

**Board of Governors
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NUCLEAR AND RADIATION SAFETY

Report by the Director General

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Item 14 of the Conference's provisional agenda
(GC(66)/1 and Add.1)

Nuclear and Radiation Safety

Report by the Director General

Summary

Pursuant to resolution GC(65)/RES/8, a report covering the following subjects is submitted to the Board of Governors and the General Conference for their consideration:

- General;
- Conventions, regulatory frameworks and supporting non-legally binding instruments;
- Agency safety standards;
- Self-assessments and the Agency's peer review and advisory services;
- Nuclear installation safety;
- Radiation safety and environmental protection;
- Transport safety;
- The safety of spent fuel and radioactive waste management;
- Safety in decommissioning, uranium mining and processing, and environmental remediation;
- Capacity building;
- Safe management of radioactive sources; and
- Nuclear and radiological incident and emergency preparedness and response.

Recommended Action

- It is recommended that the Board of Governors take note of this report.

Nuclear and Radiation Safety

Report by the Director General

A. General



*Operational Safety Review Team (OSART) mission in Almaraz Nuclear Power Plant in Spain
(Photo:IAEA)*

1. This report has been produced for the 66th regular session (2022) of the General Conference in response to resolution GC(65)/RES/8, in which the General Conference requested the Director General to report in detail on implementation of nuclear and radiation safety activities in response to the resolution and on other relevant developments in the intervening period. This report covers the period from 1 July 2021 to 30 June 2022.

2. The Agency continued its efforts to maintain and strengthen nuclear, radiation, transport and waste safety, and emergency preparedness and response (EPR) capabilities, focusing, inter alia, on the technical areas and geographical regions where the need for such efforts is greatest. The Agency implemented numerous activities and services to assist Member States considering or planning for the introduction of nuclear power or radiation technology; establishing or strengthening their safety

infrastructure and regulatory framework; and building competency in several areas related to nuclear and radiation safety.¹

3. The Agency continued to encourage Member States to become Contracting Parties to the Convention on Nuclear Safety (CNS), the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention), the Convention on Early Notification of a Nuclear Accident (Early Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention). Activities related to the Conventions are reported in detail in subsequent sections of this report.²

4. In March 2022, a report by the Director General containing the draft *Nuclear Safety Review 2022* was submitted to the Board of Governors. The final version of the *Nuclear Safety Review 2022*, prepared in the light of discussions at the Board of Governors, is provided as an information document at the 66th regular session of the Agency's General Conference. The *Nuclear Safety Review 2022* includes the global trends and the Agency's activities in 2021. It also presents priorities and related activities for 2022 and beyond, as identified by the Agency, for strengthening nuclear, radiation, transport and waste safety, as well as EPR. These priorities are addressed in the Agency's Programme and Budget, including outcomes, outputs, timelines and performance indicators.³

5. The eleventh Treaty Event took place during the 65th regular session of the Agency's General Conference. It provided Member States with a further opportunity to deposit their instruments of ratification, acceptance or approval of, or accession to, the treaties deposited with the Director General, including those related to nuclear safety, security and civil liability for nuclear damage.⁴

6. Through the Legislative Assistance Programme, the Agency continued to provide assistance to its Member States to support the development of adequate and comprehensive national legal frameworks and to promote adherence to the relevant international legal instruments in all branches of nuclear law. Specific bilateral legislative assistance was provided to seven Member States through written comments and advice on drafting national nuclear legislation. Support in gaining a better understanding of the relevant international legal instruments and the elements of comprehensive national nuclear law was also provided to nine Member States through meetings, awareness missions and workshops. Moreover, a regional workshop on nuclear law was held virtually for English-speaking Member States in Latin America and the Caribbean in July 2021. Two targeted virtual workshops on nuclear law provided diplomats and officials from permanent missions located in Berlin, Brussels, Geneva, Paris and New York with a high-level overview of international and national nuclear law and the Legislative Assistance Programme. A total of 110 diplomats and officials from 57 countries participated in the events. A regional workshop for Spanish-speaking Member States will be held in Buenos Aires, Argentina, 12-16 September 2022. In addition, a sub-regional workshop for Member States in Asia and the Pacific will be held in Hanoi, Vietnam, 8-12 August 2022⁵.

7. In April 2022, the Agency held the First International Conference on Nuclear Law: The Global Debate in Vienna, where 1,100 participants from 127 Member States and 31 international organizations shared experiences and discussed the implementation of the international legal instruments and capacity building programmes in this field, as well as challenges for the next generation of nuclear lawyers. During the six plenary sessions, 14 technical sessions, and five roundtable discussions leading global

¹ This relates to operative paragraphs 1 and 2 of resolution GC(65)/RES/8.

² This relates to operative paragraph 19 of resolution GC(65)/RES/8.

³ This relates to operative paragraphs 4 and 126 of resolution GC(65)/RES/8.

⁴ This relates to operative paragraph 19 of resolution GC(65)/RES/8.

⁵ This relates to operative paragraph 19 and 97 of resolution GC(65)/RES/8.

experts from governments, industry, academia and civil society also examined nuclear law in the context of current and emerging peaceful applications of nuclear science and technology, with a view to identifying areas for possible further development. The IAEA published a book “Nuclear Law: The Global Debate” accessible for free download; and signed cooperation agreements with six academic institutions from the Middle East, Africa and Latin America to increase education and professional development opportunities for students and aspiring professionals in the field of nuclear law.⁶

8. The Agency held a Meeting of the Steering Committee of the Regulatory Cooperation Forum and Support Meeting with the European Commission in Vienna in June 2022 to review the status of regulatory infrastructure development in countries receiving support from the Regulatory Cooperation Forum (RCF) to foster the exchange of experiences. The Agency held a Task Force Meeting of the RCF in Vienna in February 2022 to monitor and evaluate the implementation of the RCF Strategic Plan and related activities. The Agency also held a virtual Regulatory Cooperation Forum Meeting on National Regulatory Infrastructure Development in November–December 2021 to share good practices and experiences related to the development of regulatory infrastructure for nuclear power.⁷

9. In December 2021, the Agency held a virtual Training Workshop on the Assessment of the National Nuclear Infrastructure to Support a New Research Reactor Project. It provided participants with practical information on the Agency-developed methodology for evaluating the status of development of national nuclear infrastructure in support of a new research reactor project, and to train participants in the application of the methodology.⁸

10. In collaboration with the Federal Authority for Nuclear Regulation of the United Arab Emirates, the Agency held an interregional workshop in Abu Dhabi in November 2021 on the roles and responsibilities of regulatory bodies during the development, construction and operation of a nuclear power plant (NPP). Issues related to human resources development, the global nuclear safety regime, developing and implementing the licensing process, and regulatory inspection were also addressed.⁹

11. The Agency developed guidance for the conduct of an expert mission to embarking countries in Phase 2 as defined in *Establishing the Safety Infrastructure for a Nuclear Power Programme* (IAEA Safety Standards Series No. SSG-16 (Rev. 1)) as an alternative to an Integrated Regulatory Review Service (IRRS) mission under the assumption that an IRRS mission will take place in Phase 3.¹⁰

12. In November 2021, the Agency organized the International Conference on a Decade of Progress After Fukushima-Daiichi: Building on the Lessons Learned to Further Strengthen Nuclear Safety, in Vienna. The conference focused on lessons learned, experiences shared, results, and achievements from actions undertaken by national, regional and international communities following the accident, as well as identifying ways to further strengthen nuclear safety.¹¹

13. The Agency held two virtual meetings of the International Nuclear Safety Group (INSAG), in October 2021 and March 2022, to discuss current and emerging nuclear safety issues of interest to the

⁶ This relates to operative paragraphs 19 and 97 of resolution GC(65)/RES/8.

