts as of the beginning of the third quarter of 2023 are focused on raising the €200 000 that is estimated to still be needed for the outfitting of the FML-2 laboratories building. Greater clarity on any outstanding project funding requirements related to construction will be gained at the conclusion of the ongoing procurement processes.

Zoonotic Disease Integrated Action (ZODIAC) Project

A. Background

1. In resolution GC(66)/RES/9.A.4., the General Conference took note of the Director General's report as contained in document GOV/2022/30-GC(66)/9 submitted to the Board of Governors.

2. The General Conference recognized that the Agency has a long-standing 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 the 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, including vector-borne diseases such as malaria, yellow fever, chikungunya virus, and dengue fever, have a significant and long-term implications on human health and the socio-economic 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 and enhance their preparedness to address emerging and re-emerging zoonotic diseases, through the use of molecular biology nuclear and nuclear-derived methods, 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 Veterinary Disease Diagnostic Laboratories (VETLAB) Network, and other delivery mechanisms such as Coordination Research Projects and the Technical Cooperation Programme under project INT5157 and that they form part of the Agency's support to Member States in combatting zoonotic diseases and preventing future pandemics.

7. The General Conference recalled the expansion of the Revised Arrangement between the Agency and the FAO in 2021 to include the "improvement of monitoring and controlling of transboundary animal, zoonotic and plant diseases" as a key area, integrating the Joint FAO/IAEA Centre laboratories' capacities into FAO's work on One Health and acknowledged that ZODIAC aims to build on the existing partnership between the Agency and the FAO, to include coordination with the United Nations Environmental Programme (UNEP), the World Health Organization (WHO), and the World Organisation for Animal Health (WOAH).

8. The General Conference welcomed the prompt response of the Secretariat in organizing the "ZODIAC Workshop on Monkeypox and Lassa Fever Infections in Animal Reservoirs and the Risks for Public Health Transmission", while leveraging the ZODIAC National Laboratories (ZNLs) network, following the outbreak of monkeypox on three continents and of Lassa fever in Africa.

9. The General Conference took note of the establishment of the ZODIAC Ad-Hoc Scientific Panel (ZOSP), which is composed of independent scientists and experts.

10. The General Conference requested the Director General to report on the progress made in the implementation of this resolution to the Board of Governors and the General Conference at its sixty-seventh (2023) regular session.

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

11. 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 research and development (R&D) activities in the field of animal health at its Animal Production and Health Laboratory in Seibersdorf, coordinating the VETLAB Network, and supporting Member States in the context of animal health through their relevant national and regional technical cooperation projects.

12. Respiratory infections caused by viruses are among the most common global infectious diseases. The majority of these viruses originate from animal reservoirs or hosts and cross the species barrier, transferring to humans. The Agency evaluated two multiplex polymerase chain reaction (PCR) based assays for the surveillance and monitoring of zoonotic viruses. The assays are for the detection of flavivirus, influenza A (H1N1) and paramyxovirus in birds. These virus families include the avian influenza virus, which can cause a pandemic. The first assay was modified and improved from an existing singleplex probe-based real-time reverse transcription–polymerase chain reaction (rRT–PCR) detection, to a multiplex PCR that enables the detection and identification of the three virus families. The second assay involves a multiplex reverse transcription (RT)–PCR for the detection of the three virus families, followed by nanopore sequencing of the PCR product. The application of nanopore sequencing (which uses a portable nanopore MinION device to directly detect zoonotic pathogens by sequencing short PCR amplicons targeting viral families) confirms the detected virus families and can identify different species of viruses belonging to the same family. These cost-effective, quick and practical assays are expected to facilitate the surveillance and monitoring of zoonotic viruses in birds, especially migratory birds, which contribute to the spread of pathogens. This approach will be made available through ZODIAC and will facilitate zoonotic disease surveillance in Member States. The Agency also continued supporting Member States in the characterization of their local isolates of the highly pathogenic avian influenza H5N1 virus, and in identifying alternative reagents for diagnosing the disease in countries that face challenges in maintaining a cold chain throughout the process of handling the live samples. These research results contribute to the knowledge made available to ZNLs.

13. The Secretariat continued to update the ZODIAC Portal which, after receiving about 1000 visitors a month upon its release, now receives a steady number of around 300 regular users per month. The number of users of the iVetNet platform, which was developed under the VETLAB Network and which is a key component accessible to registered users from the ZODIAC Portal, continues to increase — 1969 institutions from 202 countries and territories worldwide currently benefit from laboratory information, standard operating procedures (SOPs) and facilities for getting ISO certification, among other things. This platform informs on activities related to zoonotic and transboundary animal diseases worldwide.

14. The Agency continued its dialogue with the WHO, maximizing on the complementarity of the expertise and mandate. This resulted in the participation of the WHO Secretariat and experts in the relevant training courses organized under the ZODIAC project, as well as the regular participation of

the Agency Secretariat in the Joint External Evaluations that are organized by WHO and during which ZODIAC is presented and discussed with the national authorities. The implementation of ZODIAC is also discussed in monthly meetings between the Joint FAO/IAEA Centre for Nuclear Techniques in Food and Agriculture and its corresponding Division in Rome.

15. The Agency continued making full use of its partnerships to ensure additional access to information and training for the ZNLs and ZODIAC National Coordinators (ZNCs), as well as visibility for ZODIAC. The Institut Pasteur de Dakar in Senegal hosted a ZODIAC regional training course in September 2022. Following discussions and briefings with representatives of PREZODE and Eklipse in November 2022 and April 2023, ZNLs and ZNCs of five South East Asian Member States were invited, through cooperation with the French National Center for Scientific Research and funding by Le Fonds de Solidarité pour les Projets Innovants of the Government of France, to attend meetings organized in the context of One Health South East Asia. The Agency continued to attend meetings organized by PREZODE.

16. In January 2023, the first meeting of the ZOSP, composed of 17 renowned scientists from 17 Member States, applauded the establishment and objective of the ZODIAC project.

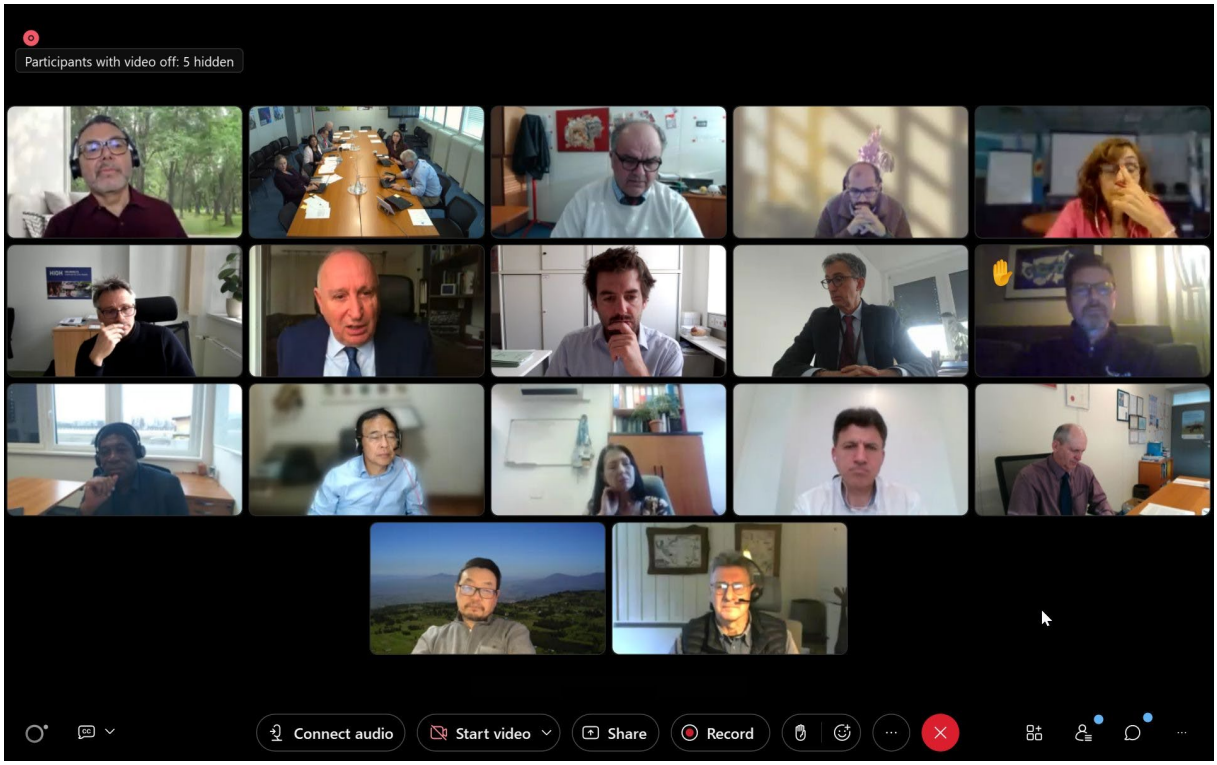


FIG. B.1. First meeting of the ZODIAC Ad-Hoc Scientific Panel in January 2023. (Source: IAEA)

17. As of June 2023, resource mobilization efforts had led to generous contributions from 15 Member States, including Belgium, Bulgaria, Estonia, France, Israel, Japan, the Republic of Korea, Kuwait, Morocco, Pakistan, Poland, Portugal, Saudi Arabia, Switzerland and the United States of America, amounting to €13.7 million received and/or pledged.

18. The Secretariat continued its efforts to mobilize resources from non-traditional partners, developing projects for funding that focus on parts of ZODIAC, and publishing its needs for equipment on the United Nations Global Marketplace. While the Secretariat is currently in discussion with a supplier for equipment under Pillar 1, a successful partnership was established with Amazon Web Services for data management services that will greatly support the research on human health initiated under Pillar 4.

19. The requests for participation in ZODIAC continue to increase. As of June 2023, 150 Member States had designated a ZNC and 127 had designated a ZNL.

20. Training remains a high priority for ZODIAC, in order to ensure that all participating laboratories acquire the capabilities required for efficient detection of emerging zoonotic diseases. Under technical cooperation project INT5157 "Supporting National and Regional Capacity in Integrated Action for Control of Zoonotic Diseases", four regional training courses on the generic verification of newly introduced SOPs in local laboratories were conducted in September 2022 and February, March and May 2023, in Dakar; Incheon, Republic of Korea; Buenos Aires; and Sofia, respectively, for ZNLs of the respective regions. Participants were trained on how to verify and adopt SOPs for new serological and molecular techniques, therefore enhancing the national and regional capacity in the surveillance, detection and control of emerging and re-emerging zoonotic diseases.

FIG. B.2. Conclusion of Regional Training Course in the Republic of Korea from 6-10 February 2023. (Source: IAEA)

21. In February 2023, under technical cooperation project RAF5082 "Enhancing Veterinary Diagnostic Laboratory Biosafety and Biosecurity Capacities to Address Threats from Zoonotic and Transboundary Animal Diseases (AFRA)", and maximizing on the complementarity of activities planned under the technical cooperation programme, participants from ZNLs of 12 African Member States (Algeria, Angola, Benin, Cameroon, Chad, Côte d'Ivoire, the Democratic Republic of the Congo, Eswatini, Lesotho, Malawi, Mali and Mozambique) were trained in and certified for the calibration, verification and maintenance of biosafety cabinets, an essential part of bio-risk management in laboratories, at the IAEA Seibersdorf laboratories. Workshops were also held to assess the biorisk management situation in veterinary laboratories in Africa (April 2023, Botswana) as well as, virtually, for Latin America (April 2023), Europe (May 2023), and Asia and the Pacific (May 2023). Participants

from ZNLs were trained on the identification of priority procedures to develop biorisk management activities in laboratories for the presentation of internationally recommended structures of biological risk management systems and to suggest improvements.

22. In July 2023, a sub-regional meeting was held in Kuwait City on "Preparedness and Capabilities of Member States in the Gulf Cooperation Council (GCC) to Respond to the Threats of Zoonotic Diseases", with the participation of representatives from Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, and with the expert support from WOAH.

23. One of the main objectives of ZODIAC is to serve as a platform for sharing information and experience. In June 2023, a virtual seminar was organized under INT5157 entitled "Avian Influenza in Africa – Lessons Learnt on Preparedness and Control of Avian Influenza" with the support of experts from Cote d'Ivoire, Egypt, Italy, Nigeria, the United Kingdom and FAO. Though the workshop was primarily intended for ZNLs and ZNCs from Africa, it was attended by 214 participants from over 90 Member States.

24. Individual training courses were provided for three scientists from Indonesia, Senegal and Tunisia on whole-genome sequencing at the Agency's Seibersdorf laboratories to enhance the capacity of ZNLs in the early and rapid detection and characterization of re-emerging zoonotic pathogens.

FIG. B.3. Individual training courses on whole-genome sequencing have started at the Agency's Seibersdorf laboratories. (Source: IAEA)

25. Equipping ZNLs in this phase of ZODIAC is critical. Under technical cooperation project INT5157, and following a thorough technical needs analysis, 39 ZNLs (15 in Africa, 7 in Asia and Pacific, 9 in Europe and 8 in Latin America) were supplied with equipment for the serological and molecular detection and characterization of zoonotic pathogens. Next generation sequencing (NGS) hardware platforms were supported in 9 laboratories (3 in Africa, 2 in Asia and the Pacific, 2 in Europe, and 2 in Latin America and the Caribbean) for the rapid implementation of appropriate technologies and bioinformatics, as well as for the laboratories to become, where relevant, regional centres for the dissemination of NGS knowledge and skills. Procurement needs for additional ZNLs will be addressed as funding becomes available.

26. Research and development are an integral part of ZODIAC. Under Pillar 2, technical contracts have been awarded to three institutes in the Republic of Korea, while six research contracts for institutes in Cambodia, Indonesia, Mongolia, Nepal, Thailand and Viet Nam are in the process of being awarded as part of the ZODIAC project's research and development in the Asia and the Pacific Region. Under Pillar 4, the implementation of the research planned under the coordinated research project "ZODIAC Respiratory Disease Phenotype Observatory" will be initiated, following the 18 research contracts awarded to institutes in Austria, Brazil, Colombia, Cuba, Egypt, France, Germany, Guatemala, India, the Islamic Republic of Iran, the Republic of Korea, Lebanon, Mexico, the Netherlands, Pakistan, Paraguay, the Philippines, South Africa, Thailand, Tunisia and the United Kingdom, and four agreements and two contracts awarded to laboratories.

FIG B.4. Director General Rafael Mariano Grossi briefs the Africa Group on topics including Rays of Hope, NUTEC Plastics and ZODIAC during a meeting at the Agency headquarters in Vienna, Austria, 7 November 2022. (Source: IAEA)

Plan for Producing Potable Water Economically Using Small and Medium Sized Nuclear Reactors

A. Background

1. In resolution GC(66)/RES/9.A.7, the General Conference requested the Director General to continue consultations and strengthen interactions with interested Member States, the competent organizations of the United Nations system, regional development bodies and other relevant intergovernmental and non-governmental organizations in activities relating to seawater desalination using nuclear energy.

2. Resolution GC(66)/RES/9.A.7 encouraged TWG-ND to continue its functions as a forum for advice and review on nuclear desalination and integrated water resources management activities. The General Conference stressed the need for continued strengthening of international cooperation in the planning and implementation of nuclear desalination demonstration programmes through national and regional projects open for the participation of any interested country.

3. The General Conference also requested the Director General, subject to the availability of resources, to (a) continue to hold regional training workshops and technical meetings and to use other available mechanisms for disseminating information on nuclear desalination and water management using SMRs and to undertake further activities aimed at better establishing how existing reactors may offer options for nuclear desalination; (b) issue a revised version of the existing document NG-G-3.1 (Rev. 1), *Milestones in the Development of a National Infrastructure for Nuclear Power*, to address aspects of nuclear cogeneration projects including desalination, (c) continue to develop the Agency's activities in assessing the role of nuclear desalination within the context of sustainable development and climate change mitigation, and (d) continue to increase the Agency's activities related to training, capacity building and disseminating information on nuclear desalination using SMRs;

4. In resolution GC(66)/RES/9.A.7, the General Conference invited the Director General to raise funds from extrabudgetary sources in order to catalyse and contribute to the implementation of all Agency activities relating to nuclear desalination and cogeneration, and the development of innovative SMRs; and requested the Director General to note the high priority given by a growing number of interested Member States to the nuclear desalination of seawater in the process of preparing the Agency's Programme and Budget.

5. The General Conference further 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-seventh (2023) regular session under an appropriate agenda item.

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

6. In its efforts to contribute to the implementation of GC(66)/RES/9.A.7, the Agency held the eighth meeting of the Technical Working Group on Nuclear Desalination (TWG-ND) and the first of the 2021–

2024 TWG-ND cycle in Vienna in September 2022. The meeting of the TWG-ND, which has a membership of 16 countries, was attended by 14 members and 1 technical advisor, and reviewed activities undertaken by the Agency and Member States in the fields of nuclear desalination and integrated water resources management (IWRM), exchanged views on the future of nuclear desalination, and provided conclusions and recommendations for future Agency activities in support of nuclear desalination. In addition, the members of the TWG-ND provided updates on the most recent developments in national and international programmes in the areas of nuclear desalination and IWRM.