⁷ This relates to operative paragraphs 2 and 25 of resolution GC(65)/RES/8.

⁸ This relates to operative paragraphs 3, 7 and 49 of resolution GC(65)/RES/8.

⁹ This relates to operative paragraphs 3 and 97 of resolution GC(65)/RES/8.

¹⁰ This relates to operative paragraphs 3 and 46 of resolution GC(65)/RES/8.

¹¹ This relates to operative paragraphs 1 and 4 of resolution GC(65)/RES/8.

nuclear community and the public. Furthermore, a draft publication on the safety and security interface was developed jointly by INSAG and the Advisory Group on Nuclear Security.¹²

14. The Agency held three workshops on safety culture self-assessment (SCSA) for regulatory bodies, in Amman in September 2021 and virtually for Belarus in August 2021 and Türkiye in June 2022 to identify key success factors for implementing a safety culture programme and to enhance regulatory bodies' understanding of elements involved in systematically working with safety culture.¹³

15. A virtual regional training course on SCSA for regulatory bodies for radiation safety for the Europe region was conducted by the Agency in January 2022 to help regulatory bodies comprehend and implement the methodologies for conducting SCSAs.¹⁴

16. The Agency held the 17th Meeting of the Steering Committee of the Global Nuclear Safety and Security Network virtually in December 2021 and the 18th Meeting in Vienna in June 2022 to review the Network's action plan and its implementation, and to provide a platform for members of the Network to share information.¹⁵

17. In October 2021, the Agency held the Fifth Global Nuclear Safety and Security Communication Network Steering Committee Meeting virtually to review the outcomes of the Network's 2021 activities as well as to discuss and approve the 2022 work plan. In addition, the Agency conducted a six-part webinar series from March to September 2021 with a focus on improving Member States' capacities to communicate more effectively with interested parties during normal operation.¹⁶

18. The seventh and eighth meetings of the Steering Committee of the European and Central Asian Safety Network (EuCAS Network) were held virtually in July 2021 and January 2022 to review the progress of the Network's activities and to plan and discuss the 2022 work plan. The Agency also held the 17th and 18th meetings of the Steering Committee of the Forum of Nuclear Regulatory Bodies in Africa virtually in December 2021 and June 2022 to review, develop and approve work plans for 2022, as well as to review the status of radiation and nuclear safety infrastructure in member countries. Additionally, the Agency held the 31st Meeting of the Steering Committee of the Asian Nuclear Safety Network virtually in December 2021 to review the progress of its activities.¹⁷

19. The Agency participated in the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO) Steering Committee meetings held virtually in July 2021 and in Santiago de Chile in April 2022. In addition, over 15 virtual meetings were held under the FORO extrabudgetary programme. The topics covered included: safety culture in industrial radiography facilities; periodic verification and maintenance of reusable packaging for the transport of radioactive material not subject to design approval; harmonization of inspection practices for research reactors; licensing criteria and inspection requirements for centralized radiopharmacies; regulatory practices in the licensing of nuclear reactor operators; and improvement of the FORO web-based information technology platform. FORO approved its Action Plan for 2021–2023 and a new project on security during the transport of radioactive material at its annual plenary meeting in July 2021. Additionally, a joint IAEA–FORO publication on safety

¹² This relates to operative paragraph 6 of resolution GC(65)/RES/8.

¹³ This relates to operative paragraphs 5 and 12 of resolution GC(65)/RES/8.

¹⁴ This relates to operative paragraphs 5 and 12 of resolution GC(65)/RES/8.

¹⁵ This relates to operative paragraphs 8 and 99 of resolution GC(65)/RES/8.

¹⁶ This relates to operative paragraphs 8 and 99 of resolution GC(65)/RES/8.

¹⁷ This relates to operative paragraphs 8 and 99 of resolution GC(65)/RES/8.

culture in organizations, facilities and activities with sources of ionizing radiation (IAEA TECDOC No. 1995) was issued in Spanish in April 2022.¹⁸

20. The Agency participated in a virtual meeting of the European Nuclear Safety Regulators Group (ENSREG) in November 2021. Moreover, the Agency participated in two virtual meetings of the ENSREG Working Group 1, in September 2021 and February 2022, to exchange information in the area of nuclear safety and, specifically, on the conduct of IRRS missions.¹⁹

B. Conventions, Regulatory Frameworks and Supporting Non-Legally Binding Instruments



Representatives at the Second Meeting of the Contracting Parties and Signatories to the Convention on Supplementary Compensation for Nuclear Damage in Vienna in May–June 2022

21. The Agency continued to encourage Member States, especially those planning, constructing, commissioning or operating NPPs, or considering a nuclear power programme, to become Contracting Parties to the CNS. This was done through discussions with Member States' representatives during Agency conferences, meetings, peer review missions and visits of the Director General to Member States, as well as through technical cooperation projects. During the reporting period, there were no new Contracting Parties to the CNS. The Agency held an Organizational Meeting for the Joint Eighth and Ninth Review Meeting of the Contracting Parties to the Convention on Nuclear Safety in Vienna in

¹⁸ This relates to operative paragraphs 5 and 9 of resolution GC(65)/RES/8.

¹⁹ This relates to operative paragraph 9 of resolution GC(65)/RES/8.

October 2021 to confirm, inter alia, the Officers for the Joint review meeting, the composition of Country Groups and to consider any other matters relevant to the implementation of the Convention.²⁰

22. The Agency held a hybrid Regional Workshop on the Preparation of National Reports under the Convention on Nuclear Safety for countries in the Africa region in November 2021 and a hybrid Educational Workshop on the Convention on Nuclear Safety in May 2022 to provide participants with guidelines on the identification of the main articles of the CNS to be reported on and the drafting of National Reports.²¹

23. The Agency continued to encourage its Member States to become Contracting Parties to the Joint Convention and to participate actively in the peer review process and contribute to the effectiveness of that process. During the reporting period, 4 Member States became new Contracting Parties to the Joint Convention, bringing the total number of Contracting Parties to 88.²²

24. The Fourth Extraordinary Meeting of the Contracting Parties to the Joint Convention was held in Vienna in May 2022 to discuss possible ways to improve the procedural mechanisms of the Joint Convention, taking into account the growing number of Contracting Parties and with a view to identifying and eliminating technical discrepancies between existing procedural documents of the Joint Convention.²³

25. The Agency held the Seventh Review Meeting of the Contracting Parties to the Joint Convention in Vienna in June–July 2022, to present, discuss and review National Reports, and to address the measures taken by Contracting Parties to implement the obligations of the Joint Convention.²⁴

26. In January 2022, the Agency held three virtual national training workshops, for the Syrian Arab Republic and Zimbabwe in English and for the Congo in French, to provide participants with tools and assistance for developing their first National Reports under the Joint Convention.²⁵

27. In September 2021, the Agency organized a virtual Workshop to promote the Early Notification Convention and the Assistance Convention and assist Member States with adherence to and implementation of these instruments.²⁶

28. As of 30 June 2022, 141 States had made a political commitment to implement the Code of Conduct on the Safety and Security of Radioactive Sources, of which 124 also notified the Director General of their intention to act in a harmonized manner in accordance with the Code's supplementary Guidance on the Import and Export of Radioactive Sources. A total of 146 States nominated points of contact to facilitate the export and import of radioactive sources. In addition, 45 States notified the Director General of their intention to act in a harmonized manner and in accordance with the Code's supplementary Guidance on the Management of Disused Radioactive Sources.²⁷

29. The Agency continues efforts in raising awareness of the Member States for the need and benefits of expressing political commitment to the Code and its supplementary guidance. A Technical Meeting

²⁰ This relates to operative paragraphs 17 and 19 of resolution GC(65)/RES/8.

²¹ This relates to operative paragraphs 17 and 19 of resolution GC(65)/RES/8.

²² This relates to operative paragraph 19 of resolution GC(65)/RES/8.

²³ This relates to operative paragraphs 17 and 19 of resolution GC(65)/RES/8.

²⁴ This relates to operative paragraph 17 of resolution GC(65)/RES/8.

²⁵ This relates to operative paragraph 19 of resolution GC(65)/RES/8.

²⁶ This relates to operative paragraph 19 of resolution GC(65)/RES/8.

²⁷ This relates to operative paragraphs 20 and 107 of resolution GC(65)/RES/8.

to create awareness of the need for political commitment to the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary guidance for Member States in Latin America and the Caribbean that have not yet expressed political support was held in Vienna in May 2022, to provide comprehensive information on the benefits of political commitment to the Code.²⁸

30. In November 2021, the Agency held a virtual Technical Meeting on the Safety of Research Reactors Under Project and Supply Agreements and Review of their Safety Performance Indicators to exchange information on the safety status of research reactors, discuss safety performance indicators and identify areas for operational improvements, as well as to discuss experience in applying the provisions of the Code of Conduct on the Safety of Research Reactors.²⁹

31. The Agency organized two virtual regional workshops on the application of a graded approach to regulating nuclear installations, for the Latin America region in October 2021 and for the Europe region in January 2022.³⁰

32. The First Programme Committee Meeting of the International Conference on Effective Nuclear and Radiation Regulatory Systems was held virtually in March 2022. The conference announcement was produced, and preliminary discussions were held on the structure of the scientific and technical programme for the conference, which is planned to take place in Abu Dhabi in February 2023.³¹

33. The Agency hosted a virtual Consultancy Meeting of the Technical and Scientific Support Organization Forum (TSOF): Developing Guidelines for Building and Strengthening Technical and Scientific Capabilities in March 2022 to discuss, analyse and further incorporate the necessary changes into the TSOF self-assessment methodology.³²

34. The Secretariat continued to assist Member States in their efforts to adhere to the relevant nuclear liability instruments. A virtual Workshop on Civil Liability for Nuclear Damage for ASEAN Plus Three was held in June–July 2021 as a regional outreach activity of the International Expert Group on Nuclear Liability (INLEX), with a focus on the Convention on Supplementary Compensation for Nuclear Damage (CSC). The Agency also held the Second Meeting of the Contracting Parties and Signatories to the CSC in Vienna in May–June 2022 to foster dialogue among CSC Contracting Parties and Signatories on CSC implementation matters, as well as to promote participation in the CSC worldwide.³³

35. The Secretariat continued with the preparations for the 22nd regular meeting of INLEX, which is planned to take place in September 2022 and will serve as a forum to present new developments in Member States and activities by the Secretariat in the field of civil liability for nuclear damage, as well as to discuss future outreach activities.³⁴

²⁸ This relates to operative paragraphs 20 and 107 of resolution GC(65)/RES/8.

²⁹ This relates to operative paragraphs 22 and 49 of resolution GC(65)/RES/8.

³⁰ This relates to operative paragraphs 25 and 26 of resolution GC(65)/RES/8.

³¹ This relates operative paragraph 25 of resolution GC(65)/RES/8.

³² This relates to operative paragraph 28 of resolution GC(65)/RES/8.

³³ This relates to operative paragraph 32 of resolution GC(65)/RES/8.

³⁴ This relates to operative paragraph 33 of resolution GC(65)/RES/8.

C. Agency Safety Standards



IAEA Safety Requirements on Radiation Protection Online Learning Module

36. The Commission on Safety Standards (CSS) met in Vienna in November 2021 and April 2022. The Waste Safety Standards Committee met virtually in July and October 2021, and in Vienna in June 2022. The Transport Safety Standards Committee met virtually in November 2021 and in Vienna in June 2022. The Nuclear Safety Standards Committee met virtually in July 2021 and in Vienna in November 2021 and in June 2022. The Radiation Safety Standards Committee (RASSC) met virtually in October 2021 and in Vienna in June 2022. The Emergency Preparedness and Response Standards Committee (EPRReSC) met in Vienna in December 2021 and June 2022. The Nuclear Security Guidance Committee met virtually in November 2021 and in Vienna in June 2022. The Agency used electronic means to facilitate the remote participation of Member States' representatives in these meetings.³⁵

37. The Interface Group, which gathers together the chairs of the Safety Standards Committees and the Nuclear Security Guidance Committee, reviewed 11 publication proposals for possible safety–security interfaces following a recommendation from the Secretariat's Coordination Committee on Safety Standards and Nuclear Security Series Publications.³⁶

38. The Secretariat developed and implemented an action plan that aims at clearing the backlog of safety standards awaiting publication and at finding a sustainable solution. All safety standards approved up to the 50th CSS meeting in November 2021 have now been issued or are at the last stage of editing before publication.³⁷

³⁵ This relates to operative paragraphs 36 and 38 of resolution GC(65)/RES/8.

³⁶ This relates to operative paragraphs 6 and 36 of resolution GC(65)/RES/8.

³⁷ This relates to operative paragraph 37 of resolution GC(65)/RES/8.

39. The CSS endorsed the following draft Safety Guides for submission for publication³⁸:

- *Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (DS497A)*;
- *Modifications to Nuclear Power Plants (DS497B)*; *The Operating Organization for Nuclear Power Plants (DS497C)*;
- *Core Management and Fuel Handling for Nuclear Power Plants (DS497D)*;
- *Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants (DS497E)*;
- *Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (DS497F)*;
- *Conduct of Operations at Nuclear Power Plants (DS497G)*;
- *Protection Against Internal and External Hazards in the Operation of Nuclear Power Plants (DS503)*;
- *Compliance Assurance for the Safe Transport of Radioactive Material (DS515)*;
- *Criticality Safety in the Handling of Fissile Material (DS516)*;
- *Commissioning of Research Reactors (DS509A)*;
- *Maintenance, Periodic Testing and Inspection of Research Reactors (DS509B)*;
- *Core Management and Fuel Handling for Research Reactors (DS509C)*;
- *Operational Limits and Conditions and Operating Procedures for Research Reactors (DS509D)*;
- *The Operating Organization and the Recruitment, Training and Qualification of Personnel for Research Reactors (DS509E)*;
- *Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors (DS509F)*;
- *Ageing Management for Research Reactors (DS509G)*;
- *Instrumentation and Control Systems and Software Important to Safety for Research Reactors (DS509H)*;
- *Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors (DS511)*;
- *Safety of Conversion Facilities and Uranium Enrichment Facilities (DS517A)*;
- *Safety of Uranium Fuel Fabrication Facilities (DS517B)*;
- *Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities (DS517C)*; and
- *Human Induced External Hazards in Site Evaluation for Nuclear Installations (DS520)*.

³⁸ This relates to operative paragraph 39 of resolution GC(65)/RES/8.