7. Following a recommendation by the TWG-ND on future high-priority activities to support Member States with nuclear desalination, the Agency started an activity to review and identify recent technological developments, and innovative ideas, that can make use of nuclear energy, and of heat in particular, in an effective manner for seawater desalination. This activity is intended to prepare the groundwork for a Technical Meeting in December 2023 where the identified ideas and technologies can be discussed with all interested Member States; and to prepare the initial material for a reference publication that will provide information to Member States on selecting low-carbon desalination technologies, as well as on informing research and development decisions in the area of nuclear-powered desalination.

8. The Agency's Milestones approach continues to be the leading programmatic guide for Member States embarking on or expanding existing nuclear power programmes. In an effort to ensure the continued applicability of *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)), the Agency is finalizing a revision of the publication to incorporate lessons learned from Member States, present the main findings of Integrated Nuclear Infrastructure Review missions and address the needs of expanding countries. The revision will also include an annex on infrastructure considerations for small and medium sized or modular reactors (SMRs) and will note the need to consider possible alternative applications of reactor technology when formulating national positions.

9. At the request of Jordan, the Agency delivered a workshop on nuclear desalination using SMRs, in the framework of the country's Integrated Work Plan (IWP), at the Jordan Atomic Energy Commission (JAEC) headquarters in Amman in November 2022. The workshop was attended by about 20 national participants, including representatives from the JAEC, the Ministry of Water and Irrigation, the Ministry of the Environment and the Industrial and Mineral Regulatory Body.

10. The Agency will conduct an expert mission on "Using Small Modular Reactors (SMRs) including economic analysis for electric power generation and for nuclear desalination" to Jordan in August 2023. About 12 Agency and three external experts are contributing to this mission.

11. The Agency participated in the Sixth Arab Forum on the Prospects of Electricity Generation and Seawater Desalination, organized by the Arab Atomic Energy Agency and the Nuclear Power Plants Authority of Egypt, in cooperation with the League of Arab States and the Arab Ministerial Council for Electricity, in Cairo in December 2022, where it presented its activities in the area of nuclear desalination and other non-electric applications.

Nuclear power applications

Introduction

A. Background

1. In resolution GC(66)/RES/9.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).

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 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 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 COP26 conference in Glasgow, United Kingdom, and encouraged the Secretariat to continue these efforts in its preparations for the upcoming COP27, to be held in November 2022 in Sharm El Sheikh, Egypt, and COP28, to be held in the United Arab Emirates in November 2023.

5. The General Conference also looked forward to the 5th International Ministerial Conference on Nuclear Power in the 21st Century, to be held from 26–28 October 2022, in Washington, DC, the United States of America, and emphasized the importance of an inclusive approach to participation of all interested Member States.

6. The General Conference acknowledged the importance of the Agency's technical cooperation 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.

7. 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.

8. 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 nuclear power plants, to determine the value of nuclear power in the energy mix considering environmental conditions and, inter alia, climate objectives.

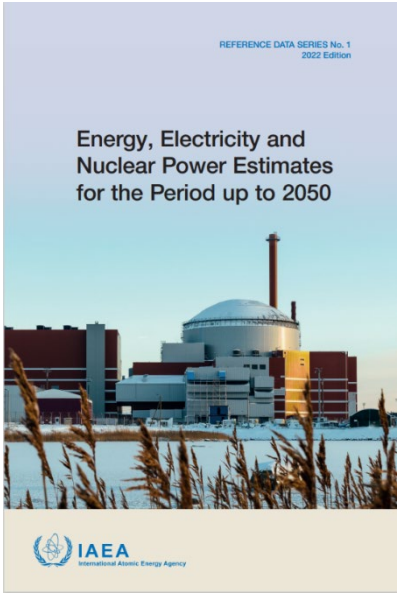
9. The General Conference stressed the importance, when planning, deploying, or decommissioning nuclear energy facilities, including nuclear power plants and related fuel cycle activities, of ensuring the highest standards of safety and emergency preparedness and response, security, non-proliferation, 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 role of the IAEA in fostering exchange of expertise and discussions within the international nuclear community on such issues.

10. The General Conference also welcomed the continuation of the IAEA Peaceful Uses Initiative 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, including with 'in-kind' contributions.

11. The General Conference welcomed the establishment of the Technical Working Group on Nuclear Power in Low-Carbon Energy Systems (TWG-NPLCES), and encouraged the Secretariat to consider establishing a TWG on Nuclear Fuel Cycle Facilities' Operation, which would include ageing and upgrade challenges.

12. The General Conference, in resolution GC(66)/RES9.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-seventh (2023) regular session.

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



13. In September 2022, the Agency published the 2022 edition of *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050* (Reference Data Series No. 1). For the second year in a row, the 'high case' projection was revised upwards compared with the previous edition, with a projected capacity of 873 gigawatts electrical (GW(e)) by 2050, very close to the nuclear capacity modelled by the International Energy Agency's (IEA's) Net Zero Emissions by 2050 Scenario published in the IEA's *World Energy Outlook 2022*.

14. The Nuclear Innovation: Clean Energy Future (NICE Future) initiative launched a new campaign entitled "Research Impacts on Social Equity and Economic Empowerment" (RISE3), and the Agency contributed to it with a case study on "Quantifying the Economic Impact Associated with Investments in SMR Newbuilds in

Nuclear Newcomer Countries using the IAEA EMPOWER Tool" in a RISE3 case studies report published in September 2022.

15. The Agency continued to support interested Member States embarking on new nuclear power programmes in building their national nuclear infrastructure through early awareness-building and guidance development, including the organization of relevant Technical Meetings, capacity building workshops and training courses as well as providing integrated support through the Integrated Work Plan (IWP) process.

16. The 17th annual Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure, which took place in March 2023 in Vienna, was attended by 84 participants representing 38 Member States and two 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 Agency's Milestones approach to establish the infrastructure required for a safe and successful nuclear power programme and prioritizing and sequencing the activities needed.

17. The Agency organized four webinars in January, February, May, and September 2023 covering topics related to nuclear infrastructure development support and publication updates. Each webinar attracted an audience of approximately 300 participants from diverse Member State organizations.

18. The Agency organized a training course on the equipment reliability and ageing management programmes in nuclear power plants (NPPs) for the Bushehr NPP in the Islamic Republic of Iran in November 2022 to support Member States' capacity building for safe operation of NPPs.

19. The Agency launched a new version of the Nuclear Energy Capacity Building Hub (CBH) on the IAEA CONNECT platform. The CBH is an information hub for collaboration, industry best practices and other helpful tools for Member States. Sections are devoted to the sharing of human resource strategies for gender equality, including a database of best practices; and to support for national modelling of human resources for the nuclear power workforce.

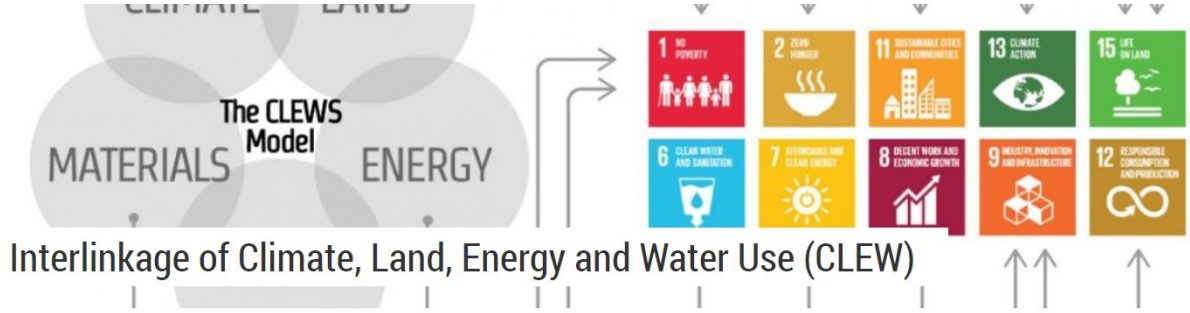
20. The Agency continued to maintain and strengthen its assistance and advisory services for Member States embarking on or expanding nuclear power programmes through Integrated Nuclear Infrastructure Review (INIR) missions to assess the status of nuclear power infrastructure development. An INIR Phase 1 follow-up mission to Kazakhstan was conducted, upon the Member State's request, in March 2023.

21. The Agency continued its assistance to Member States embarking on nuclear power programmes or expanding such programmes, and conducted 12 IWP meetings with 12 Member States, which involved the participation of cross-Departmental teams. The Agency further continued to offer national workshops under the respective IWPs to support individual Member States in reviewing funding for nuclear power infrastructure and financing options for nuclear power programmes.

22. Moreover, the Agency continued the revision and development of infrastructure-related publications. The second revision of *Evaluation of the Status of National Nuclear Infrastructure Development* (IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 2)) was published in September 2022 and provides guidance on taking a holistic approach to evaluating progress in the development of nuclear power infrastructure.

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

24. The Agency developed additional training materials to strengthen the provision of capacity building support for Member States in integrated climate, land, energy and water (CLEW) assessment and planning. As part of the Agency's tools and methodologies, the CLEW framework helps Member States assess different pathways to meet their energy needs while considering objectives related to sustainable land use and agriculture, water management and climate change.



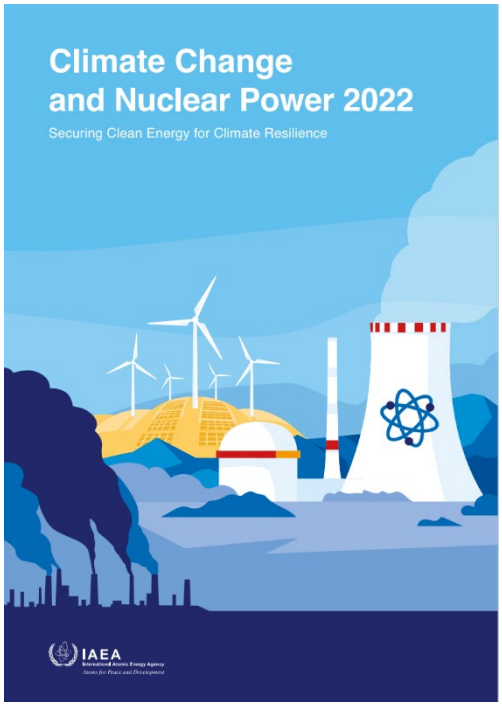
25. In April 2023, the Agency organized a three-day Workshop on Reimagining Nuclear Energy in Vienna, which explored creative and innovative ways of engaging stakeholders and increasing public acceptance of this low carbon energy source. Over 60 participants from 32 countries and five international organizations showcased their efforts and strategies with regard to public outreach for nuclear energy, exchanging experiences and lessons learned from engaging and communicating with various stakeholders (Figure B.1.).

FIG.B.1. Director General Rafael Mariano Grossi delivers his closing remarks on the last day of the Workshop on Reimagining Nuclear Energy in Vienna, 28 April 2023

26. The Agency organized a Technical Meeting for Municipalities with Nuclear Facilities, held in October–November 2022, in Vienna. The event brought together 50 mayors and participants from 25

Member States and provided a unique opportunity for dialogue among elected officials of local communities hosting or involved with the siting process of any one of a range of nuclear facilities, including NPPs, radioactive waste management facilities and spent fuel storage facilities.

27. In November 2022, the Agency conducted a Technical Meeting on Stakeholder Involvement and Public Communication in Vienna, attended by 76 participants from 39 Member States and two international organizations. This 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.



28. In September 2022, the Agency released *Climate Change and Nuclear Power 2022*: *Securing Clean Energy for Climate Resilience*. This flagship publication, which includes multiple contributions from Member States and international organizations, addresses key topics on nuclear energy's potential for both climate change mitigation and adaptation, covering nuclear energy's role in the transition to low carbon electricity systems, non-electric applications for hard-to-abate sectors, ensuring resilience to climate change and broader sustainable development. The publication also outlines key policy measures to support the clean energy transition. Furthermore, the publication contains novel analysis of climate, weather and water risks that may affect nuclear sites in the future, and summarizes actions that Member States are already taking to mitigate them. Finally, it presents an in-depth review of challenges and opportunities for nuclear energy in Africa and the Middle East.

29. In March 2023, the Agency responded to an invitation from the Chairs of the United Nations Framework Convention on Climate Change's Subsidiary Body for Implementation and Subsidiary Body for Scientific and Technological Advice and provided inputs to the first 'Global Stocktake' under the Paris Agreement. The findings of the Global Stocktake will be presented at COP28. The Agency's inputs addressed the contribution of nuclear energy to climate change mitigation, adaptation, finance and technology, economic aspects and cross-cutting issues, drawing on recent Agency publications, including *Nuclear Energy for a Net Zero World* and *Climate Change and Nuclear Power 2022: Securing Clean Energy for Climate Resilience*.

30. The Agency is preparing the Second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero, to be held in October 2023. Consultations with Member States, which started in 2022, continued in 2023 with the first meeting of the Programme Committee held in April 2023, which helped develop a first draft of the conference programme, with high-level panel discussions. The call for abstracts closed at the end of April 2023, with over 160 submissions to be reviewed. The second meeting of the Programme Committee will take place in July 2023.

31. The fifth International Ministerial Conference on Nuclear Power in the 21st Century was held in Washington DC, United States of America, in October 2022. The conference was attended by around 800 participants from 69 Member States and nine international organizations. The event provided a forum for ministers, policymakers, senior officials and experts to engage in high-level dialogue on the role of nuclear energy in the transition to clean energy sources, and its contribution to sustainable development and climate change mitigation. The conference noted that many Member States recognized nuclear as a low-carbon, energy-dense and proven technology. This is essential for meeting global net zero targets,

contributing to their energy security, and providing a reliable and solid foundation for power generation on which renewable technologies can build (Figure B.2.).

FIG. B.2. The Director General with Jennifer Granholm, US Secretary of Energy, at the International Ministerial Conference on Nuclear Power in the 21st Century, Washington DC, October 2022

32. 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 through the continuation of the revision of *Alternative Contracting and Ownership Approaches for New Nuclear Power Plants* (IAEA-TECDOC-1750), published in 2014.

33. Within the framework of Integrated Nuclear Infrastructure Training, the Agency organized the second part of an interregional training course, in cooperation with Electricité de France, in October 2022, during which 25 participants from 25 Member States learned about economic and financing aspects to consider when developing a nuclear power programme.

34. In October 2022, the Agency organized a webinar entitled "Decarbonization and Nuclear Energy: The Role of Green Finance", with speakers from the Climate Bonds Initiative, Nucleareurope, the Generation IV International Forum, Morgan Stanley and the Chung-Ang University in the Republic of Korea to discuss the importance of public and private sector sustainable finance mechanisms to increase access to capital for nuclear technology and lower interest rates during the construction, commissioning and operation phases of the nuclear life cycle. Dedicated investment in clean energy technologies, including nuclear power, is necessary to ensure a fair and economic transition to a decarbonized energy system.

35. In September 2022, the Agency organized a Technical Meeting on Costing Approaches for Nuclear Infrastructure Development hosted by the Nuclear Research Institute Řež, Czech Republic, under the United States of America-funded Peaceful Uses Initiative (PUI) cost basis project. The meeting facilitated the exchange of information on planning and cost estimation methodologies for activities carried out prior

to reactor construction and followed up on previous workshops that discussed the economics of existing and emerging reactor concepts.

36. In June 2023, the Agency held a Training Workshop on the Extended Input Output Model for Nuclear Power Plant Impact Assessment (EMPOWER) modelling tool. The objective was to improve Member States' capabilities to conduct macroeconomic impact assessments of investments in low-carbon energy sources, including nuclear power.

37. The Agency continued the revision of *Managing Environmental Impact Assessment for Construction and Operation in New Nuclear* Power *Programmes* (IAEA Nuclear Energy Series No. NG-T-3.11) to provide a more holistic and phased approach for environmental protection in new nuclear power programmes and take into account lessons learned and best practices in Member States.

38. The Agency continued to benefit greatly from the ongoing generous extrabudgetary contributions received from several donor Member States towards funding the implementation of activities in the area of nuclear infrastructure development, as well as through continued implementation of several projects within the framework of the PUI.

39. Examples of PUI projects supporting the implementation of activities in the area of nuclear economics and energy planning include the project "Nuclear Cost Basis: a key foundation for newcomer decision making" and a new project entitled "Modelling the Contribution of Nuclear Energy to Energy Transitions towards Net Zero".

40. The Technical Working Group on Nuclear Power in Low-Carbon Energy Systems (TWG-NPLCES) had its second meeting in September 2022, during which the participants discussed the impact of climate change on the resilience of energy systems, energy planning and modelling of transitions of energy systems to net zero, and activities on economics and financing of nuclear power. The TWG-NPLCES was also briefed on the preparation of the Second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero to be held in October 2023, and provided valuable input to the Agency.

41. Two TWGs (on nuclear knowledge management (NKM) and on human resource development (HRD)) were merged to provide a more efficient, cost-effective service with a broader and more connected range of support activities in line with current practices in Member States. The first meeting of the new Technical Working Group on Managing Human Resources and Knowledge was held in Vienna in May 2023. Eight members of the working group participated in person, with the other members participating virtually. Two international organizations joined the meeting: the European Nuclear Education Network and the Organisation for Economic Co-operation and Development. The discussions covered NKM topics such as knowledge-loss risk management, monitoring implementation of knowledge management programmes, and nuclear education and networks.