40. The Agency published two General Safety Guides and 12 Specific Safety Guides³⁹:

- *Remediation Strategy and Process for Areas Affected by Past Activities or Events* (IAEA Safety Standards Series No. GSG-15);
- *Leadership, Management and Culture for Safety in Radioactive Waste Management* (IAEA Safety Standards Series No. GSG-16);
- *Seismic Hazards in Site Evaluation for Nuclear Installations* (IAEA Safety Standards Series No. SSG-9 (Rev. 1));
- *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2018 Edition)* (IAEA Safety Standards Series No. SSG-26 (Rev. 1));
- *Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2018 Edition)* (IAEA Safety Standards Series No. SSG-33 (Rev. 1));
- *Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities* (IAEA Safety Standards Series No. SSG-60);
- *Format and Content of the Safety Analysis Report for Nuclear Power Plants* (IAEA Safety Standards Series No. SSG-61);
- *Protection against Internal Hazards in the Design of Nuclear Power Plants* (IAEA Safety Standards Series No. SSG-64);
- *Preparedness and Response for a Nuclear or Radiological Emergency Involving the Transport of Radioactive Material* (IAEA Safety Standards Series No. SSG-65);
- *Format and Content of the Package Design Safety Report for the Transport of Radioactive Material* (IAEA Safety Standards Series No. SSG-66);
- *Seismic Design for Nuclear Installations* (IAEA Safety Standards Series No. SSG-67);
- *Design of Nuclear Installations Against External Events Excluding Earthquakes* (IAEA Safety Standards Series No. SSG-68);
- *Equipment Qualification for Nuclear Installations* (IAEA Safety Standards Series No. SSG-69);and
- *Protection Against Internal and External Hazards in the Operation of Nuclear Power Plants* (IAEA Safety Standards Series No. SSG-77).

41. The Agency included all new safety standards and nuclear security guidance publications in the Nuclear Safety and Security Online User Interface (NSS-OUI) platform. The NSS-OUI platform was used to develop a strategic plan for the revision of Safety Guides on the safety of nuclear fuel cycle facilities.⁴⁰

42. The Agency continued to attend meetings of committees of the International Commission on Radiological Protection (ICRP) and participated in several ICRP task groups on specific topics. The Agency continued its cooperation with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), focusing in particular on the UNSCEAR project to assess radiation exposure of the public, and provided support for the preparation of a draft report on the evaluation of

³⁹ This relates to operative paragraph 40 of resolution GC(65)/RES/8.

⁴⁰ This relates to operative paragraph 40 of resolution GC(65)/RES/8.

occupational exposure to ionizing radiation. Moreover, as recommended by the CSS, the Secretariat continued the preparation of a draft Safety Report on the implications of the 2012 UNSCEAR report to the General Assembly and its Annexes on attribution of health effects and inference of risk. UNSCEAR continued to participate as an observer in the review committees, including RASSC, EPRSC and the CSS.⁴¹

D. Self-Assessments and the Agency's Peer Review and Advisory Services



*Experts at the OSART mission review in Kalinin Nuclear Power Plant in the Russian Federation in 2021
(Photo: Kalinin NPP)*

43. The Agency conducted four IRRS missions, to Denmark in August–September 2021, Switzerland in October 2021, Portugal in February–March 2022 and Slovenia in April 2022. Five IRRS follow-up missions were conducted, to Cameroon in November 2021, Belarus in December 2021, Pakistan in February–March 2022, Zimbabwe in May 2022 and India in June 2022. The Agency held a series of virtual national workshops on IRRS missions and self-assessments, based on the Self-Assessment of Regulatory Infrastructure for Safety methodology, the Integrated Review of Infrastructure for Safety methodology and the new online self-assessment tool, for Bosnia and Herzegovina in November 2021, India in February 2022, Poland in March 2022 and the Czech Republic in May 2022. A webinar on IRRS missions was organized by the Agency for the Europe and Central Asia region in November 2021

⁴¹ This relates to operative paragraph 41 of resolution GC(65)/RES/8.

to provide background information on the IRRS process, to present the benefits of IRRS missions and to encourage EuCAS Network Member States to invite such missions.⁴²

44. Seven Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) missions were conducted by the Agency: in Ireland in October 2021; Hungary and Romania in March 2022; and Cyprus, Denmark, Lithuania and Slovenia in May 2022. The Agency also held a webinar on ARTEMIS missions for the Europe and Central Asia region in November 2021, to provide background information on the ARTEMIS process and encourage EuCAS Network Member States to invite such missions.⁴³

45. The Agency developed guidance on how to conduct IRRS–ARTEMIS missions in a back-to-back manner, and this guidance was used for the first time in an IRRS mission to Slovenia in April 2022 followed by an ARTEMIS mission in May 2022.⁴⁴

46. Three Operational Safety Review Team (OSART) missions were conducted by the Agency in France in September–October 2021 and November–December 2021, and in the Russian Federation in November 2021. Six OSART follow-up missions were also conducted, in Slovakia in September 2021, Belarus in October 2021, the Russian Federation in October 2021, France in December 2021 and May 2022, and the Islamic Republic of Iran in June 2022.⁴⁵

47. The Agency held four Safety Aspects of Long Term Operation (SALTO) missions, in Spain and Bulgaria in July 2021, Slovenia in October 2021 and South Africa in March 2022. Five SALTO follow-up missions were conducted, in Armenia and Sweden in October 2021, Argentina in November 2021, and Brazil and Mexico in June 2022.⁴⁶

48. The Agency conducted one Integrated Safety Assessment of Research Reactors (INSARR) mission in the Netherlands in September 2021, and a safety review mission on ageing management and continued safe operation in the Netherlands in June 2022.⁴⁷

49. Two Integrated Nuclear Infrastructure Review (INIR) Phase 1 missions were organized by the Agency: to Uganda in November–December 2021 and to Sri Lanka in April 2022. The Agency also held an Integrated Nuclear Infrastructure Review for Research Reactors mission in Thailand in December 2021 to assess the national nuclear infrastructure for new research reactor projects.⁴⁸

50. The Agency held a Site and External Events Design (SEED) mission in Uzbekistan in August 2021 and two SEED missions to two NPPs in Czech Republic in May 2022.⁴⁹

51. The Agency completed the Technical Safety Review (TSR) of the preliminary safety analysis report and the TSR of the probabilistic safety assessment report for the Paks II NPP project in Hungary in September 2021. The Agency also conducted a TSR of the periodic safety review documentation for Koeberg NPP in South Africa in October 2021– May 2022.⁵⁰

⁴² This relates to operative paragraphs 8, 43, 44, 45 and 46 of resolution GC(65)/RES/8.

⁴³ This relates to operative paragraphs 8, 43, 44, 45 and 46 of resolution GC(65)/RES/8.

⁴⁴ This relates to operative paragraphs 43, 44 and 46 of resolution GC(65)/RES/8.

⁴⁵ This relates to operative paragraphs 43, 44 and 45 of resolution GC(65)/RES/8.

⁴⁶ This relates to operative paragraphs 43 and 44 of resolution GC(65)/RES/8.

⁴⁷ This relates to operative paragraphs 43 and 44 of resolution GC(65)/RES/8.

⁴⁸ This relates to operative paragraph 3, 7, 43 and 44 of resolution GC(65)/RES/8.

⁴⁹ This relates to operative paragraphs 12, 43 and 44 of resolution GC(65)/RES/8.

⁵⁰ This relates to operative paragraphs 43 and 44 of resolution GC(65)/RES/8.

52. In March 2022, the Agency hosted a webinar on the implementation and enhancement of its TSR service to present the experiences and lessons learned from the implementation of TSRs and to provide a forum for information exchange among Member States.⁵¹

53. The Agency conducted a virtual Safety Culture Continuous Improvement Process (SCCIP) mission in Mexico in September 2021.⁵²

54. A virtual Technical Meeting on the Assessment and Evaluation of the Occupational Radiation Protection Appraisal Service was held in September 2021, where participants discussed lessons learned and shared best practices and strategies used in ORPAS missions.⁵³

55. In October 2021, the Agency held the first phase of an Education and Training Appraisal (EduTA) mission virtually for Nigeria, to begin assessing education and training in radiation safety.⁵⁴

56. The Agency conducted the two first Advisory Missions on Regulatory Infrastructure for Radiation Safety and Security of Radioactive Material (RISS), in the Democratic Republic of the Congo in March–April 2022 and in Seychelles in May 2022. The missions aimed at providing support in the countries' efforts to establish or improve national regulatory infrastructure for radiation safety and security of radioactive material, and to comply with the provisions of the Agency's safety standards and nuclear security guidance, as well as with the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary guidance.⁵⁵

57. A hybrid Technical Meeting on Peer Review and Advisory Services in Nuclear Safety and Security was held in May 2022 to continue assessing and strengthening the overall structure, effectiveness and efficiency of peer review and advisory services.⁵⁶

58. The Agency continued to cooperate with the World Health Organization (WHO) within the framework of the Inter-Agency Committee on Radiological and Nuclear Emergencies in areas of joint interest, in line with the Joint Radiation Emergency Management Plan of the International Organizations and on EPR Standards in the area of developing and implementing safety standards in EPR. This includes collaboration between Emergency Preparedness Review (EPREV) and WHO Joint External Evaluation stakeholders to ensure coordinated assessment of relevant national arrangements against respective standards that are co-sponsored by the Agency and the WHO.⁵⁷

⁵¹ This relates to operative paragraphs 44 and 45 of resolution GC(65)/RES/8.

⁵² This relates to operative paragraphs 5, 43 and 44 of resolution GC(65)/RES/8.

⁵³ This relates to operative paragraphs 44 and 45 of resolution GC(65)/RES/8.

⁵⁴ This relates to operative paragraphs 43 and 44 of resolution GC(65)/RES/8.

⁵⁵ This relates to operative paragraphs 43, 44 and 107 of resolution GC(65)/RES/8.

⁵⁶ This relates to operative paragraphs 44, 45 and 46 of resolution GC(65)/RES/8.

⁵⁷ This relates to operative paragraphs 47 and 124 of resolution GC(65)/RES/8.

E. Nuclear Installation Safety



Nuclear power plant in Flamanville, France (Photo: A. Morin/ EDF)

59. The Agency hosted the Ninth Annual Meeting of the Regional Advisory Safety Committee for Research Reactors and the Workshop on Managing the Interface Between Nuclear Safety and Security for Research Reactors in Asia and the Pacific virtually in October 2021 and June 2022, to share knowledge and experiences related to research reactor safety. The Agency held a workshop on Self-assessment of Research Reactor Safety in May 2022 to assist Member States to build capacity of performing self-assessment against application of the IAEA safety standards.⁵⁸

60. In March 2021, the Agency held a virtual Technical Meeting on the Use of Periodic Safety Reviews for Long Term Operation of Nuclear Power Plants to discuss the results of SALTO reviews performed between 2016 and 2020, and to collect Member States' suggestions and lessons learned for the improvement of the SALTO peer review programme.⁵⁹

61. The Agency held a meeting of Working Group 4 on Regulatory Experience of International Generic Ageing Lessons Learned (IGALL) Phase 6 in Vienna in May 2022. The following IGALL Phase 5 virtual meetings were also held: a Steering Committee meeting in December 2021; meetings on updated ageing management programmes for Paks NPP in August, September and October 2021; and a meeting of Working Group 2 on Electrical and Instrumentation and Control Components in August 2021.⁶⁰

62. In July 2021, the Agency organized a virtual Technical Meeting on the Use of a Graded Approach in the Application of the Safety Requirements for Fuel Cycle Facilities. The Agency also held a virtual

⁵⁸ This relates to operative paragraphs 6, 8 and 49 of resolution GC(65)/RES/8.

⁵⁹ This relates to operative paragraphs 51 and 53 of resolution GC(65)/RES/8.

⁶⁰ This relates to operative paragraph 52 of resolution GC(65)/RES/8.

Technical Meeting on Ageing Management and Life Extension of Nuclear Fuel Cycle Facilities in December 2021 to support Member States based on the operating experience feedback received, as well as to update the Nuclear Fuel Cycle Facilities Database. A Technical Meeting on Periodic Safety Review of Nuclear Fuel Cycle Facilities was also held in June 2022 to assist Member States to plan and implement safety reviews at these facilities.⁶¹

63. A Technical Meeting on Experiences in Using Probabilistic Safety Assessment in the Design of Nuclear Power Plants was held in Vienna in April 2022, to share experiences in the development of probabilistic safety assessment (PSA) models that could be instrumental in supporting the use of PSA for justification and optimization of design safety for innovative technologies, including those used for small modular reactors (SMRs).⁶²

64. The Agency published *Level 1 Probabilistic Safety Assessment Practices for Nuclear Power Plants with CANDU-Type Reactors* (IAEA TECDOC No. 1977) in September 2021. The Agency held a virtual Technical Meeting on CANDU Probabilistic Safety Assessment in October 2021 to facilitate cooperation and information exchange among the members of the CANDU Probabilistic Safety Assessment Working Group. The Agency also held a virtual meeting of the CANDU Senior Regulators Group in November 2021 to share lessons learned from recent events as well as regulatory and operating experience in CANDU type reactors.⁶³

65. In October 2021, the Agency held a Technical Meeting on Protection of Nuclear Installations Against External Hazards virtually to review the progress of the extrabudgetary programme activities supporting the development and implementation of the relevant safety standards. The Agency also held a hybrid Technical Meeting on the Investigation of Site Characteristics and Assessments of Radiological Environmental Impact for Nuclear Installations and a virtual Technical Meeting on Benchmarking of Current Practices in Probabilistic Fault Displacement Hazard Assessment for Nuclear Installations in November 2021.⁶⁴

66. The Agency published *An Introduction to Probabilistic Fault Displacement Hazard Analysis in Site Evaluation for Existing Nuclear Installations* (IAEA-TECDOC-1987) in November 2021, and *Methodologies for Seismic Soil-Structure Interaction Analysis in the Design and Assessment of Nuclear Installations* (IAEA-TECDOC-1990) and *Benchmark Analysis of Numerical Codes for Tsunami Simulation* (IAEA-TECDOC-1973) in February 2022.⁶⁵

67. The Agency hosted the Fourth Research Coordination Meeting on Probabilistic Safety Analysis Benchmark for Multi-Unit, Multi-Reactor Sites virtually in November 2021 to review the research and development activities related to the associated coordinated research project (CRP) at each participating institute; to discuss completion of CRP tasks, complete the benchmark analyses and accordingly draft the related IAEA Technical Document (TECDOC) content; to discuss the development of training materials relevant to the CRP scope; and to discuss follow-up activities.⁶⁶

68. A Technical Meeting on Upgrades to Digital Instrumentation and Control Systems for Research Reactors was held in Vienna in August 2021 to exchange information and experiences related to the

⁶¹ This relates to operative paragraphs 51 and 52 of resolution GC(65)/RES/8.

⁶² This relates to operative paragraph 53 of resolution GC(65)/RES/8.

⁶³ This relates to operative paragraph 53 of resolution GC(65)/RES/8.

⁶⁴ This relates to operative paragraph 54 of resolution GC(65)/RES/8.

⁶⁵ This relates to operative paragraph 54 of resolution GC(65)/RES/8.