42. The Agency conducted three International Nuclear Management Academy (INMA) missions, including an INMA Assist Visit to Sofia University "St. Kliment Ohridski" in Bulgaria in March 2023, an INMA Assessment Visit to the KEPCO International Nuclear Graduate School in the Republic of Korea in May 2023 and an INMA Assessment Visit to the University of Idaho in the United States of America in June 2023. An INMA Assist Visit to Ontario Tech University in Canada is scheduled for July 2023. These INMA missions provided insight, from international experts, and recommendations that can be considered by the requesting organization as part of the further strengthening of their master's degree programmes.

43. The Nuclear Knowledge Management Hub was extensively updated during 2022 and re-commissioned in spring 2023. By spring 2023, there were over 600 registered users, and its collaborative project spaces started to be actively used by more than 90 representatives from 33 Member States,

including in the framework of technical cooperation project “Enhancing the Capacities of Educational Institutions for the Sustainable Use of Nuclear Technologies” (Figure B.3.).

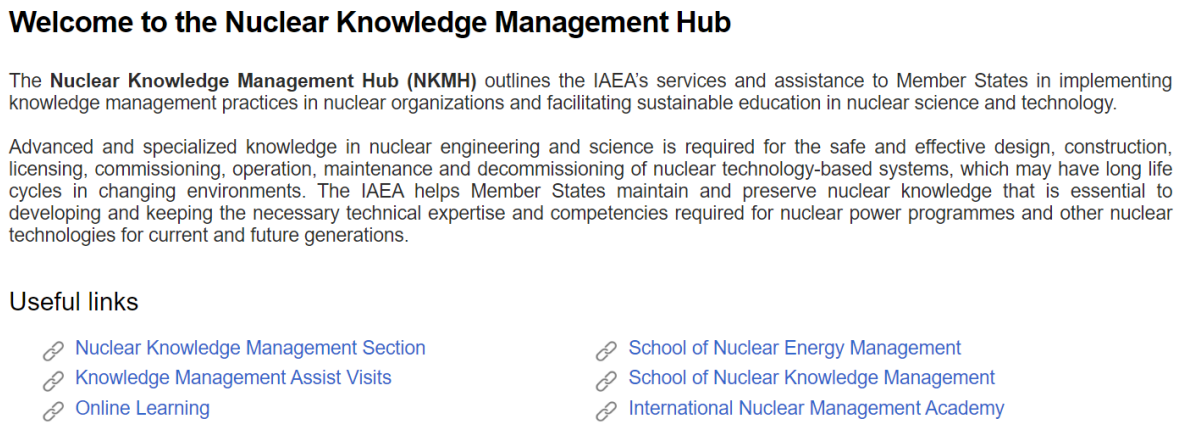


FIG. B.3. The Agency’s re-commissioned Nuclear Knowledge Management Hub provides Member States with easy access to the latest information on NKM guidance and services to support Member States in their nuclear programmes. This includes publications and reports; an overview of missions, schools and upcoming Agency activities; presentations from Agency meetings, expert workshops and training events; examples of NKM good practices, experiences and lessons learned from nuclear organizations; and e-learning courses and training materials

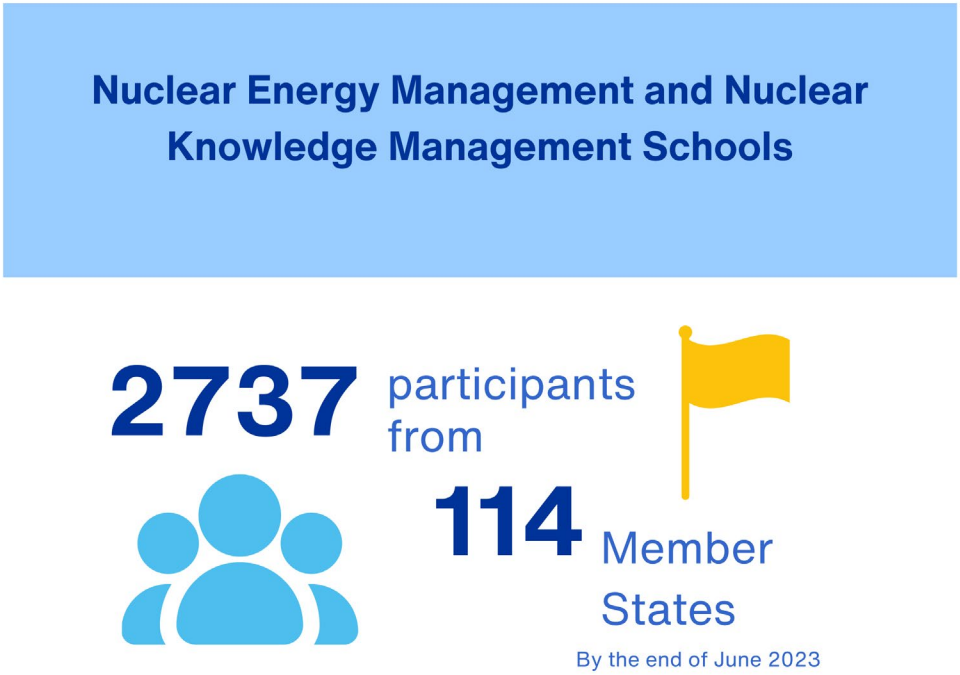
44. The Agency issued *Guide to Knowledge Management Strategies and Approaches in Nuclear Energy Organizations and Facilitie*s (IAEA Nuclear Energy Series No. NG-G-6.1) in October 2022. It provides guidance to Member State nuclear organizations and facilities on systematically developing a strategic NKM programme that is effectively aligned to organizational safety and business goals.

45. The Technical Meeting on the Implementation and Assessment of Knowledge Management Programmes, held virtually in October 2022, gathered 75 experts from 57 organizations in 40 Member States, who discussed, inter alia, a new IAEA Technical Document (TECDOC) provisionally entitled *Methodology to Determine Critical Knowledge in Nuclear Organizations*.

46. *Training and Human Resource Considerations for Nuclear Facility Decommissioning* (IAEA Nuclear Energy Series No. NG-T-2.3 (Rev. 1)) was published in 2022. The revision addresses the advancement of decommissioning technologies driven by innovations in digitization and robotics, and the application of the systematic approach to training methodology to the decommissioning phase of all types of nuclear facilities.

47. A total of 10 Knowledge Management Assist Visit (KMAV) missions were conducted to Member States: a KMAV Level 1 mission to Nigeria in September 2022; a KMAV Level 3 mission to the National Research and Innovation Agency in Indonesia in September 2022; a KMAV Level 1 mission to Tunisia in September 2022; a KMAV Level 1 mission to South Africa in October 2022; a KMAV Level 1 mission to the Syrian Arab Republic in October 2022; a KMAV Level 2 mission to the National Centre for Nuclear Science and Technology in Tunisia in November 2022; a KMAV Level 1 mission to Georgia in March 2023; a KMAV Level 1 mission to the Nuclear Power Corporation of India Limited in India in April 2023; a KMAV Level 2 mission to the Nuclear Power Plant Authority in Egypt in May 2023; and a KMAV Level 2 mission to the Armenian NPP in June 2023.

48. Since 2010, 2737 participants from 114 Member States had attended the Agency's Nuclear Energy Management (NEM) and NKM Schools.[1]



49. In October 2022, the second China–IAEA NEM School was held virtually, with the support of the Nuclear Industry Management College of China. The two-week event was intended for young professionals involved in their national nuclear programmes. The school was attended by 108 professionals from various institutions in 15 Member States, including academia, national regulatory bodies, relevant ministries and the nuclear energy industry.

50. In October 2022, the 17th Abdus Salam International Centre for Theoretical Physics (ICTP)–IAEA NKM School took place in Trieste, Italy. Such international NKM schools have been organized yearly by the Agency in cooperation with the ICTP since 2004. The one-week event focused on deepening the participants' understanding of key issues in NKM. The school was attended by 24 professionals from 17 Member States,

51. The second part of the ninth Japan–IAEA NEM School took place in October 2022. In cooperation with the Agency, it was organized by the Japan Atomic Energy Agency (JAEA), the Japan Atomic Industrial Forum (JAIF); the JAIF International Cooperation Center; the Japan Nuclear Human Resource Development Network (JN-HRD NET) and the University of Tokyo. It was held in person and included technical tours, and brought together 13 participants from eight Member States.

52. The seventh Russian Federation–IAEA Advanced Nuclear Energy Management School was held in June 2023 in St. Petersburg, Russian Federation. 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,

[1] Status as of end of June 2023.

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.

FIG. B.4. The first Poland–IAEA NEM School held in May 2023, in Krakow, Poland, gathered 30 young professionals from 14 Member States

53. In May 2023, the first Poland–IAEA NEM School was held in Krakow, Poland in cooperation with the Polish Nuclear Society. This was the second time that an NEM school had been held in conjunction with the European Nuclear Young Generation Forum. A total of 30 young professionals from 14 Member States participated, further strengthening their learning and professional networking (Figure B.4.).

54. The third United States of America–IAEA NEM School was held in June 2023 at Oak Ridge National Laboratory, United States of America. The event was aimed at young professionals in the nuclear sector from countries in Africa, with a view to enhancing the managerial and technical competencies essential for establishing national nuclear energy programmes. The school brought together 26 managers and leaders from 17 Member States.

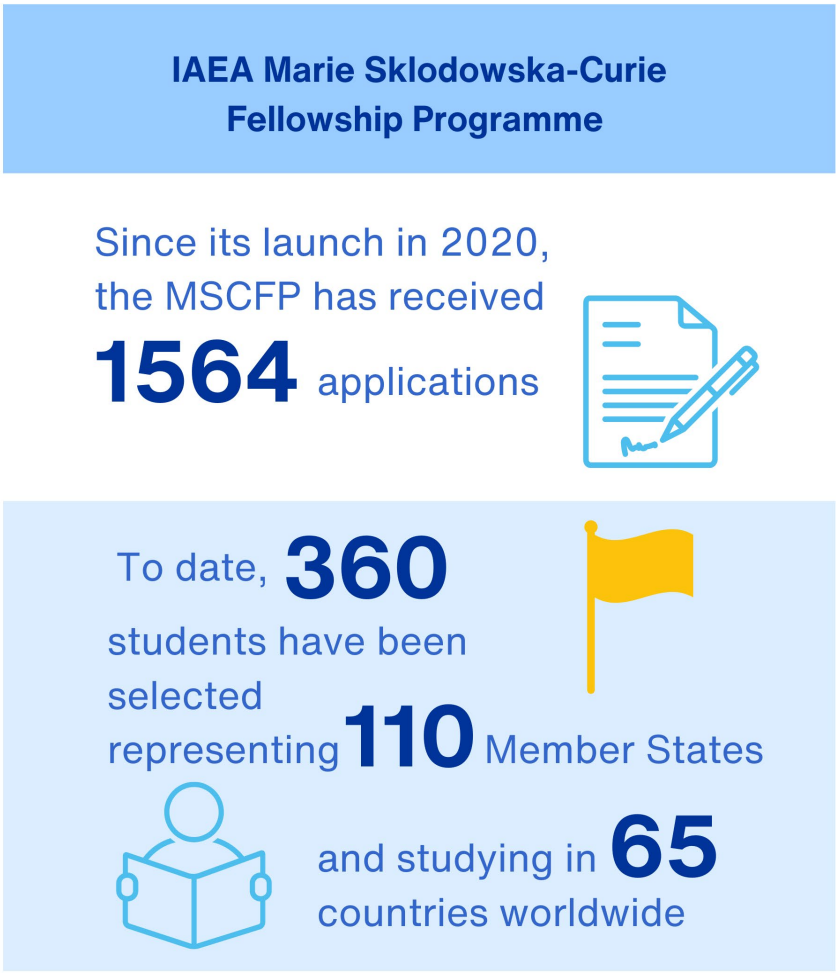
55. In July 2023, the 13th Joint ICTP–IAEA NEM School was held in Trieste, Italy, hosting 25 participants from 18 Member States. Such international NEM schools have been organized yearly by the Agency in cooperation with the ICTP since 2010. The two-week event focused on broadening young professionals' 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.

56. The eleventh Japan–IAEA NEM School is scheduled to take place in August–September 2023 in Tokyo and Fukushima. In cooperation with the Agency, it is being organized by the JAIF International Cooperation Center, the JAEA, the JAIF, JN-HRD NET and the University of Tokyo. The aim of the school is to support young professionals in the nuclear sector in enhancing managerial and technical competencies that are essential for maintaining national nuclear energy programmes.

57. In August 2023, the Agency is scheduled to hold the fourth Russian Federation–IAEA NKM School. This school will take place in Moscow, Russian Federation, and is organized by the Agency in cooperation with Rosatom through the Rosatom Technical Academy. This one-week event will offer 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.

58. A Technical Meeting on the Implementation and Assessment of Knowledge Management Programmes was held virtually in October 2022 to discuss approaches and share experiences in key aspects of NKM programmes in nuclear organizations. In total, 75 counterparts from 57 nuclear organizations in 40 Member States participated.

59. A virtual Training Workshop on IAEA Methodology to Assess Knowledge Management Programmes in Nuclear Organizations and Education Providers was held in October 2022, with 76 participants from 34 Member States.



60. To promote gender equality and diversity and to encourage Member States to establish an inclusive workforce within their nuclear industry, the Director General launched the IAEA Marie Skłodowska-Curie Fellowship Programme (MSCFP) in March 2020, which aims to inspire and encourage women to pursue a career in nuclear science and technology, nuclear safety and security, non-proliferation or nuclear law by providing scholarships for master's programmes in nuclear-related fields and an opportunity to pursue internships facilitated by the Agency relating to their field of study. Since its launch in 2020, MSCFP has received 1564 applications. To date, 360 students have been selected, representing 110 Member States, studying in 65 countries worldwide. The programme is currently in its third year of implementation.

FIG. B.5. Josephine Nikhula, an MSCFP fellow from Malawi and an intern in the Agency's Dosimetry and Medical Radiation Physics Section in the Division of Human Health, next to the TRIGA Mark II research reactor at the Institute of Atomic and Subatomic Physics in Vienna. She attended the experimental reactor physics module in 2022 as a requirement for her master's degree.

Josephine says: "Thank you to the donors for recognizing that women can make a difference, and for giving us a chance to pursue a career that we have so much passion for."

FIG. B.6. Amèlia Jansen van Vuuren, an MSCFP fellow from South Africa and intern at the iThemba Laboratory for Accelerator Based Sciences in Cape Town, South Africa, culturing a primary elephant dermal fibroblasts cell line.

Amèlia says: "When I look back at my life, the IAEA MSCFP changed it in a million ways. It provided me with opportunities that would otherwise be lost. I have grown as a young aspiring scientist and, most importantly, as an individual"

61. Under the MSCFP, 110 students completed their master's programmes, of which, as of June 2023, 71 have been offered internships facilitated by the Agency (Figures B.5. and B.6.). The internships take place across the Agency's technical departments and at IAEA Collaborating Centres, as well as at private sector companies and other partner organizations. The MSCFP recipients also benefit from participation in various technical and training events, as well as conferences. To date, they have contributed to over 20 technical events organized by the Agency or its partners. Moreover, 150 recipients have already benefited from participation in the Agency's annual International School on Nuclear Security organized for MSCFP recipients. Additionally, 63 more MSCFP recipients have been selected to participate in the third International School on Nuclear Security, scheduled for summer 2023.

62. The programme also launched the MSCFP Student and Alumnae LinkedIn group, where students can connect to their peers, exchange knowledge and experience, and access information about technical programmes and events that can benefit their personal and professional development.

63. As of June 2023, the MSCFP has received pledges amounting to €10.2 million. In addition, it received in-kind contributions sponsoring 55 students. Donors include the European Union, 21 Member States, 2 Member State institutions, industry (two private sector partners) and one academic institution.

64. The application period for the fourth MSCFP cycle will open on 15 July 2023 and close on 30 September 2023. The review and selection activities will conclude by the end of 2023, with the aim of selecting 200 female students.

65. The Agency's Lise Meitner Programme (LMP) was launched on 8 March 2023 by the Director General to boost the career development of women in the nuclear sector (Figure B.7.). It provides early- and mid-career women professionals with opportunities to participate in a multi-week visiting professional programme and advance their technical and soft skills. The LMP focuses on retention and includes professional visits to various nuclear facilities, such as those under construction, operation or decommissioning; research centres; scientific institutions; laboratories; and industry and start-up companies. In addition, the participants have an opportunity to broaden their individual professional relationships with a range of leaders and experts in the field.

FIG. B.7. Rafael Mariano Grossi, IAEA Director General at the launch event of the IAEA Lise Meitner Programme, March 2023.

66. The visiting professional programme typically lasts between two and four weeks, gathering 10 to 15 visiting professionals per cohort. The first two visiting professional programmes were scheduled to take place in the United States of America in 2023. The first visiting professional programme was hosted by the North Carolina State University, USA in June 2023 for two weeks. 13 women professionals participated.

67. The LMP is actively engaged in outreach activities to promote the programme and encourage countries/institutions to host future professional visits and/or provide financial support.