⁶⁶ This relates to operative paragraph 55 of resolution GC(65)/RES/8.

technical and managerial aspects of research reactor projects (both modernization projects and projects for the design and construction of new facilities) involving digital instrumentation and control systems.⁶⁷

69. The Agency organized the First Research Coordination Meeting on Developing a Phenomena Identification and Ranking Table (PIRT) and a Validation Matrix, and Performing a Benchmark for In-Vessel Melt Retention virtually in December 2021.⁶⁸

70. A virtual Training Workshop on the Development of Severe Accident Management Guidelines Using the IAEA's Severe Accident Management Guideline Development Toolkit was held in December 2021.⁶⁹

71. The Incident Reporting System for Research Reactors and the Fuel Incident Notification and Analysis System (FINAS) continued to facilitate the exchange of information on nuclear incidents and accidents in Member States. In 2021, the number of reports submitted to FINAS increased by 3, bringing the total number of reports to 296. About 90% of the world's nuclear fuel cycle facilities are currently part of the system. The Agency held a virtual a Technical Meeting for the National Coordinators of FINAS in September 2021 to exchange information and lessons learned from safety significant events at research reactors and to identify actions to enhance the effectiveness of FINAS.⁷⁰

72. The Agency held a virtual Technical Meeting of International Reporting System for Operating Experience National Coordinators on Recent Events in Nuclear Power Plants in October 2021 to share lessons learned from operating experience at NPPs and to exchange information on recent safety significant events at NPPs.⁷¹

73. Virtual meetings of the SMR Regulators' Forum Steering Committee and Working Group were held in November 2021 and April 2022 to provide an opportunity for the members to receive reports from, and provide guidance to, the Forum's Working Groups, as well as to discuss strategic and administrative issues.⁷²

74. In October 2021, the Agency held a Technical Meeting on Next Generation Reactors and Emergency Preparedness and Response to discuss Member State perspectives on hazard assessment methodologies and adequate EPR arrangements for next generation reactors, including SMRs; to provide an update on the deployment of such reactors; to share advances in research; and to discuss additional EPR considerations.⁷³

75. To update Member States' regulatory bodies on challenges identified by the SMR Regulators' Forum in regulating SMRs and to inform them of any necessary changes needed to their regulatory requirements and practices, the Agency organized an Educational Workshop on Regulatory Challenges in Small Modular Reactors, in Amman in December 2021.⁷⁴

76. The Agency hosted a virtual Technical Meeting on the Licensing of Advanced Nuclear Fuels for Water Cooled Reactors in October 2021, where Member States shared their national practices in the

⁶⁷ This relates to operative paragraphs 3 and 57 of resolution GC(65)/RES/8.

⁶⁸ This relates to operative paragraphs 58 and 109 of resolution GC(65)/RES/8.

⁶⁹ This relates to operative paragraph 60 of resolution GC(65)/RES/8.

⁷⁰ This relates to operative paragraph 61 of resolution GC(65)/RES/8.

⁷¹ This relates to operative paragraph 61 of resolution GC(65)/RES/8.

⁷² This relates to operative paragraph 62 of resolution GC(65)/RES/8.

⁷³ This relates to operative paragraphs 62 and 112 of resolution GC(65)/RES/8.

⁷⁴ This relates to operative paragraph 62 of resolution GC(65)/RES/8.

licensing (or in the preparatory steps prior to licensing) of advanced nuclear fuels for water cooled reactors. The Agency also held a hybrid Technical Meeting on the Safety of High Temperature Gas Cooled Reactors (HTGRs) and Molten Salt Reactors (MSRs) in May 2022, to discuss challenges related to the safety approach in the design and the safety analysis of HTGRs and MSRs, exchange perspectives on the design safety with the Generation IV International Forum (GIF) and establish a mechanism for coordinating the work of IAEA and GIF in this area.⁷⁵

77. The Agency held a virtual Research Coordination Meeting on the CRP “Development of Approaches, Methodologies and Criteria for Determining the Technical Basis for Emergency Planning Zone for SMR Deployment” in July 2021.⁷⁶

F. Radiation Safety and Environmental Protection



A patient undergoing a PET/CT scan (Photo: L. Dojcanova/IAEA)

78. A national workshop on the implementation of *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (IAEA Safety Standards Series No. GSR Part 3) was conducted by the Agency in Yaoundé in November 2021 to present and discuss the requirements of GSR Part 3 and its implementation in national regulations and industrial practices.⁷⁷

79. In August 2021, the Agency held a virtual national workshop on GSR Part 3 for Thailand in to introduce GSR Part 3 requirements and address specific areas of national interest, such as occupational, public and medical exposure. The Agency also held a virtual national workshop on GSR Part 3 for Mongolia in November 2021 to explain the requirements of GSR Part 3 with regard to addressing

⁷⁵ This relates to operative paragraph 62 of resolution GC(65)/RES/8.

⁷⁶ This relates to operative paragraphs 62, 109 and 112 of resolution GC(65)/RES/8.

⁷⁷ This relates to operative paragraph 63 of resolution GC(65)/RES/8.

existing exposure situations, with a focus on radon and naturally occurring radioactive material (NORM).⁷⁸

80. The Agency continued to support the Information System on Occupational Exposure (ISOE), jointly operated by the Agency and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD). Moreover, participants from the IAEA ISOE Technical Centre attended the virtual ISOE Management Board Meeting and a workshop organized by the ISOE Asian Technical Centre in December 2021.⁷⁹

81. The Agency held a virtual Technical Meeting on the Establishment of a Web-based Information Exchange Platform for Occupational Radiation Protection in Industries Involving Naturally Occurring Radioactive Material in November 2021. The Agency also conducted a global survey on the Information System on Occupational Exposure in Medicine, Industry and Research — Industrial Radiography (ISEMIR-IR) and received responses from 284 non-destructive testing companies from 42 Member States and 46 regulatory authorities from 43 Member States. Survey results were published on the ISEMIR web page in November 2021.⁸⁰

82. The Agency developed the Internal Dosimetric Analyser software tool to perform individual dose assessments using the latest dosimetric data obtained from the ICRP's *Occupational Intakes of Radionuclides* series of publications. The tool was presented at the International Conference on Individual Monitoring of Ionising Radiation in Krakow, Poland in April 2022.⁸¹

83. In June 2022, the Agency hosted the Annual Meeting of the Regulatory Forum for Safety of Uranium Production and Naturally Occurring Radioactive Materials virtually to review the progress made in activities identified as 'high priority' at the 2021 Annual Meeting.⁸²

84. The Agency, in association with the Radiation Protection Symposium North-West Europe, organized the Tenth International Symposium on Naturally Occurring Radioactive Material in Utrecht, the Netherlands in May 2022 to provide a forum for the industrial, technical and scientific communities as well as regulatory bodies involved in the management of NORM to disseminate scientific information, research and knowledge with a focus on the use of residues from industrial operations involving NORM.⁸³

85. Four virtual Interregional Workshops for Radiation Safety Information Management System Coordinators were conducted by the Agency, in October and November 2021 and March and April 2022, to assist Radiation Safety Information Management System (RASIMS) national coordinators in providing information on radiation safety infrastructures using the RASIMS 2 platform.⁸⁴

86. In March 2022, the Agency hosted a virtual Technical Meeting on Radiation Protection in Fluoroscopically Guided Interventional Procedures to review existing guidance and resources for the prevention and management of unintended medical exposures in fluoroscopically guided interventional

⁷⁸ This relates to operative paragraphs 63 and 67 of resolution GC(65)/RES/8.

⁷⁹ This relates to operative paragraph 64 of resolution GC(65)/RES/8.

⁸⁰ This relates to operative paragraph 65 of resolution GC(65)/RES/8.

⁸¹ This relates to operative paragraph 66 of resolution GC(65)/RES/8.

⁸² This relates to operative paragraphs 67 and 93 of resolution GC(65)/RES/8.

⁸³ This relates to operative paragraph 67 of resolution GC(65)/RES/8.