IAEA Communication, Cooperation with Other Agencies and Stakeholder Involvement

A. Background

1. In resolution GC(66)/RES/9.B.2, the General Conference welcomed efforts of the Secretariat 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 most current and which have been superseded, in order to enhance accessibility and navigation among these documents. Further, the General Conference welcomed the development of the IAEA website in all official languages of the IAEA and encouraged the Secretariat to include more content relevant to policy makers and experts involved in IAEA activities, such as organizational charts and activities of expert groups, and to make access to Agency guidance documents and TECDOCs easier.

2. The General Conference also requested the Secretariat to continue cooperation with international initiatives such as UN-Energy, and to explore the possibility of cooperation with Sustainable Energy for All (SE4All), 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, OECD Nuclear Energy Agency (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 Generation IV International Forum (GIF), IFNEC, the European Sustainable Nuclear Industrial Initiative (ESNII) and the International Thermonuclear Experimental Reactor (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 on stakeholder engagement and public information as well as organizing conferences, technical meetings and workshops, among other mechanisms.

4. The General Conference, in resolution GC(66)/RES/9.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-seventh (2023) regular session.

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

5. In January 2023, the Agency conducted a Technical Meeting on Industrial Involvement to Support a National Nuclear Power Programme in Vienna, with 26 participants from 19 Member States. The meeting provided an opportunity for participants to contribute to the revision of the publication entitled *Industrial Involvement to Support a National Nuclear Power Programme* (IAEA Nuclear Energy Series No. NG-T-3.4).

6. The Agency published the booklet entitled *Hydrogen Production with Operating Nuclear Power Plants — Business Case*, which discusses how low carbon hydrogen produced from nuclear power can support clean energy transitions. To leverage the impact of this publication, in March 2023 the Agency hosted the webinar "Hydrogen Production with Operating Nuclear Power Plants — the Business Case". The webinar was attended by close to 150 participants.

7. The Agency modernized its Thermo-Physical Materials Properties Database (THERPRO Database), which provides information about various properties of materials found in the operating fleet of light and heavy water reactors and their advanced designs (Figure B.1.).

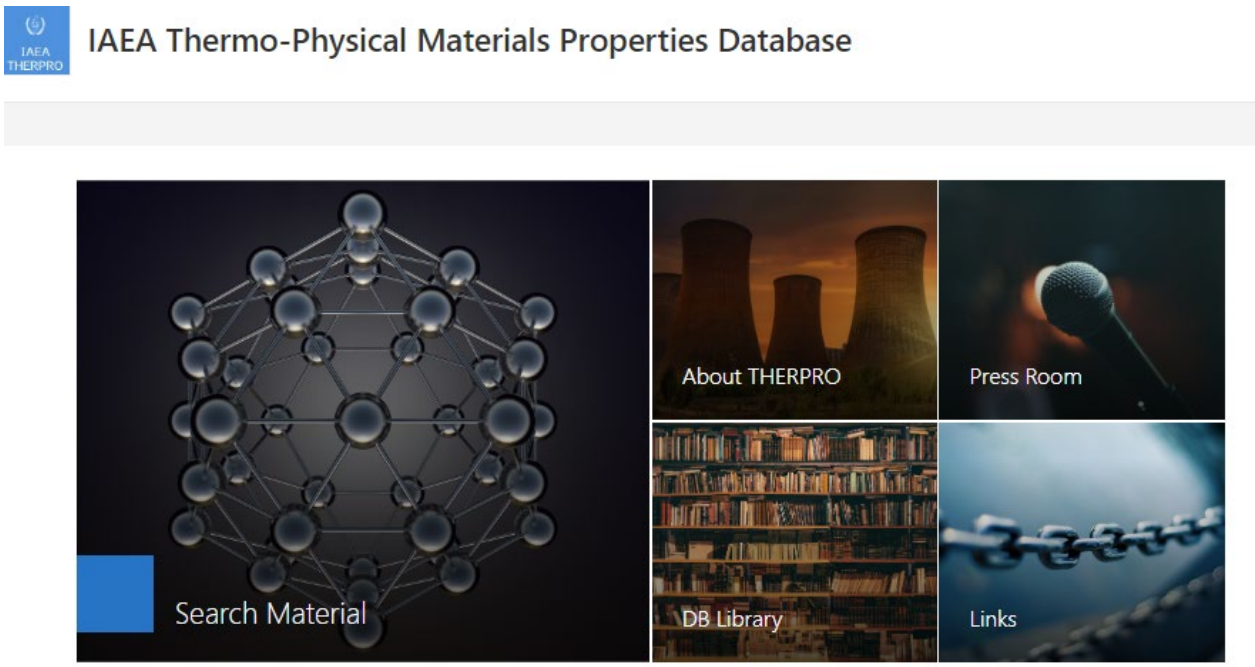


FIG. B.1. The THERPRO Database is an online database representing a comprehensive collection of thermo-physical material properties data. Data relating to more than 11 000 properties of about 1600 materials are compiled within THERPRO

8. The Agency issued annual reports summarizing nuclear power plant (NPP) performance and country nuclear programme statuses and plans. These included *Nuclear Power Reactors in the World* (IAEA document Reference Data Series No. 2), the annual release of Power Reactor Information System (PRIS) data, a poster, the 2022 edition of *Operating Experience with Nuclear Power Stations in Member States* and the annual update of country nuclear power profiles (CNPPs).

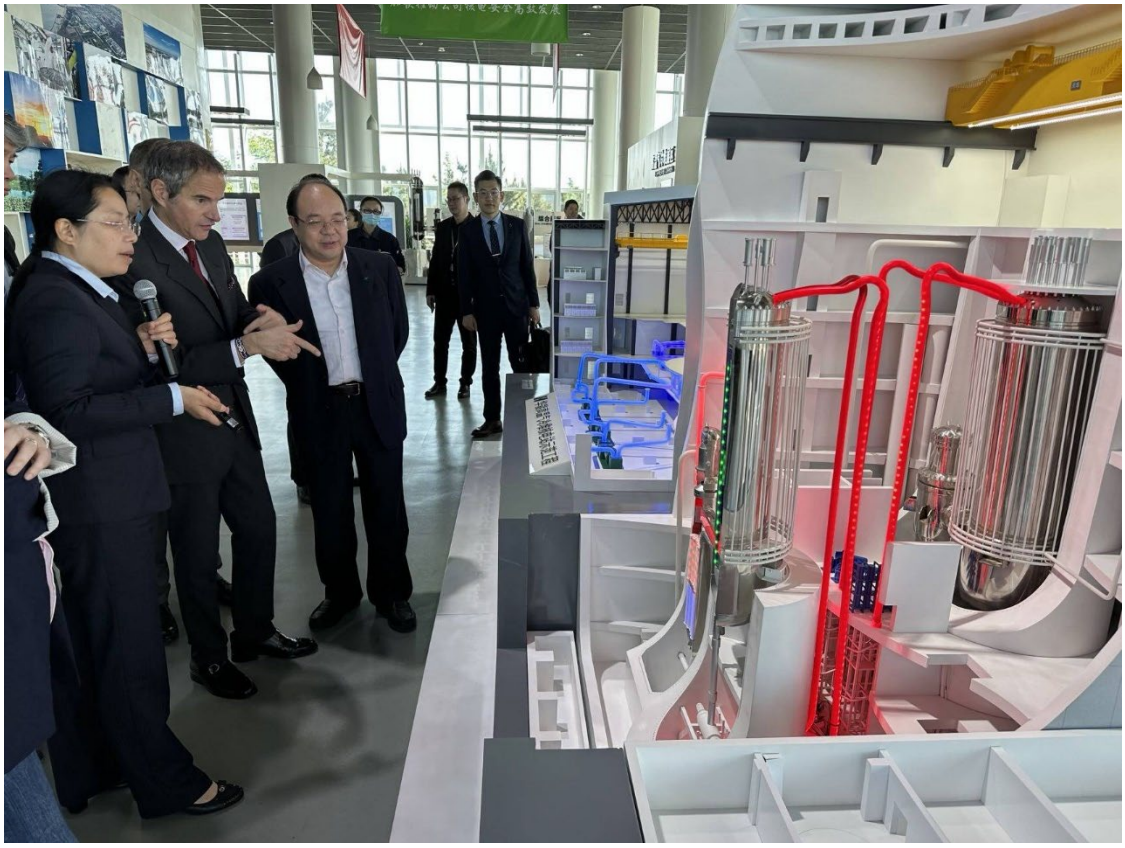


FIG. B.2. Rafael Mariano Grossi, IAEA Director General, visiting Shidaowan Nuclear Power Plant, which is home to a 200 MWe high-temperature gas-cooled reactor, in Shandong province in eastern China

9. The Agency recently deployed an upgraded CNPP system, modernizing both the data acquisition processes and the public website. The new platform was developed in consultation with participating Member States, incorporating previous recommendations. The CNPP serves as a valuable resource to diverse stakeholders around the world and is routinely in the top ten most accessed Agency sites (Figure B.3.).

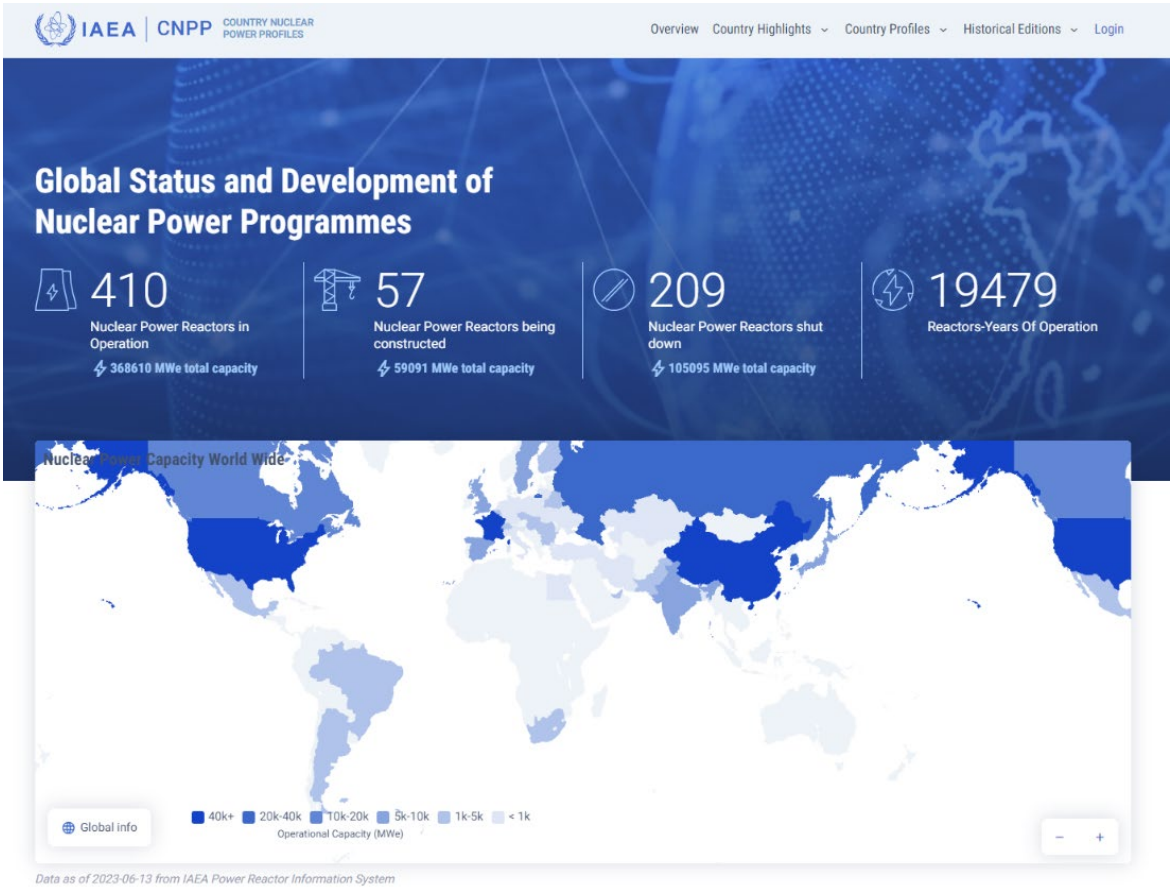


FIG. B.3. CNPPs provide background information on the status and development of nuclear power programmes of Member States. Their main objectives are to consolidate information on the nuclear power infrastructure and developments in participating countries, and to serve as a resource in the effective planning, decision making and implementation of nuclear power programmes that lead to the safe and economical operation of NPPs

10. Preparations are under way for the 2023 CNPP annual online publication, with over 30 participating Member States using the newly upgraded CNPP system for the first time. The publication will provide a high-level overview of nuclear power programmes, along with corresponding data acquired through the PRIS database. Currently, it contains historical country information for 50 countries, including over 30 countries currently operating NPPs, as well as those with past or planned nuclear power programmes. The CNPP reports are updated based on information voluntarily provided by participating Agency Member States. Each of the profiles in this publication is self-standing and contains information officially provided by the respective national authorities.

11. The Agency provided access to the collected data through the PRIS public web page, which is one of the Agency's most popular web pages, having accumulated almost 1 million page views and 93 000 unique users over the past year. The Agency is currently developing a project to revamp the PRIS public web page by deploying a multilayer, intuitive and innovative data exploration data browser in order to provide high-level user experience and maximize the utilization of all data to develop the best possible statistical reports and infographics.

12. The IAEA and IFNEC continued cooperation in the area of nuclear infrastructure development.

13. The Agency continued cooperation with the Association of Southeast Asian Nations and its Nuclear Energy Cooperation Sub-sector Network in the area of nuclear infrastructure development under the existing Practical Arrangement.

14. In September 2022, the Agency signed a Memorandum of Cooperation with the African Commission on Nuclear Energy that includes capacity building related to nuclear power as one of the envisaged areas of cooperation.

15. Under a Memorandum of Cooperation with the Arab Atomic Energy Agency (AAEA), the Agency participated in the AAEA's events, such as the Sixth Arab Forum on the Prospects of Nuclear Power for Electricity Generation and Seawater Desalination, which took place in Egypt in December 2022.

16. The Agency and WANO continued cooperating through the New Unit Assistance Working Group (NUAWG), the Equipment Reliability Industrial Working Group and interface meetings, which were organized on a regular basis. The Agency and WANO–NUAWG built synergy to optimize the Agency's services to ensure maximum added value and minimize the burden on the relevant organizations in the lead up to commissioning and operations. The Agency participated in the latest meeting of the WANO–NUAWG in Paks, Hungary, where its services and activities supporting owner/operating organizations in the construction and operation phases were highlighted.

17. The Agency continued its cooperation with the Electric Power Research Institute, the Organisation for Economic Co-operation and Development (OECD/NEA), the Sustainable Nuclear Energy Technology Platform and the European Commission's Joint Research Centre through, for example, the International Network on Innovation to Support Operating Nuclear Power Plants and the International Network on Life Management of Nuclear Power Plants.

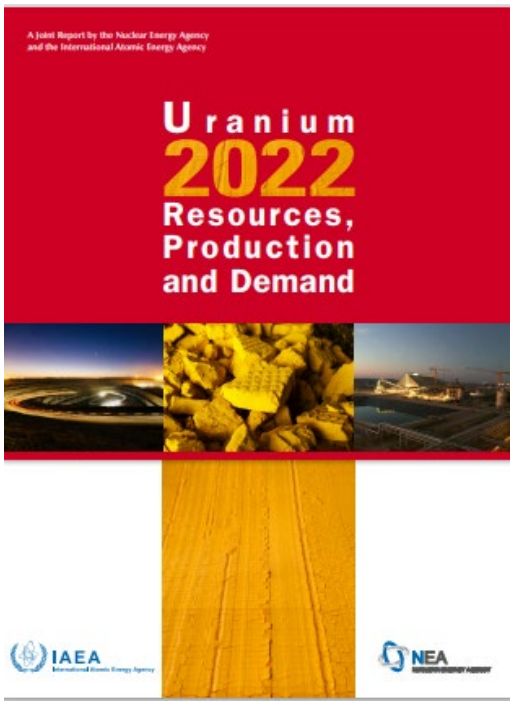
18. The OECD/NEA participated as an observer in the newly created Technical Working Group on Managing Human Resources and Knowledge in the Field of Nuclear Energy, whose first meeting took place in May 2023.

19. The Agency continued its cooperation with WANO and the OECD/NEA through respective Technical Working Groups dedicated to human and organizational factors and their role and impact on nuclear power programme performance. The Agency participated actively as a member, and provided presentations on human and organizational performance related activities.

20. In February 2023, the Agency participated in the meeting of the OECD/NEA's Working Party on Nuclear Energy Economics, to present the Agency's current and future work in the areas of cost assessment and financing, the economics of small modular reactors, climate change mitigation and the energy modelling of net zero transitions, and to identify areas of mutual interest and cooperation. The Agency and OECD/NEA collaborated on events at COP27 and will continue at COP28.

Fig. B.4. Rafael Mariano Grossi, IAEA Director General at the United Nations Climate Change Conference 2022 in Sharm El-Sheikh, Egypt. 8-11 November 2022

21. The 58th Meeting of the Joint OECD/NEA–IAEA Uranium Group was held in a hybrid mode in February 2023. It was attended by 54 experts from 36 Member States and 2 international organizations. The Group reviewed Member States' Red Book 2022 submissions and coordinated the preparation of the Red Book 2024, including approving its questionnaire.



22. In April 2023, the OECD/NEA and the Agency jointly published *Uranium 2022: Resources, Production and Demand* (Red Book 2022), which features a comprehensive assessment of uranium supply and demand, as well as projections through the year 2040. In particular, it compares available uranium resource estimates (according to categories of geological certainty and production cost) and mine production capability with anticipated demand for uranium arising from projected installed nuclear capacity.

23. The Agency participated as an observer in the OECD/NEA's virtual Workshop on the Management of Spent Fuel, Radioactive Waste and Decommissioning in SMRs and Advanced Reactor Technologies, which was held in November 2022.

24. The annual GIF–IAEA Interface Meeting will be held on 11–12 July 2023 and the Agency participated at the regular meetings of the GIF Policy Group as an observer.

25. The Agency strengthened cooperation with the GIF Working Group on Education and Training and jointly organized webinars on nuclear–renewable hybrid energy systems and thorium-based advanced reactor design concepts.

26. In January 2023, the Agency hosted the 33rd meeting of the GIF Proliferation Resistance and Physical Protection Working Group (PRPPWG) in Vienna. The meeting was attended by 19 participants from ten Member States. The status of the PRPPWG work plan was reviewed at the meeting and country reports were presented. A session was also held to review the on-going update of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) Methodology for Sustainability Assessments of Nuclear Energy Systems: Proliferation Resistance manual.

27. In addition to having a presence in IFNEC's Steering Group, the Agency cooperates with IFNEC via its two working groups — the Infrastructure Development Group and the Reliable Nuclear Fuel Services Working Group. A representative from IFNEC participated in the Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure, which was held in Vienna in March 2023.

28. The Agency continued to underline stakeholder engagement, including public communication, as one of the key issues in the Milestones approach. The Agency initiated the development of the Nuclear Energy Series publication provisionally entitled *Stakeholder Engagement in New Nuclear Power Programmes*, which is intended to support the Milestones approach and complement the overarching publication *Stakeholder Engagement in Nuclear Programmes* (IAEA Nuclear Energy Series No. NG-G-5.1).

29. In May 2023, the Agency conducted the Interregional Training course on Effective Stakeholder Engagement for New Nuclear Power Programmes in St. Petersburg, Russian Federation. The course was attended by 19 participants from 13 Member States and covered a range of topics relevant to stakeholder engagement and public communication for nuclear power programmes (Figure B.5.).

FIG. B.5. Participants discuss during a group activity at the Interregional Training Course on Effective Stakeholder Engagement for New Nuclear Power Programmes, St. Petersburg, Russian Federation, 22–26 May, 2023

30. Two panel sessions dedicated to stakeholder engagement were held during the International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Innovation for Sustaining Future Resources and Production and the International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future, which were both held in May 2023 in Vienna.

Nuclear Fuel Cycle and Waste Management

A. Background

1. In resolution GC(66)/RES/9.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; encouraged the Agency to finalize the publication of the guidance document on a step by step approach for countries considering or initiating a uranium production programme; and encouraged interested Member States to use the IAEA 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, and 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, and supported Member States in the adoption of best practices for managing naturally occurring radioactive material (NORM) residue/wastes (including inventory determination, reuse, recycle, storage, and disposal options) and to remediate NORM contaminated sites.

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 development of Qualified Technical Centres for DSRS management 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. The General Conference, in resolution GC(66)/RES/9.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-seventh (2023) regular session.

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

7. The International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Innovation for Sustaining Future Resources and Production was held in May 2023 and attracted 260 participants from 62 Member States and three international organizations, who analysed supply-demand scenarios and discussed the latest developments and innovations in uranium geology, exploration, mining, processing and site decommissioning to ensure a sustainable supply of uranium for use as nuclear fuel.

8. The International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future was held in May 2023. The Conference attracted over 470 registered and invited participants from 69 Member States and six international organizations to discuss achievements, challenges and lessons learned in the decommissioning of nuclear facilities, highlighting current priority needs and sharing information on strategies and approaches that enhance the safe, secure and cost-effective implementation of programmes (Figure B.1.).

FIG. B.1. Rafael Mariano Grossi, IAEA Director General, delivers his remarks at the opening of the International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future, held at the Agency headquarters in Vienna in May 2023

9. A Training Workshop on Mineral Exploration Planning and Management for Uranium and Thorium Projects was held in Finland in May–June 2023 for those who are newly engaged in uranium exploration or with very little previous experience. It was attended by seven participants from seven Member States. Participants learned from four experts the basic principles needed to plan and execute an exploration programme in their home country utilizing best practices and a systematic approach: structural geology, geochemical sampling, mineral system analysis, geological mapping and how to record observations in the field.

10. In May 2023, the Agency organized the webinar "Challenges in the post-operational phase of uranium mining and processing facilities", which was attended by about 100 participants from 25 Member States who discussed, through real examples, critical elements to be dealt with upon the termination of uranium mining and processing operations such as determining restoration objectives, applicable regulatory framework and the role of regulatory bodies, the definition of future uses of the site and site end state, long-term stewardship and institutional controls, and innovative approaches that could comprise circular economy principles.

11. In January 2023, the Agency published *Milestones in the Development of National Infrastructure for the Uranium Production Cycle* (Nuclear Energy Series No. NF-G-1.1), which is intended to be used as guidance on how to evaluate progress on establishing or re-establishing a national uranium production programme and to aid in the planning steps necessary to develop the national infrastructure requirements for uranium production in a Member State.

12. In August 2022, the Agency published the Chinese language version of *Fuel Modelling in Accident Conditions (FUMAC)* (IAEA-TECDOC-1889), which was published in English in December 2019.

13. In September 2022, the Agency published the Russian language version of *Analysis of Options and Experimental Examination of Fuels for Water Cooled Reactors with Increased Accident Tolerance (ACTOF)* (IAEA-TECDOC-1921), which was published in English in July 2020.

14. A Technical Meeting of the Coordinators of the Nuclear Fuel Cycle Facilities Information System to Discuss Operating Experience of Nuclear Fuel Cycle Facilities will be held in August 2023 to share the status and operating experience of nuclear fuel cycle facilities and to collect feedback on the upgraded Nuclear Fuel Cycle Facilities Database.

15. The Technical Meeting on the Storage of Radioactive Waste, held in August 2022 in Vienna, discussed current approaches and practices in the storage of radioactive waste, including the design of storage facilities. The lack of waste acceptance criteria for storage facilities and ageing management were among the needs identified by the 110 participants from 51 Member States.

16. A Technical Meeting on Waste Minimization (Optimization) at Nuclear Power Plant Operations (International Predisposal Network, IPN), held in Vienna in November 2022, provided a forum to discuss approaches and practices for minimizing the volume of waste at nuclear power plants. The meeting was attended by 30 participants from 23 Member States.

17. In April 2023, the Agency organized a virtual Technical Meeting on Benchmarking of Waste from Nuclear Power Plant Operations. The meeting focused on improving the management of radioactive waste arising from nuclear power plant operations, specifically water cooled, water moderated power reactor operations. The meeting was attended by 16 participants from 7 Member States.

18. A Technical Meeting on the Management and Preservation of Spent Fuel Data was held virtually in December 2022. It was attended by 32 experts from 18 Member States and one international organization, who discussed experiences and lessons learned relating to the management and preservation of spent fuel data. Information gathered at the meeting will be used to update the

publication *Data Requirements and Maintenance of Records for Spent Fuel Management: A Review* (IAEA-TECDOC-1519), which was first published in 2006.

Fig. B.2. Rafael Mariano Grossi, IAEA Director General during his official visit to the IAEA LEU Bank located at the Ulba Metallurgical Plant in Oskemen, Kazakhstan, April 2023.

19. An update on the status of the operation of the IAEA Low Enriched Uranium (LEU) Bank since the previous report from May 2022 (IAEA document GOV/INF/2022/12) was issued in May 2023 in IAEA document GOV/INF/2023/8.

20. The Cylinder Management Programme was pursued to ensure the long term safety and security of all LEU cylinders, in situ at the IAEA Low Enriched Uranium Storage Facility and during subsequent transport, through a recertification campaign that took place in June 2023 (see FIG B.3.), in compliance with the requirements of revised ISO standard 7195:2020(E).

FIG. B.3. Recertification of the LEU-filled 30B cylinders at the IAEA LEU Bank.

21. The First Research Coordination Meeting on Performance Assessment of Storage Systems for Extended Durations was held in March 2023. It was attended by 26 experts from 12 Member States, who discussed individual research activities and identified areas of additional collaboration between coordinated research project (CRP) participants.

22. The 21st Meeting of the Technical Working Group on Nuclear Fuel Cycle Options and Spent Fuel Management was held in May 2023. It was attended by three experts from international organizations and 21 experts from 17 Member States, who presented their national programmes. The experts discussed nuclear fuel cycle options and spent fuel management issues and provided recommendations for future Agency activities on these topics. A session was dedicated to the back end challenges of envisaged technologies for small modular reactors.

23. The Technical Working Group on Radioactive Waste Management and Technologies (WATEC) was updated on radioactive waste management activities by the Agency, including the interfaces with nuclear safety, security and safeguards aspects. One of the recommendations is for the Agency to develop strategies and implementation plans to ensure that waste management is optimized across the life cycle, from concept/creation through to disposal. The meeting was held in Vienna in May 2023 and was attended by 17 experts from 16 Member States and four representatives from international organizations.

24. A Training Workshop on Communication and Stakeholder Involvement in Radioactive Waste Disposal, held in Tokyo in December 2022, highlighted good practices in communication and stakeholder involvement in radioactive waste disposal in Canada, Japan, Sweden and Switzerland. It was attended by 18 participants from ten Member States.

25. The Agency hosted a Technical Meeting on the Management of Hazardous Waste Arising from the Operation and Decommissioning of Nuclear Facilities in Vienna in May 2023. In total, 71 participants from 40 Member States shared lessons learned in the treatment and processing options for the management of hazardous waste and provided case studies for future publication.

26. A Technical Meeting on Operational Experiences of Spent Fuel and High Level Waste Transportation was held in Vienna in October 2022. It was attended by 38 experts from 16 Member States and three international organizations, who presented case studies on successful spent fuel and high-level waste transportation and discussed how lessons learned could be best utilized by organizations planning to carry out spent fuel and high-level waste transportation in the future.

27. In October 2022, the webinar "60 Years of Spent Fuel Storage: Challenges and Opportunities" provided 203 participants from 41 Member States with the findings of collaborative projects that have been undertaken by the Agency over the last 40 years, as well as Agency resources available to support Member States in all aspects of spent fuel storage.

28. In November 2022, the Agency organized the webinar "Women Leading Nuclear Back End Projects: Their Stories and Achievements", which attracted 102 participants from 22 Member States (Figure B.4.).

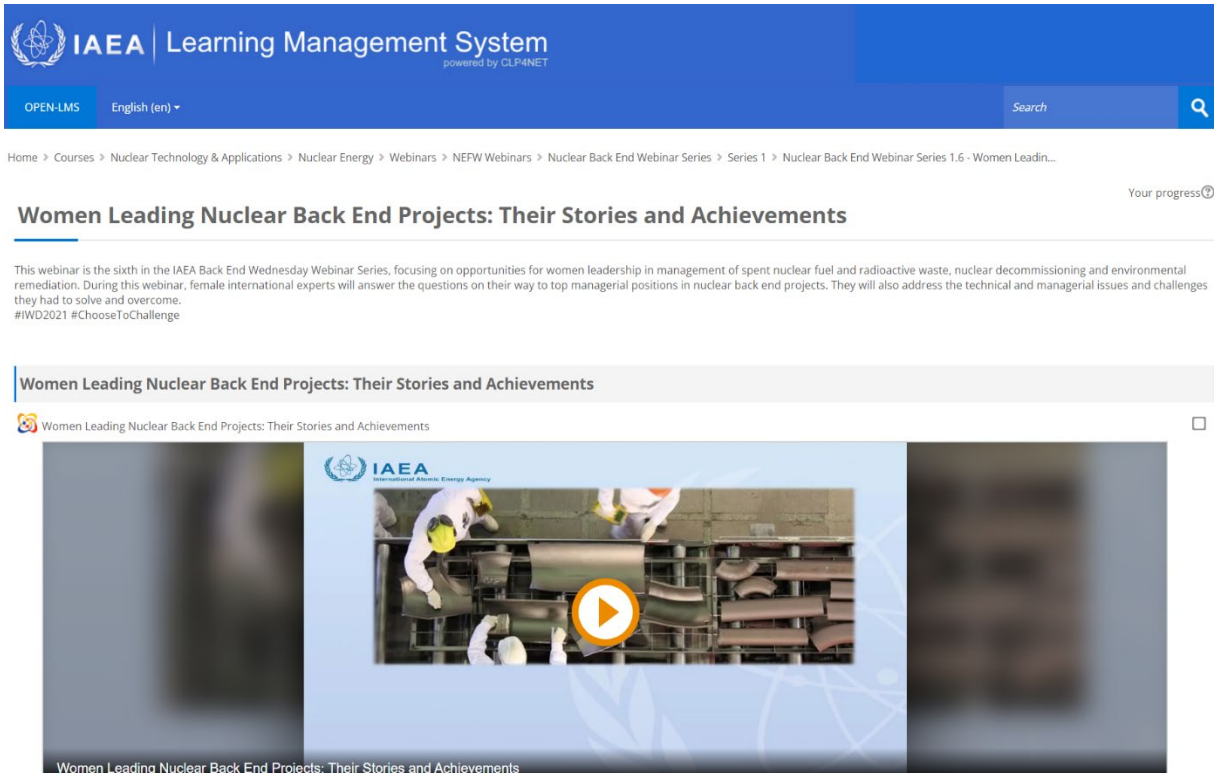


FIG. B.4. The webinar "Women Leading Nuclear Back End Projects: Their Stories and Achievements" focused on opportunities for leadership by women in the management of spent nuclear fuel and radioactive waste, nuclear decommissioning and environmental remediation

29. The Agency published the French translation of the *Policies and Strategies for Radioactive Waste Management* (IAEA Nuclear Energy Series No. NW-G-1.1), which was first published in 2009.

30. The Agency's publication *The Management of Site Investigations for Radioactive Waste Disposal Facilities* (Nuclear Energy Series No. NW-T-1.40) was made available in a pre-print version. It presents a broad range of tried-and-proven technologies used to conduct investigations and obtain required site data, and provides guidance on the management of a site investigation programme for disposal.

31. In the framework of a professional network, the Agency organized a virtual Technical Meeting of the Underground Research Facilities Network for Geological Disposal on Global Progress in Developing Geological Disposal Solutions. The event provided updates on the progress of deep

geological repositories programmes in 12 Member States, and the work completed at underground research facilities around the world. It was attended by 47 participants from 25 Member States.

32. The Technical Meeting of the International Low Level Waste Disposal Network (DISPONET) on Lessons Learned from the Disposal of Low Level Waste was hosted in Kozloduy, Bulgaria, in October 2022. The meeting was attended by 33 representatives from 24 Member States with the technical focus on the closure of near surface repositories.

33. The second edition of *Status and Trends in Spent Fuel and Radioactive Waste Management* (IAEA Nuclear Energy Series No. NW-T-1.14 (Rev. 1)) was published in January 2022. The Technical Meeting on Status and Trends in Spent Fuel and Radioactive Waste Management held in February 2023 focused on drafting the report on the Status and Trends in Spent Fuel and Radioactive Waste Management.

34. The Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) mission in Finland in November–December 2022 recognized the effective implementation of the national strategy to develop a geological disposal facility for spent fuel, which would be the first geological disposal facility in the world (Figure B.5.).

FIG. B.5. An international team performed an ARTEMIS peer review mission to Finland, where they provided independent expert opinions and advice on radioactive waste and spent fuel management, decommissioning and remediation, based upon the IAEA safety standards and technical guidance, as well as good international practices

35. The new Disused Sealed Radioactive Sources Technical Centre peer review service was introduced to Member States during the 66th General Conference at a side event. As a peer review service, more Member States can participate; not only those with well-equipped facilities and resources, but also

Member States that would like to strengthen their capabilities and capacities in the management of disused sealed radioactive sources (DSRSs) (Figure B.6.).

FIG. B.6. At a side event of the 66th General Conference, the Agency launched a new peer review service for the management of DSRSs

36. The Agency will hold the very first meeting of the Disused Sealed Radioactive Sources Network in August–September 2023. Members of the Network will have the opportunity to review its work programme and provide recommendations for future activities in both the short and medium terms.

37. The Agency is working closely with Malaysia in the implementation of the first Borehole Disposal Project by providing technical and engineering support, covering training on the use of the Mobile Tool Kit Facility, waste package preparation and cement formulation (Figure B.7.).

FIG. B.7. Training on the use of the Mobile Tool Kit Facility in Malaysia for the Borehole Disposal Project

38. Two publications were published by the Agency to further strengthen support for the effective management of DSRSs. *Management of Depleted Uranium Used as Shielding in Disused Radiation Devices* (IAEA Nuclear Energy Series No. NW-T-1.30), published in January 2023, addresses the various options for the safe management of depleted uranium and safeguards considerations. *Management of Disused Radioactive Lightning Conductors and Their Associated Radioactive Sources* (IAEA Nuclear Energy Series No. NW-T-1.15), published in October 2022, helps Member States to safely remove lightning conductors from the public domain and provides information on the management of the retrieved sealed radioactive sources.