⁸⁴ This relates to operative paragraph 68 of resolution GC(65)/RES/8.

procedures; to evaluate the status of the Safety in Radiological Procedures reporting system; to identify any need for development; and to review new aspects of occupational radiation protection in this area.⁸⁵

87. The Agency, in collaboration with the International Labour Organization, published *Assessment of Prospective Cancer Risks from Occupational Exposure to Ionizing Radiation* (IAEA TECDOC No. 1985) in November 2021.⁸⁶

88. A Regional Training Course on the Authorization and Inspection of Radiation Safety and Nuclear Security for Medical Practices for the Latin America and the Caribbean region was held in Montevideo in March 2022, where participants enhanced their skills in the review, assessment, authorization and enforcement of the safety and nuclear security of radioactive material.⁸⁷

89. The Agency held a virtual Technical Meeting on Strengthening Safety in Radiotherapy in July 2021 to review the effectiveness of incident learning systems in radiotherapy and identify opportunities to improve these systems.⁸⁸

90. In December 2021, the Agency held a National Workshop on Justification of Application and Radiation Safety of Non-Medical Human Imaging and Inspection Devices in Bucharest. The Agency also coordinated the development of a document on non-medical human imaging prepared by the Inter-Agency Committee on Radiation Safety.⁸⁹

91. A Technical Meeting on Establishing Efficient Regulatory Control for Protection Against Radon in Workplaces was hosted by the Agency in Vienna in April 2022 to discuss protection against radon in mixed exposure situations and sources, enforcement of regulatory control and other aspects identified during the preparation of the draft Safety Guide provisionally entitled *Protection of Workers Against Exposure due to Radon*.⁹⁰

92. The Agency held a virtual Technical Meeting on Radionuclides in Food and Drinking Water in Non-emergency Situations in September 2021 to discuss the management of natural and human-made radionuclides in food and drinking water with a view to developing a harmonized management approach. The Agency held the sixth meeting of the International Steering Group for the project “Radionuclides in Food and Drinking Water in Non-Emergency Situations” virtually in March 2022. As a result of this project starting in 2018 two publications were developed in collaboration with the Food and Agriculture Organization of the United Nations and the WHO and approved for publication, namely *Exposure due to Radionuclides in Food Other than During a Nuclear or Radiological Emergency. Part 1: Technical Material* (Safety Reports Series No. 114) and the TECDOC *Exposure due to Radionuclides in Food Other than During a Nuclear or Radiological Emergency Part 2: Considerations in Implementing Requirement 51 of IAEA General Safety Requirements Part 3 (International Basic Safety Standards)*. Moreover, an information document for the food safety regulatory community was jointly prepared by the three organizations and presented to the Codex Committee on Contaminants in Food in May 2022.⁹¹

⁸⁵ This relates to operative paragraph 69 of resolution GC(65)/RES/8.

⁸⁶ This relates to operative paragraph 69 of resolution GC(65)/RES/8.

⁸⁷ This relates to operative paragraph 69 of resolution GC(65)/RES/8.

⁸⁸ This relates to operative paragraphs 69 and 70 of resolution GC(65)/RES/8.

⁸⁹ This relates to operative paragraph 71 of resolution GC(65)/RES/8.

⁹⁰ This relates to operative paragraph 72 of resolution GC(65)/RES/8.

⁹¹ This relates to operative paragraphs 73 and 75 of resolution GC(65)/RES/8.

93. The Agency developed and approved for publication a safety report on construction and building materials *Regulatory Control of Exposure Due to Radionuclides in Building Materials and Construction Materials* (Safety Reports Series No. 117). The Agency also held a virtual Consultancy Meeting on a draft Safety Report on the application of radiological criteria for international trade of non-food commodities containing radionuclides in October 2021 to review the draft to include more practical and technical information that would be useful for trade purposes, to review international practices that could be considered in developing the report and to identify other technical areas that need further work.⁹²

94. The Agency also organized a virtual Consultancy Meeting to identify issues related to radiation safety in international trade of commodities in November 2021 in order to discuss national experiences in radiation safety in trade of commodities; identify regulatory challenges related to contamination of artificial and natural radionuclides in commodities; and advise the Secretariat on the work plan for developing guidance in a proposed Safety Report on this topic.⁹³

95. The publication *Inventory of Radioactive Material Resulting from Historical Dumping, Accidents and Losses at Sea — For the Purposes of the London Convention 1972 and London Protocol 1996* (IAEA TECDOC No. 1776) was most recently updated in 2015. The Agency communicates with the secretariat of the related Convention at the International Maritime Organization and updates the inventory when requested to do so.⁹⁴

⁹² This relates to operative paragraphs 74 and 75 of resolution GC(65)/RES/8.

⁹³ This relates to operative paragraph 74 of resolution GC(65)/RES/8.

⁹⁴ This relates to operative paragraph 76 of resolution GC(65)/RES/8.

G. Transport Safety



International Conference on the Safe and Secure Transport of Nuclear and Radioactive Materials in December 2021 (Photo: A. Tarhi)

96. The Agency continued its efforts to identify and address the issues related to denial of shipment of radioactive material. As a result of the establishment of a Denial of Shipment Working Group (DoS WG) comprising interested Member States and other stakeholders, the Agency held a Technical Meeting on the Development of the Terms of Reference for the Denial of Shipment Working Group virtually in August 2021, where participants discussed the situations that lead to the problem of delay or denial of shipment and developed draft Terms of Reference for the DoS WG to guide its future activities.⁹⁵

97. In December 2021, the Agency organized the virtual International Conference on the Safe and Secure Transport of Nuclear and Radioactive Materials. The conference increased Member States' awareness of the importance of effectively managing the interface between transport safety and transport security. The sessions and discussions during the conference informed the Agency of the potential needs of Member States in this area, which will assist in the planning of future programmes.⁹⁶

98. The Agency launched Version 2.0 of Modules 0–4 of the transport safety e-learning platform in Chinese to reflect *Regulations for the Safe Transport of Radioactive Material* (IAEA Safety Standards Series No. SSR-6 (Rev. 1)) in October 2021.⁹⁷

⁹⁵ This relates to operative paragraphs 79 and 80 of resolution GC(65)/RES/8.

⁹⁶ This relates to operative paragraphs 1, 83 and 112 of resolution GC(65)/RES/8.

⁹⁷ This relates to operative paragraph 81 of resolution GC(65)/RES/8.

H. Safety of Spent Fuel and Radioactive Waste Management



Storage hall for low- and medium-level radioactive waste at ZWILAG Switzerland. (Photo: ZWILAG Zwischenlager Würenlingen AG)

99. In September 2021, the Agency organized the Second Plenary Meeting of the International Harmonization and Safety Demonstration Project for Predisposal Radioactive Waste Management virtually to discuss the Working Groups' activities, review the structure and chapters of the project report that had been developed, and revise the work plan for the project.⁹⁸

100. The Agency held the Annual Meeting of the Forum on the Safety of Near Surface Disposal virtually in October 2021 to assist Member States in ensuring the safety of near surface disposal facilities by enabling the exchange of information on good practices; developing guidance, methods and tools, as appropriate; and facilitating the education and training of staff.⁹⁹

101. In October 2021, the Agency hosted the Fourth Plenary Meeting on the International Project on Demonstration of the Operational and Long Term Safety of Geological Disposal Facilities for Radioactive Waste (GEOSAF Part III) virtually to discuss the results of the project and ongoing international and national activities. The Agency also held a virtual Technical Meeting on Guidance on Preparing for and Conducting Regulatory Reviews and Assessments of Geological Disposal Programmes in April 2022.¹⁰⁰

102. A hybrid Regional Workshop on Safety and Technical Requirements for Radioactive Waste Storage Facilities for the Europe region was held in October 2021 to exchange information and experience related to developing and implementing storage projects, as well as to discuss interdependencies and integrated waste management issues.¹⁰¹

⁹⁸ This relates to operative paragraph 87 of resolution GC(65)/RES/8.