39. The Agency organized a Technical Meeting on the Global Radium-226 Management Initiative in Vienna in June 2023. The meeting was attended by 78 participants from 52 Member States who reviewed the implementation status of recycling the legacy radium-226 stocks and discussed the effectiveness of the Agency's platform established to facilitate this endeavour.

40. A Workshop on Characterization and Monitoring to Support the Management of Radioactively Contaminated Land was held in October 2022 in Vienna. The event was attended by 32 participants from 23 Member States who provided positive feedback and discussed the challenges experienced in the implementation of remediation owing to resource constraints.

41. The Agency organized the Biennial Forum of the Network on Environmental Management and Remediation in October 2022 in Vienna. Altogether, about 100 participants attended both in person and

virtually from over 40 Member States. Activities in the field of environmental remediation and NORM management were reviewed and follow-up initiatives were discussed.

42. A virtual Technical Meeting on Application of Circular Economy Principles to Decommissioning Projects was held in November–December 2022. Over 30 registered participants from 17 Member States, as well as from the European Commission's Joint Research Centre and the European Demolition Association, supported topical sessions on waste minimization, recycling and reuse, circular economy versus sustainability, stakeholder involvement and learning from non-nuclear industries.

43. An International Workshop on Managing the Transition from Operation to Decommissioning was organized in December 2022 in Vienna. The event was attended by 65 participants (31 in person) from 28 Member States and the World Association of Nuclear Operators. Participants shared information, experiences and lessons learned on the different aspects of preparing and managing the transition from operation to decommissioning. They also actively contributed to the working group exercises addressed to review and evaluate different scenarios in the transition from operation to decommissioning.

44. A Technical Meeting on Decommissioning Considerations for Fusion Facilities was held in February 2023, in Cadarache, France, in collaboration with the French Alternative Energies and Atomic Energy Commission and ITER. In total, 56 participants (22 in person and 34 virtually) from 12 Member States and 2 international organizations met to facilitate the collection, sharing and analysis of good practices and experiences on decommissioning and related waste management considerations for fusion facilities (Figure B.8.).

FIG. B.8. Site visit of the ITER facility (Photo: ITER)

45. *Global Status of Decommissioning of Nuclear Installations* (IAEA Nuclear Energy Series No. NW-T-2.16) was published in April 2023 ahead of the International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future, which was held in May 2023.

46. 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) was published in April 2023.

47. A Technical Meeting on Decommissioning of Nuclear Fuel Cycle Facilities was held in June 2023 in Cherbourg, France and was attended by 36 participants from 19 Member States. The event allowed to collect practical examples and case studies on strategies, approaches, technologies, specific issues and challenges related to the decommissioning of fuel cycle facilities in order to address the increasing interest of Member States in this area.

48. A Technical Meeting on Methodologies and Technologies Used for the Characterization of Radioactively Contaminated Land will be organized in August 2023 in Vienna. The event will be centred on the sharing of good practices, experiences and lessons learned to support the characterization of radioactively contaminated land.

49. A Technical Meeting on Digital Technologies to Advance Decommissioning of Nuclear Facilities will be held in September 2023 in Vienna. The purpose of the event is to share with Member States the preliminary results of the collaborative project launched in August 2022 on new and emerging digital tools and technologies used in the data management, planning, licensing and implementation of decommissioning.

50. A Technical Meeting on Decision Making for Environmental Remediation will be held in September 2023 in Vienna. The purpose of the event is to collect, share and discuss experiences regarding decision making to support the implementation of remediation projects in line with sustainability and circularity principles, and supported by innovative approaches and technologies that can transform legacy sites from liabilities into assets.

51. The Agency published *Determination of Environmental Remediation End States* (IAEA Nuclear Energy Series No. NW-G-3.2) in May 2023. The objective of the publication is to provide guidance on making an informed and transparent decision on a mutually agreed end state for a site under the remediation process.

Research Reactors

A. Background

1. In resolution GC(66)/RES/9.B.4, 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 that are pursuing new reactor projects following the Agency-developed Specific Considerations and Milestones for a Research Reactor Project, including systematic, comprehensive and appropriately graded infrastructure development.

2. 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.

3. Furthermore, the General Conference encouraged the Secretariat to further strengthen its efforts to support capacity building based on research reactors.

4. Finally, the General Conference called on the Secretariat to continue to support international programmes working to minimize the civilian use of HEU, for example through the development and qualification of LEU high density fuel for research reactors, where such minimization is technically and economically feasible.

5. 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-seventh (2023) regular session.

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

6. In September 2022, the Agency conducted an expert mission to Saudi Arabia in support of the national Workshop on Strategy and Utilization of the First Saudi Nuclear Research Reactor, held at the King Abdulaziz City for Science and Technology in Riyadh.

7. Several Integrated Research Reactor Utilization Review (IRRUR) missions were implemented in 2022. In September, an IRRUR mission was held at the 10 MW RP-10 research reactor located at the RACSO Nuclear Centre and operated by the Peruvian Institute of Nuclear Energy (IPEN). In November,

another IRRUR mission was held at the 20 MW SAFARI-1 research reactor, operated by the South African Nuclear Energy Corporation (Necsa) at the Pelindaba nuclear research centre (Figures B.1. and B.2.).

FIG. B.1. Agency and IPEN teams taking part in the IRRUR mission at the RP-10 research reactor, September 2022 (Photo: IPEN)

FIG. B.2. Agency and Necsa teams taking part in the IRRUR mission at the SAFARI-1 research reactor, November 2022 (Photo: Necsa)

8. In 2023, several other IRRUR missions were held by the Agency. In May, an IRRUR mission was held to the Isfahan Research Reactors located at the Isfahan Nuclear Technology Centre in the Islamic Republic of Iran. In June, an IRRUR mission was organized to the Idaho National Laboratory's Neutron Radiography (NRAD) research reactor, located in Idaho Falls, United States of America. Finally, in June, an IRRUR mission was organized to Massachusetts Institute of Technology research reactor, located in Cambridge, United States of America.

9. In November 2022, the tenth African Conference on Research Reactor Safety, Operation and Utilization was held under the theme "Strengthening the Capacity for Research Reactor Safety and Applications in Africa", hosted by the Egyptian Atomic Energy Authority, Cairo, and was attended by 54 participants from 15 African Member States. In January 2023, the conference proceedings were published as a Special Issue of the *Arab Journal of Nuclear Sciences and Applications*.

10. In March 2023, a Regional Workshop on Strategic and Business Planning for Research Reactors took place in Cairo, and was attended by 22 participants and experts from ten Member States.

11. In July 2023, the Agency published *Guidelines for the Integrated Research Reactor Utilization Review (IRRUR)* (Services Series No. 48), which provides guidance on the preparation, implementation and reporting of IRRUR missions, including follow-up missions.

12. In March 2023, a new Agency-facilitated Regional Network of Research Reactors and Related Institutions in Latin America and the Caribbean was established, which includes Argentina, the Plurinational State of Bolivia, Brazil, Chile, Colombia, Cuba, Jamaica, Mexico and Peru. This new network will serve to assess the national and regional needs, share information and coordinate joint efforts to provide services and products by these national facilities.

13. In May 2023, the Agency published *Research Reactor Exercises for Higher Education Programmes* (IAEA-TECDOC-2024), which provides practical guidelines for the development of practical exercises using research reactor to be integrated into education programmes in nuclear science and technology.

14. Participants of a new coordinated research project (CRP) entitled "Development of Coupled Neutronic and Thermal-Hydraulic Calculational Methodologies for Research Reactors including Analysis and Treatment of Uncertainties" work to assess and enhance efforts on modelling the behaviour of research reactor fuel to enhance the performance and safety of the operation of research reactors. The initial research coordination meeting was held in Vienna in November 2022 with 50 participants (23 in person) representing 17 Member States, which resulted in the development of the work plan for the CRP. In March 2023, a workshop was held at the Argonne National Laboratory in Lemont, United States of America, to allow CRP participants to share and discuss a variety of approaches to coupling and uncertainty analysis. The workshop was attended by 68 participants (23 in person) from 17 Member States.

15. The pilot National Workshop on the Use of Decision Support Tools in Research Reactor Spent Fuel Management was conducted in November 2022 in Malaysia with 20 local participants. Discussions on several disposal scenarios by a diverse group of Malaysian government experts and stakeholders resulted in a strong consensus on a method for the disposal of the Malaysian spent fuel.

16. As part of efforts to assist Member States in the management of spent fuel and fissile materials for which reprocessing is not a viable option, a new publication provisionally entitled *Treatment and Conditioning Options for Research Related Fissile Materials* is being developed to illustrate the available technologies and approaches to preparing materials for the cost-effective, safe and secure long-term storage and preparation of final waste forms.

17. In April 2023, the Agency issued a new publication, *Post-irradiation Examination Techniques for Research Reactor Fuels* (IAEA Nuclear Energy Series No. NF-T-2.6), which supports efforts to develop low enriched uranium (LEU) fuels for research reactors. The publication provides information on the post-irradiation examination techniques applied in the development of research reactor fuels, the equipment used and examples of the results obtained.

18. A peer review of Indonesia's programme for decommissioning and storage of radioactive waste and spent fuel was organized in October 2022 on the request of Indonesia's National Research and Innovation Agency (BRIN) and focused on three research reactors and associated facilities in Indonesia. The objective of the peer review was to provide an independent review of BRIN's nuclear back end activities related to the preparation of research reactors for decommissioning, the long-term storage of radioactive waste and the storage of spent fuel longer than initially designed (Figure B.3.).

FIG. B.3. Peer review site visit of the research reactor in Yogyakarta, Indonesia (Photo BRIN)

19. In September 2022, the Agency held the Technical Meeting on Lessons Learned from High Enriched Uranium Take-back Programmes in Plzeň, Czech Republic, to review efforts over the past 20 years to repatriate HEU to its country of origin under various take-back programmes. Based on a recommendation from the meeting, a new publication has been initiated that will support the future transport of spent nuclear fuel from research reactors without the support and guidance of the take-back programmes. The publication, provisionally entitled *Experience in Removal of High Enriched Uranium from Research Reactors*, will illustrate the method and requirements associated with the safe transport of spent fuel and will capture the lessons learned from take-back programmes that have repatriated many tons of HEU.

Fig. B.4. Rafael Mariano Grossi, IAEA Director General during a visit to the China Institute of Atomic Energy where he visited, among others, the advanced research reactor and proton cyclotron, May 2023.

Operating Nuclear Power Plants

A. Background

1. In resolution GC(66)/RES/9.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 nuclear power plants, and to continue its support to interested Member States, in particular through strengthening their knowledge, experience, and capacity in management of ageing and plant life management.

2. The General Conference also encouraged the Secretariat to share best practices and lessons learned with respect to procurement, supply chain, 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.

3. Furthermore, the General Conference recognized the need to enhance the support for grid and nuclear power plant interfaces, grid reliability, and cooling water usage, and recommended that the Secretariat collaborate on these matters with Member States that have operating nuclear power plants.

4. The General Conference, in resolution GC(66)/RES/9.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-seventh (2023) regular session.

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

5. In November 2022, the Agency issued *Sustaining Operational Excellence at Nuclear Power Plants* (IAEA Nuclear Energy Series No. NR-G-3.1). The publication considers activities that are under the control of the owner/operating organization, as well as those that involve interaction with other stakeholders such as regulatory bodies, industry peers, international organizations, policy makers and academia. It supports leaders by providing strategic responses to current business challenges and effective measures to sustain high performance levels.

6. During October 2022, the Agency convened the Fourth Meeting of the Technical Working Group on Nuclear Power Plant Operations (TWG-NPPOPS). In total, 26 experts from 19 Member States and four international organizations, including the European Commission's Joint Research Centre, took part. As in the past, the event provided a platform for executives and leaders in nuclear power plant (NPP) owner/operating organizations and their supporting national, regional and international organizations to consider how to sustain and enhance the safe, reliable, efficient and strategic operations of NPPs and achieve a high level of quality, capacity, availability and longevity for operating NPPs.

7. In May 2023, the Agency held the first meeting of the Technical Working Group on Managing Human Resources and Knowledge in the Field of Nuclear Energy to ensure the reliable supply and development of a competent workforce and the implementation of knowledge management programmes in nuclear organizations for the nuclear industry and other peaceful uses of nuclear energy. The hybrid meeting, held in Vienna, was attended by 20 experts from 15 Member States and 2 international organizations.

8. In May 2023, a Technical Meeting on Embedding Leadership in the Nuclear Organization was held in Vienna with the objective: 1) to demonstrate the observable impact of immersive and experiential activities have on the development of leadership and resilient performance, and; 2) together with industry partners, to determine if a harmonized nuclear workforce development effort to strengthen leadership and resilience capabilities could be coordinated across the industry. The meeting was attended by 27 participants from 14 Member States.

9. In April 2023, a Technical Meeting on Management Systems and their Evaluation was held in Vienna. In total, 74 participants from 27 Member States attended the meeting. The participants reviewed a Nuclear Energy Series publication in preparation for the assessment of management systems for nuclear facilities, and discussed the challenges and future developments of management systems and their assessment in groups.

10. The Agency launched a new user interface for the Management, Supply Chain and Quality Network (MSCQ, formerly MSN) as a part of the IAEA CONNECT platform (Figure B.1.). The Agency issued the most recent newsletter in February 2023.

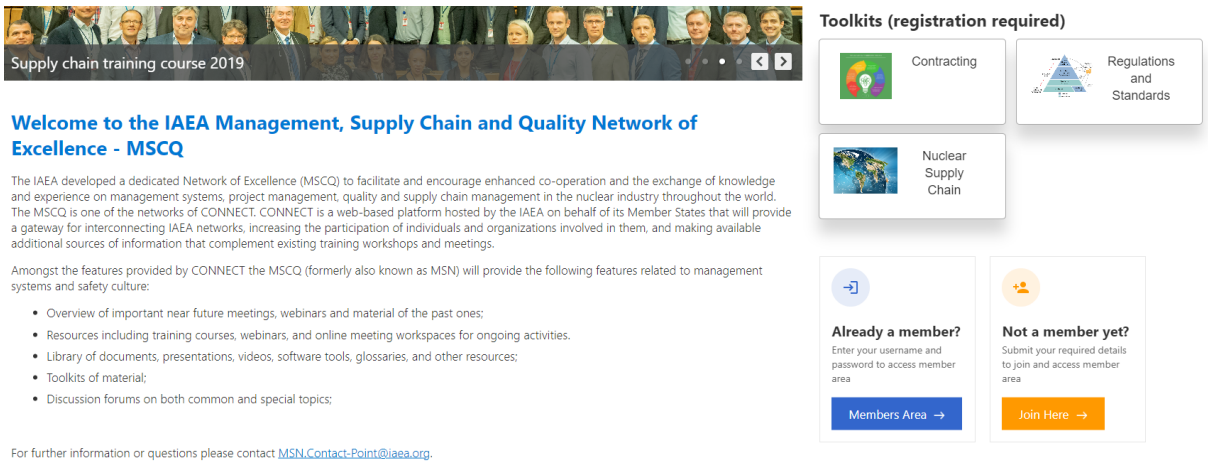


FIG. B.1. The newly launched MSCQ is an information hub for collaboration, showcasing best practices in the industry by including material on meetings, ongoing work draft publications, toolkits and newsletters. Its scope includes management systems, project management, quality and the nuclear supply chain, from operating NPPs to fusion

11. In December 2022, the Agency organized the webinar "Codes and standards in nuclear — potential for more common approaches?", which had more than 150 live participants from several Member States. The topics discussed included codes and standards related to quality, management systems, design, and different engineering and equipment qualifications.

12. The Agency conducted missions to the United Arab Emirates in October 2022 and Egypt in February 2023 to provide support on the quality and management aspects of nuclear construction, component manufacturing and modifications.

13. The Agency organized the Fifth International Conference on Nuclear Power Plant Lifetime Management in November–December 2022 in Vienna. Over 600 officially nominated experts, invited speakers and registered observers from 61 Member States and eight international organizations gathered in Vienna to discuss the status of nuclear power plant life management programme implementation, existing and emerging challenges and solutions, as well as the impact of implemented programmes and identified new challenges and solutions on safety and plant performance. The conference included 77 technical presentations in 17 parallel sessions within six topical tracks, four expert panels, three side events and four digital poster sessions.

14. In November 2022, 35 participants from 19 Member States and four international organizations gathered in the Czech Republic to launch the International Network on Life Management of Nuclear Power Plants. The Network promotes international cooperation to increase the efficiency of sharing international experience in NPP life management and to develop project-based working groups to further support the long-term operation efforts and knowledge transfer of Member States. Participants recommended six working groups to be created under the auspices of the Network. These groups will focus on gathering experience from the operation of NPPs, as well as the pre-operation period for new NPPs, risk-informed approaches to life management, climate and environmental impacts in the context of life management, equipment performance in beyond design basis conditions, and equipment reliability in the context of long-term operation and life management.

15. A Technical Meeting on the Structural Behaviour of Fuel Assemblies in Water Cooled Reactors was held virtually in October 2022. It was attended by 78 experts from 20 Member States and one international organization, who exchanged their experiences in fuel design and operation, safety analysis, analysis tools and methodologies, experimental data assessments, fluid-structural interaction,

the retrievability of used fuel, licensing aspects and regulatory acceptance, and potential gaps in the technologies to assess fuel assemblies.

16. In April 2023, 44 experts from 22 Member States and five international organizations gathered in Vienna to launch the International Network on Innovation to Support Operating Nuclear Power Plants (ISOP). A working group on artificial intelligence — convened in July 2022 as a pilot activity under the auspices of ISOP — shared both Agency-wide experiences and activities and those under way in external organizations during informal discussions via the Network's platform (Figure B.2.). The working group on artificial intelligence then gathered in May 2023 for a Technical Meeting on Artificial Intelligence and its Existing and Near-term Deployment in Operating Nuclear Power Plants, which was attended by 86 experts from 26 Member States and one international organization. Participants at the launch of the Network recommended other topics for a similar working group approach. These included advanced manufacturing, regulatory sandboxing, plant digitalization and modernization, as well as proficiency development to support innovation at operating NPPs.

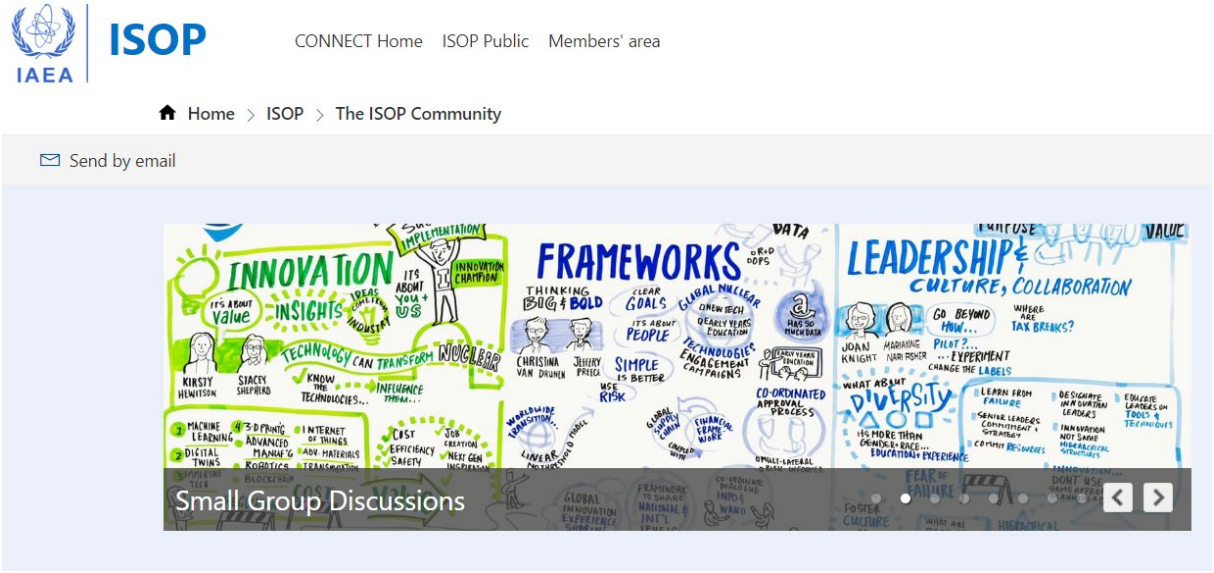


FIG. B.2. ISOP was established to increase collaboration and experience sharing in the field of innovation for the nuclear industry

17. The Agency issued *Fatigue Assessment in Light Water Reactors for Long Term Operation: Good Practices and Lessons Learned* (IAEA Nuclear Energy Series No. NR-T-3.32). This publication provides practical guidelines on how to identify and manage fatigue issues in NPPs. It explains the mechanism of fatigue, identifies which elements are the major contributors, and details how fatigue can be minimized in the design phase for new NPPs.

18. In February 2023, the Agency issued *Design Basis Reconstitution for Long Term Operation of Nuclear Power Plants* (IAEA-TECDOC-2018). This publication presents essential elements such as the drivers, goals, methods, roles, responsibilities and interfaces for an effective design basis reconstitution. It also describes current challenges, operating experience, good practices and lessons learned associated with design basis reconstitution for long-term operation.

19. In August 2022, the Agency organized the Technical Meeting on Instrumentation and Control and Other Advanced Digital Technologies for the Support of Plant Performance Optimization. This event was supported by 49 experts from 19 Member States and one international organization who exchanged information and experience on the topic, and developed an IAEA publication.

20. In October 2022, the Agency issued Management of Ageing and Obsolescence of Instrumentation and Control Systems and Equipment in Nuclear Power Plants and Related Facilities Through Modernization (IAEA Nuclear Energy Series No. NR-T-3.34). This publication assists Member States in developing strategies to address ageing and obsolescence issues for instrumentation and control systems, and provides detail on modernization considerations and information from relevant recent operator experience. An appendix summarizes cable ageing management through condition monitoring, and several annexes describe Member States' practices and experience with instrumentation and control ageing management and modernization.

21. In October 2022, the Agency issued Introduction to *Systems Engineering for the Instrumentation and Control of Nuclear Facilities* (IAEA Nuclear Energy Series No. NR-T-2.14). This publication is intended to assist Member States in understanding the philosophy and methodologies of systems engineering as presented by the ISO/IEC/IEEE standard 15288 and to provide guiding principles for the application of systems engineering to nuclear facilities and their instrumentation and control. Where necessary, it provides relevant referrals to other publications for detailed practical aspects of systems engineering.

22. In December 2022, the Agency hosted a Technical Meeting on Common Cause Failures in Nuclear Power Plant Instrumentation and Control Systems. The event provided a forum for 69 experts from 21 Member States and two international organizations to engage in the international exchange of information and experiences related to the origins, effects and management of common cause failures in NPP instrumentation and control systems.

23. The Agency organized several events to support Member States in enhancing the grid and NPP interfaces, including the Interregional Training Course on Electrical Grid Considerations and Interactions with a Nuclear Power Plant in September 2022 to support Member States' capability building in nuclear power infrastructure, with the participation of representatives from 11 Member States; a workshop for the Grid Operator on NPP Requirements for Availability of Electrical Supply for Member States in March 2023 to improve Member States' understanding of the requirements associated with the electrical grid for NPPs; and two scientific visits to learn about the NPP–electrical grid interface and hybrid electrical power systems mixed with nuclear power and renewable energy sources in March and September 2023.

24. The Agency coordinates supply chain activities with several international and non-governmental organizations. For example, the Agency co-organized the forum "Towards a sustainable nuclear supply chain" with nucleareurope in September 2022 in Helsinki, with the attendance of 70 participants from 15 Member States, to raise awareness of current supply chain challenges and avenues for solutions to improving supply chain resilience.

25. In December 2022, the Agency organized a Technical Meeting on Nuclear Power Plant Design Documentation — Format and Content. The event gathered 33 experts from 18 Member States to share and discuss international best practices regarding the possible format and content of design documentation. This will be applied to help establish a common language between NPP suppliers, designers and owners regarding the engineering design documentation work phase. This should then support the design documentation review and acceptance phase for NPP projects, thereby contributing to the effective management of project schedules and cost risks.

26. The Agency launched a new database, the Simulation and Experimental Analyses Network Information System (SANIS), that collects information on the numerical codes applicable to the simulation of severe accident progression in NPPs. It also collects information on relevant experimental facilities worldwide that support the analysis of severe accident phenomena in NPPs (Figure B.3.).

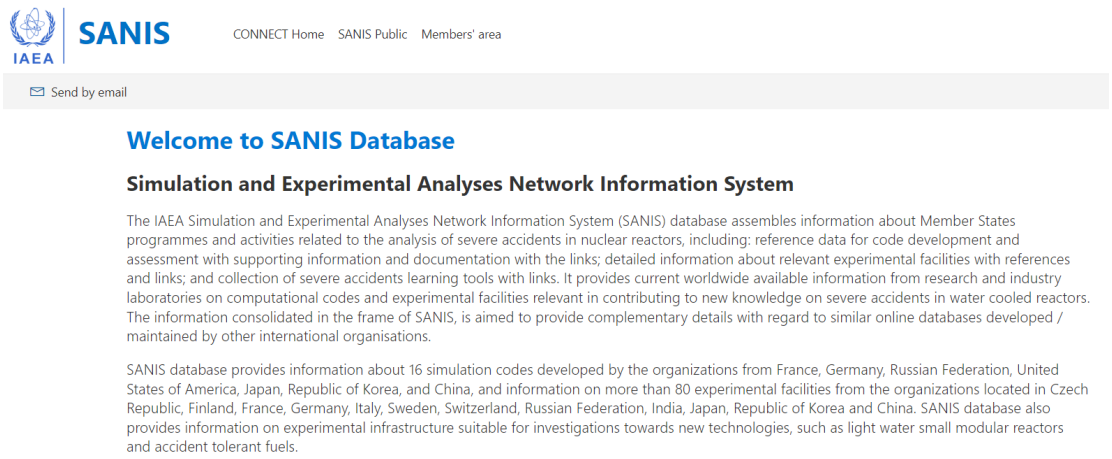


FIG. B.3. SANIS compiles information about Member States' programmes and activities related to the analysis of severe accidents in nuclear reactors

27. The Agency developed a new Educational Hypothetical Severe Accident Simulator for free distribution to its Member States per their request. This simulator is based on a generic advanced pressurized water reactor which employs active and passive safety systems that can simulate various scenarios in normal operation conditions, as well as various malfunctions, such as the initiation and progression of severe accident conditions (Figures B.4. and B.5.).

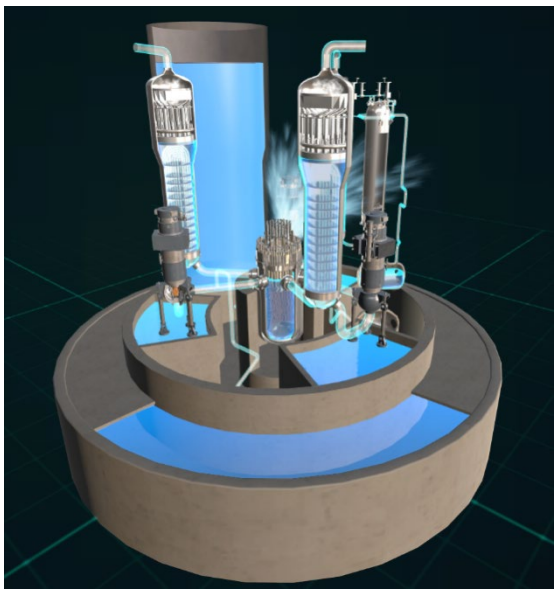


FIG. B.4. 3D primary system representation with removed containment walls for observing water and steam in pipes and vessels; the water movement during a loss of coolant accident indicates the real liquid flow rate within the pipes

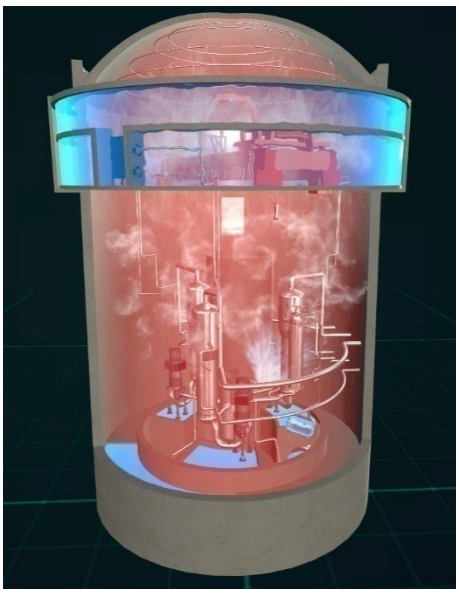


FIG. B.5. 3D view of the severe accident propagation, showing important systems inside the containment structure, the reactor coolant system, containment spray system and the associated piping

28. The Agency made available, in pre-print, *Methodologies for Assessing Pipe Failure Rates in Advanced Water Cooled Reactors* (IAEA Nuclear Energy Series No. NR-T-2.16). The publication presents methodologies for assessing pipe failure rates in advanced water cooled reactors (WCRs), including a comprehensive review of good practices for the assessment of piping reliability parameters for advanced WCRs.

29. The Agency supported Member States in their systematic approach to training (SAT) application efforts by conducting intercontinental training courses both in the Czech Republic and the United States of America in May 2023, with 25 participants from 19 countries. This systematic approach continued to be covered in several broader Agency activities, including training courses, schools and peer reviews.

30. In September 2022, the Agency introduced a new webinar series focused on strengthening the contractor's understanding of SAT methodology, the competencies necessary to implement a graded approach to training, and the advantages and challenges associated with the use of a graded approach to training. The webinar series is continuing in 2023 with new topics, which have been selected by Member States.

31. In November 2022, 50 participants from 29 countries attended the Technical Meeting on Nuclear Power Plant Personnel Training held in Vienna. The meeting focused on improving the effectiveness of NPP training programmes, implementing SAT and reviewing the draft publication provisionally entitled *Use of Graded Approach in the Application of SAT*.

Agency Activities in the Development of Innovative Nuclear Power Technology

A. Background

1. In resolution GC(66)/RES/9.B.6, the General Conference 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. It also encouraged the Secretariat to consider further opportunities to develop and coordinate the services it provides in building long-term national nuclear energy strategies and in long-term sustainable nuclear energy deployment decision-making using, inter alia, the analytical approaches and tools developed by INPRO.

2. The General Conference 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. The resolution also encouraged interested Member States to use methods and tools developed by the Agency for nuclear energy evolution scenario modelling, nuclear energy system economic assessments, comparative evaluation of nuclear energy system or scenario options, and road mapping, including ASENES service and its applications.

3. The General Conference also 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.

4. The General Conference also 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.

5. Furthermore, the General Conference encouraged the Secretariat to further its efforts on distance learning/training on development and evaluation of innovative nuclear technology for students and staff of universities and research centres, and to further develop tools supporting this activity that supports efficient delivery of services to Member States.

6. The General Conference, in resolution GC(66)/RES/9.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-seventh (2023) regular session.

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

7. The 31st Meeting of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) Steering Committee was held in November 2022, where Uzbekistan was welcomed as a new INPRO member, bringing the membership to 44. INPRO members discussed progress, the initiation of new INPRO collaborative projects, updates to the INPRO Strategic Plan for 2024–2029 and the development of the 2024-25 INPRO Subprogramme Plan. The meeting was attended by 45 participants from 22 Member States, as well as observers from the African Commission on Nuclear Energy (AFCONE), the International Science and Technology Center and the World Nuclear Association.

8. The Agency continues to initiate activities to assist interested Member States in applying the INPRO methodology and tools to develop long-term national nuclear energy strategies. For example, discussions were held during the reporting period with Viet Nam, to provide training on the use of the INPRO methodology for a nuclear energy system assessment and related INPRO tools. Meetings were also held with Member States to discuss the application of the INPRO methodology to assess the sustainability of small and medium sized or modular reactor (SMR) designs.

9. In July 2023, the Agency deployed an online training course on INPRO methods and tools on the learning management system platform to facilitate the capacity building of Member States in strategic planning for sustainable nuclear energy development and deployment.

10. The Agency held a Technical Meeting of 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 November–December 2022. The meeting was attended by 33 participants from 14 Member States.

11. The Agency published *Economic Evaluation of Alternative Nuclear Energy Systems* (IAEA-TECDOC-2014) to support Member States in conducting economic evaluations of nuclear energy system alternatives.

12. The Agency held the 20th INPRO Dialogue Forum on Challenges and Issues in Capacity Building for Ensuring Nuclear Energy Sustainable Development in March 2023 at Oak Ridge National Laboratory, Tennessee, United States of America. The event was attended by 56 participants from 27 Member States and two international organizations (AFCONE and the European Nuclear Education Network).

13. In August 2023, the Agency will hold the 21st INPRO Dialogue Forum on the Deployment of Small Modular Reactor Projects and Technologies to Support the Sustainable Development Goals in Saint Petersburg, Russian Federation.

14. The Agency published e-learning modules on advanced reactor technologies and translated most of them into other United Nations languages in addition to English. The modules provide an overview and examples of water cooled reactor technology development, pressurized water reactors, boiling water reactors, pressurized heavy water reactors, supercritical water cooled reactors, hybrid energy systems, natural circulation, severe accidents and reactor technology assessment via the Cyber Learning Platform for Network Education and Training.

15. The Agency held the first Joint ICTP–IAEA School on Nuclear Energy Strategic Planning and Application of the IAEA INPRO Methodology for Sustainability Assessment at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, in September 2022. This event was hybrid, and had 57 participants from 34 Member States.

16. The Agency held the second Joint ICTP-IAEA INPRO School on Strategic Planning for Sustainable Nuclear Energy Development at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, in June 2023. This event had 29 participants from 24 Member States.

17. The Agency launched a new coordinated research project (CRP) entitled "Benchmark of Transition from Forced to Natural Circulation Experiment with Heavy Liquid Metal Loop" that will improve Member States' analytical capabilities in the simulation of fast reactors cooled by heavy liquid metals.

18. The Agency will organize a Joint ICTP-IAEA Workshop on Open-Source Nuclear Codes for Reactor Analysis, in August 2023 in Trieste, Italy, with the objective of aiding the progress and implementation of open-source multi-physics simulation tools for the examination of advanced nuclear power reactors.

19. In May 2023, the Agency conducted the webinar "Thorium based advanced reactor design concepts", which was presented by four speakers from Canada, Denmark, Japan and the United States of America and which had 371 registered participants. The webinar provided an overview of the status of current research and future developments in using thorium-based fuel cycles for advanced reactors.

20. In September 2022, the Agency published *Near Term and Promising Long Term Options for the Deployment of Thorium Based Nuclear Energy* (IAEA-TECDOC-2009), which summarizes the results of a CRP focused on options for the deployment of thorium-based nuclear energy.

21. In April 2023, the Agency published *Energy Neutral Mineral Processing with High Temperature Reactors: Resource Identification, Uranium Recovery and Thermal Processes* (IAEA-TECDOC-2023), reporting on the findings of a CRP which investigated the use of SMRs for energy neutral mineral processing, including 12 case studies conducted by the participating Member States.

22. A Technical Meeting on Advances in Nuclear Fuel Fabrication Technologies for Power Reactors was held in June 2023 to facilitate the exchange of and collect up-to-date information on nuclear fuel fabrication technologies for operating and innovative power reactors. This included high assay low enriched uranium fuel, accident tolerant fuels and advanced technology fuels; the use of reprocessed uranium fuel in light water reactors (LWRs); the adaptation of new technology such as computer-aided technology, 3D printing technology, artificial intelligence and nano technology; the deployment of fuels for LWR-type SMRs and fast neutron SMRs; and the mass production of coated particle fuels for modular gas cooled reactors.

23. A Programme Committee Meeting for the 2023 Fusion Energy Conference, planned for October 2023, took place in Vienna in May 2023. The Committee members finalized the review of a record number of 837 abstracts by proposing overview and oral presentations, as well as poster presentations; prepared a draft technical programme; and advised the Secretariat on four side events of the Conference.

24. The Agency held a Technical Meeting on the INPRO Collaborative Project "Legal and Institutional Issues of Prospective Deployment of Fusion Facilities" in April 2023 in Vienna. The meeting was attended by 74 participants from 14 Member States. The participants identified the need for the development of a regulatory framework for fusion power plants that will support long-term sustainability.

25. In September 2022, Practical Arrangements were signed between the Agency and the Princeton Plasma Physics Laboratory, United States of America, on cooperation in fusion research.

26. In May 2023, the Agency entered into Practical Arrangements with Hefei Institutes of Physical Science, Chinese Academy of Sciences in the area of physics, technology, training and education in nuclear fusion research.

27. The Agency launched a coordinated research project (CRP) entitled “Artificial Intelligence for Accelerating Fusion Research and Development”. The CRP aims to accelerate fusion research and development (R&D) through machine learning and artificial intelligence by creating a platform and cross-community network for innovation and partnership with Member States.

28. The Agency launched a CRP entitled “Towards the Standardization of Small Specimen Test Techniques for Fusion Applications — Phase II”, which will provide a basis for the standardization of small specimens, making them available for use in fusion material irradiation facilities.

29. In August 2022, the Eighth IAEA DEMO Programme Workshop was held in Vienna, where experts discussed operational transients, coolant technologies, the tritium fuel cycle and required materials research for future demonstration fusion power plants (DEMOs). The event was attended by 41 participants from 14 Member States and two international organizations.

30. The Agency launched an e-learning course entitled “Nuclear Fusion and ITER Science and Technology”, which is based on the ITER Organization’s “ITER Talks” series, featuring lectures on the science and technology of ITER and fusion research, recorded by experts that are working on the ITER project.

31. In October 2022, the Agency held a Technical Meeting on Plasma Physics and Technology Aspects of the Tritium Fuel Cycle for Fusion Energy in Vienna, which was attended by 39 participants from nine Member States and one international organization.

32. In November 2022, the Agency held the Fourth Technical Meeting on Divertor Concepts in Vienna, which was attended by 81 participants 17 Member States and one international organization.

33. In December 2022, the Agency issued the non-serial publication *World Survey of Fusion Devices 2022*.

34. The 12th ITER International School, organized in cooperation with the Agency, was held in June 2023 in Aix-en-Provence, France, and focused on physics of energetic particles in fusion plasmas. The school was attended by 157 participants from 29 Member States.

35. The Agency published Nuclear Wiki pages on the INPRO methodology for the detailed assessment of the sustainability of nuclear energy systems. The Wiki pages provide, among others, an overview of the INPRO Methodology and contain the INPRO Manuals for performing a Nuclear Energy System Assessment (Figure B.1.).

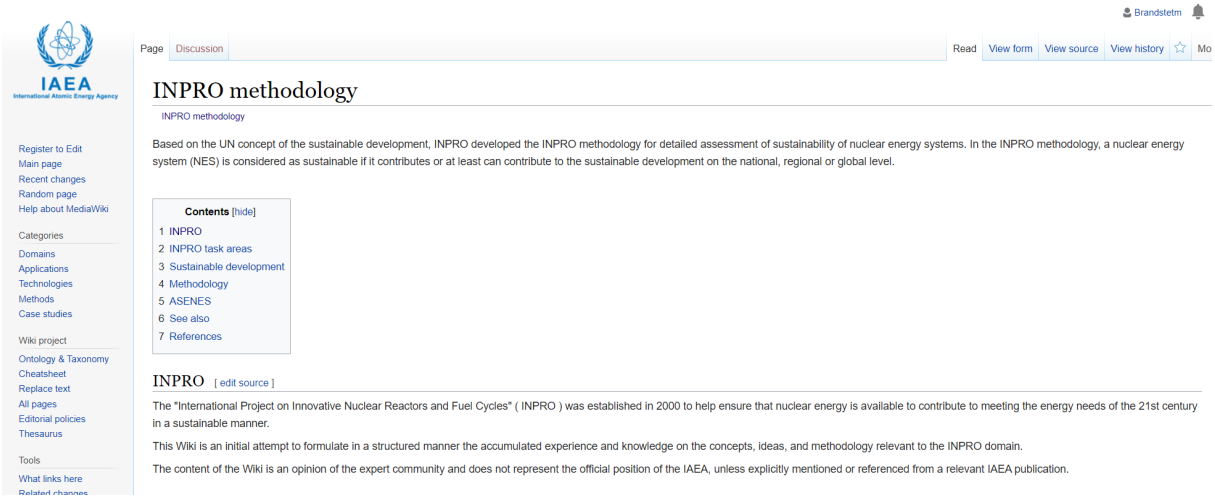


FIG. B.1. New Nuclear Wiki pages on INPRO describe the INPRO methodology, related task areas and the Analysis Support for Enhanced Nuclear Energy Sustainability service package.

Approaches to Supporting Nuclear Power Infrastructure Development

A. Background

1. In resolution GC(66)/RES/9.B.7, the General Conference encouraged the Nuclear Infrastructure Development Section to pursue its activities integrating the Agency's assistance provided to Member States embarking on or expanding nuclear power programmes, and encouraged Member States interested in or embarking on new or expanded nuclear power programmes to make use of the Agency services related to nuclear infrastructure development.

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 TECDOC 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, and encouraged them 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 also 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, and encouraged the strengthening of activities undertaken by Member States, both individually and collectively, to cooperate on a voluntary basis in nuclear infrastructure development.

4. The General Conference, in resolution GC(66)/RES/9.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-seventh (2023) regular session.

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

5. The Secretariat continued its efforts in providing integrated Agency assistance to Member States embarking on or expanding nuclear power programmes based on the Agency's Milestones approach (outlined in IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)). This support was coordinated through the inter-Departmental Nuclear Power Support Group, which provides policy and direction at Divisional Director level, and the Infrastructure Coordination Group. In addition, Member State specific core teams that include representatives from all relevant Departments and the Office of Legal Affairs participated

in bilateral meetings with the respective Member States to develop or update their national Integrated Work Plans (IWPs) and CNIPs which help plan and tailor the Agency's assistance to the needs of each Member State and to monitor the progress of national infrastructure development following an Integrated Nuclear Infrastructure Review (INIR) mission.

6. To facilitate the advancing Member States' national nuclear power projects through the Milestones approach, a revised publication entitled *Nuclear Reactor Technology Assessment for Near Term Deployment* (IAEA Nuclear Energy Series No. NR-T-1.10 (Rev. 1)) was issued. The revised publication incorporates lessons learned and includes applications to small and medium sized or modular reactors (SMRs) and non-electric applications. Furthermore, an e-learning module and an IT Toolkit on reactor technology assessment methodology were developed following the revised methodology and made available to Member States.

7. In an effort to ensure its continued applicability, the Agency is finalizing the revision of *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)) to incorporate lessons learned from Member States, present the main findings of INIR missions and address the needs of expanding countries. The revision will also include an annex on infrastructure considerations for SMRs.

8. The Secretariat continued to gather lessons learned on the process of conducting self-evaluation reports and to support pre-INIR, INIR and INIR follow-up missions, which are taken into consideration during further missions and internally documented for inclusion in the development of new and/or the revision of existing publications.

9. Additionally, a registry containing all recommendations and suggestions made during previous INIR missions is maintained and updated regularly. Lessons learned are further incorporated into the revisions of existing publications and the development of new publications related to nuclear infrastructure development.

10. The Secretariat continues to perform INIR missions and, when appropriate, will include documents in a mixture of English and one of the other official languages of the United Nations, in order 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 of the United Nations. The main INIR mission report is published in English.

11. Through the regular training of external experts and staff members from relevant Departments, most recently in June 2023, 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 provide a commercial advantage.

12. The Agency continued to promote the nuclear infrastructure development competency framework database that outlines the activities and associated competencies needed to implement a new nuclear power programme, whereby its online publication facilitates access by and increases information sharing with interested parties in the Agency and Member States. The Agency continued to promote the use of the database during Agency meetings and is using feedback to further refine its content and structure.

13. Supported by external experts, the Secretariat continued to undertake regular systematic reviews of the Nuclear Infrastructure Bibliography to detect areas not covered by existing Agency publications and to identify publications in need of revision. The regularly updated Nuclear Infrastructure Bibliography is published on the Agency website, structured according to the 19 infrastructure issues outlined in the Milestones approach, and has proven to be a useful tool in supporting embarking countries to build competence.

14. To the extent possible, and if 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 performed in cooperation with other international organizations, donors and vendors, with the aim of maximising the benefit of Agency support and avoiding its overlap with third party support.

15. The Agency also conducted a meeting to review the conditions contained in *Evaluation of the Status of National Nuclear Infrastructure Development* (IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 2)) and potential considerations related to SMRs. This draft revision will be piloted in an INIR mission planned to take place in October 2023 to a Member State that is considering applying SMR technology.

16. Within the framework of the ongoing Peaceful Uses Initiative project entitled “Supporting the Development of Management Systems and Nuclear Safety Culture Programmes”, the Agency continued to offer assistance to Member States embarking on new nuclear power programmes or expanding existing nuclear power programmes in the development of management systems, enhancing the understanding and execution of leadership, and responsibility for management systems to ensure safety, nuclear security, effectiveness and sustainability, and in establishing an adequate organizational culture in key organizations through the organization of capacity-building workshops for senior management. An annual review meeting of Member States participating in this project was conducted in January 2023 to review plans for the next two years.

17. The Agency continued to further develop and strengthen the comprehensive capacity-building programme for embarking countries based on cross-Departmental cooperation and the coordination of the development and implementation of supporting tools, mechanisms and activities. This included the release of new modules on nuclear security and radiation protection in the e-learning series for newcomer countries and the organization of 17 integrated nuclear infrastructure training courses and one workshop for more than 350 participants from 43 Member States. These courses were hosted by Austria, Finland, France, Japan, Kenya, Republic of Korea, Russian Federation, and the United States (Figure B.1.).

FIG. B.1. Participants in the Interregional Training Course on Nuclear Power Infrastructure Development, held in November 2022 in Japan, during a visit to the Hamaoka nuclear power plant Training Centre

18. A National Training Course on Reactor Technology Assessment — featuring case studies on SMRs — was conducted in March 2023 and was hosted by Egypt's Nuclear Power Plants Authority. Twenty-five participants from major nuclear institutions participated in the course. This formed part of the Agency's capacity-building activities to Member States on using reactor technology assessment methodology supported by the Advanced Reactors Information System database (which is currently being modernized) and on SMR technology development activities performed in the framework of the IAEA Platform on Small Modular Reactors and their Applications.

19. The Agency published Experiences of Regulatory Bodies and Owner/Operator Organizations in Developing Management Systems for New Nuclear Power Programmes (IAEA-TECDOC-2013) in November 2022. The document shares the experiences of regulatory bodies and owner/operator organizations in developing management systems consistent with the main activities planned from the inception of these organizations to the construction of a nuclear power plant, whilst prioritizing safety.

Small and Medium Sized or Modular Reactors — Development and Deployment

A. Background

1. In resolution GC(66)/RES/9.B.8, the General Conference requested that the Secretariat ensures coordination between the IAEA SMR Platform and the newly launched NHSI and reports back to Member States in this regard. It also 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 IAEA SMR Platform, and encouraged Member States to use these tools as well as INPRO tools and services for assessment of SMR deployment sustainability.

2. The General Conference also 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. It also encouraged the Secretariat to continue working on defining indicators of safety performance, operability, maintainability, and constructability so as to assist countries in assessing advanced SMR technologies, and developing guidance for SMR technology implementation.

3. The General Conference further encouraged the Secretariat to continue developing generic user requirements and criteria as well as codes and standards for SMRs, in the framework of the newly created NHSI and in cooperation with Member States and relevant stakeholders.

4. 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, and 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 developing countries, their potential integration with renewables, and their non-electric applications.

5. The General Conference further requested the Director General to continue to report on i) the activities coordinated and carried out by the IAEA SMR Platform, and progress made on the newly created NHSI, and ii) 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-seventh (2023) regular session.

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

6. In October 2022, the Agency published a high-level booklet entitled *Small Modular Reactors: A new nuclear energy paradigm*, aimed at policymakers in Member States. The report addresses factors to be considered by Member States when deciding whether to adopt small modular reactors and how to enable their safe, secure, peaceful and sustainable deployment.

7. The Agency has developed a medium-term strategy through 2029 to support Member States regarding small modular reactors and their applications. The purpose of the strategy is to establish strategic objectives to ensure timely, relevant and consistent Agency contributions to address the needs and requests of Member States. The identified strategic objectives range from helping Member States to make informed decisions on the deployment of small modular reactors to supporting the establishment of institutional, legal and regulatory frameworks and providing knowledge and technology transfer through technical cooperation. A high-level action plan has been developed to implement the medium-term strategy.

8. A web portal for the SMR Platform was launched to enable information exchange, outreach and networking; to facilitate internal and external collaboration with Member States; and to inform the public about the Agency's work on SMRs (Figure B.1.).

FIG. B.1. Portal for the SMR Platform

9. The terms of reference for the SMR Platform were revised to incorporate the lessons learned after it had been implemented for over a year. This offered Member States a unique opportunity to access information on all the Agency's activities and to request specific assistance regarding SMRs and their applications.

10. In April 2023, the Agency held a Technical Meeting of Analysis Support for Enhanced Nuclear Energy Sustainability: Pilot Study on Sustainable Deployment Scenarios for Small Modular Reactors (ASENES SMR) in Vienna. The event discussed the formulation of national case studies on sustainable deployment scenarios for SMRs using the Analysis Support for Enhanced Nuclear Energy Sustainability (ASENES) service package, and national and/or relevant tools. The meeting was attended by 38 participants from 19 Member States.

11. Under the Nuclear Harmonization and Standardization Initiative (NHSI), the Agency initiated the development of an IAEA Technical Document provisionally entitled *Considerations to Facilitate the Accelerated Deployment of Small Modular Reactors and Microreactors*. The document will provide a forward-looking perspective on how areas of infrastructure addressed could be adapted to facilitate and support accelerated deployment.

12. A hybrid Technical Meeting on Back End of the Fuel Cycle Considerations for Small Modular Reactors was held in September 2022. It was attended by 107 experts from 32 Member States and three international organizations, who collaboratively identified the opportunities and challenges faced at all stages of the back end of the fuel cycle (e.g. storage, transportation, reprocessing and recycling, and disposal), the gaps in current infrastructures and the knowledge required to ensure an integrated approach to the overall spent fuel management strategy, as well as the potential ways to move forward in addressing them in the near, medium and long terms.

13. The activities that initially started in 2020 to develop generic user requirements and criteria for SMR technology were integrated under NHSI Industry Track Topical Group 1. The Topical Group brings together three regional organizations (the Electric Power Research Institute (EPRI), the European

Utility Requirements (EUR) and the China Utility Requirements (CUR). A Technical Meeting was held in August 2022 for the development of a Nuclear Energy Series publication on the generic user recommendations and considerations for SMRs, to be published provisionally in 2024.

14. Under NHSI Industry Track's Topical Group 2, entitled Common Approaches on Codes and Standards, technology holders, industry, owners and operators, international organizations and other relevant organizations for global cooperation are sharing information regarding common approaches to codes and standards. The Topical Group exchanged information to enable high-level comparison of, inter alia, quality and management related requirements and the component manufacturing related inspection information, suitability assessment processes used for industrial grade components, engineering and design related codes and standards, and advanced manufacturing standards.

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