⁹⁹ This relates to operative paragraph 87 of resolution GC(65)/RES/8.

¹⁰⁰ This relates to operative paragraph 87 of resolution GC(65)/RES/8.

¹⁰¹ This relates to operative paragraph 88 of resolution GC(65)/RES/8.

103. To discuss the understanding of differences in license applications for near surface and geological disposal facilities from a regulatory perspective, as well as levels of and differences in associated hazards and risks, the Agency held a Technical Meeting on Proportionate Regulation and Licensing of Different Types of Radioactive Waste Disposal Facilities in Vienna in May 2022.¹⁰²

I. Safety in Decommissioning, Uranium Mining and Processing, and Environmental Remediation



Workers dismantling the Turbine Hall at Ignalina Nuclear Power Plant measure scrap metal for traces of radiation (Photo: J. Donovan/IAEA)

104. The Agency held two Technical Meetings of the International Project on Completion of Decommissioning, virtually in October 2021 and in Caernarfon, United Kingdom in June 2022, to continue the collaboration and information exchange between Member States on the completion of decommissioning. The Agency held two Technical Meetings of the International Project on Decommissioning of Small Facilities, virtually in November 2021 and in Brussels in May 2022, to exchange experiences and lessons learned related to the decommissioning of small medical, industrial and research facilities. The Agency also held a virtual Technical Meeting on Decommissioning Planning for Uranium Production Facilities in December 2021.¹⁰³

¹⁰² This relates to operative paragraphs 87 and 88 of resolution GC(65)/RES/8.

¹⁰³ This relates to operative paragraph 92 of resolution GC(65)/RES/8.

105. The Agency organized a Training Event on Safety Assessment for the Decommissioning of Facilities in Frascati, Italy in February 2022 and a Technical Meeting on the Field-Testing of the Training Module on Decommissioning Planning and Project Management in Stockholm in June 2022.¹⁰⁴

106. Continuing the support provided to the Central Asian Member States in monitoring uranium legacy sites before, during and after remediation, the Agency organized a virtual Workshop on the Use of Local Equipment for the Monitoring of Uranium Legacy Sites in Kyrgyzstan in September 2021. Joint field tests of the mapping technology with local experts took place in Kazakhstan and Kyrgyzstan in October 2021. The Agency also organized a virtual Training Workshop to Enhance the Capabilities of Experts from Central Asia for Environmental Monitoring of Surface, Ground and Seepage Waters at Uranium Legacy Sites in Kyrgyzstan, Tajikistan and Uzbekistan in September 2021.¹⁰⁵

107. In May 2022, the Agency held the Annual Meeting of the Coordination Group for Uranium Legacy Sites (CGULS) virtually to continue the information exchange and technical coordination activities of Member States and international organizations participating in the CGULS.¹⁰⁶

108. A virtual Technical Meeting of the International Working Forum on Regulatory Supervision of Legacy Sites on the Identification and Prioritization of Sites for Remediation was held in November 2021. The Agency also organized a virtual Joint Regional Workshop of the International Working Forum on Regulatory Supervision of Legacy Sites and the Coordination Group for Uranium Legacy Sites on Licensing for Remediation Projects in December 2021.¹⁰⁷

¹⁰⁴ This relates to operative paragraph 92 of resolution GC(65)/RES/8.

¹⁰⁵ This relates to operative paragraph 94 of resolution GC(65)/RES/8.

¹⁰⁶ This relates to operative paragraph 95 of resolution GC(65)/RES/8.

¹⁰⁷ This relates to operative paragraph 95 of resolution GC(65)/RES/8.

J. Capacity Building



Virtual School on Nuclear and Radiological Leadership for Safety organized in cooperation with University of Tokai in Japan for the attendees from Asian Nuclear Safety Network (ANSN) participating countries (Photo: A. Collins/IAEA)

109. In June 2022, the Agency conducted a Regional Training Course on the Authorization and Inspection of Radiation Safety and Nuclear Security for Industrial Practices for the Latin America and the Caribbean region in Santiago de Chile.¹⁰⁸

110. The Agency held a virtual Regional Workshop on Inspection and Enforcement of Nuclear Installations by Regulatory Bodies for countries in the Asian region in October 2021 to provide the participants with knowledge of the Agency's safety standards as well as country-specific examples related to the development and implementation of inspection and enforcement programmes for nuclear installations.¹⁰⁹

111. A Regional Workshop on Nuclear Safety Knowledge Management Programmes for Member States of the Arab network of Nuclear Regulators was organized by the Agency in Cairo in June 2022 to exchange information, experience and lessons learned in developing nuclear safety knowledge management programmes at both the national and organizational levels.¹¹⁰

112. The Agency signed Practical Arrangements for the establishment of a new capacity building centre for EPR with the Institute for Radiological Protection and Nuclear Safety, France, in September 2021;

¹⁰⁸ This relates to operative paragraphs 12 and 96 of resolution GC(65)/RES/8.

¹⁰⁹ This relates to operative paragraph 96 of resolution GC(65)/RES/8.

¹¹⁰ This relates to operative paragraph 96 of resolution GC(65)/RES/8.

and extended its cooperation in EPR with the Korea Institute of Radiological and Medical Sciences, Republic of Korea, in October 2021, and with the Civil Protection School, Austria, in November 2021.¹¹¹

113. The Agency published *Training Materials: Arrangements for the Termination of a Nuclear or Radiological Emergency* in February 2022, to support the implementation of IAEA Safety Standards Series No. GSG-11.¹¹²

114. Four Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources were organized by the Agency: in Algeria in October 2021–April 2022; for Argentina (virtual) in July–December 2021; in Ghana in September 2021–February 2022; and in Amman in November 2021–April 2022.¹¹³

115. The Agency held a regional workshop for European countries on competence and learning path of radiation protection officers and qualified experts in occupational and public exposure in Athens in May 2022.¹¹⁴

116. In December 2021, the Agency conducted a virtual Regional Training Course for First Responders to Radiological Emergencies to provide training on the concepts and objectives of EPR, with an emphasis on the first response to a radiological or nuclear emergency.¹¹⁵

117. The Agency organized a National Workshop on Regulatory Control and Vendor Inspection of Long Lead Items in Cairo in June 2022. The Agency also held a hands-on inspector training event for the competency development of regulatory bodies in performing inspections of NPPs at the Zwentendorf NPP in Austria in May 2022.¹¹⁶

118. The Agency finalized the curriculum for a pilot international master's degree programme in EPR based on the Agency's safety standards, to be implemented in Member States to ensure an adequate level of national preparedness for and response to nuclear or radiological emergencies. The first university to implement the curriculum was Peter the Great St Petersburg Polytechnic University, Russian Federation, in September 2021.¹¹⁷

119. The International School of Nuclear and Radiological Leadership for Safety was conducted by the Agency in Athens in November 2021 to train early- to mid-career professionals in nuclear and radiological leadership for safety. Additionally, the Agency, in cooperation with Tokai University, Japan, held a virtual School on this topic in February–March 2022.¹¹⁸

120. In December 2021, the Agency hosted a virtual Meeting of the Steering Committee on Regulatory Capacity Building and Knowledge Management to exchange information on the current activities of the Secretariat and Member States in managing, developing and strengthening regulatory competence.¹¹⁹

¹¹¹ This relates to operative paragraphs 96 and 110 of resolution GC(65)/RES/8.

¹¹² This relates to operative paragraph 96 of resolution GC(65)/RES/8.

¹¹³ This relates to operative paragraphs 12, 39 and 97 of resolution GC(65)/RES/8.

¹¹⁴ This relates to operative paragraphs 8, 63 and 96 of resolution GC(65)/RES/8.

¹¹⁵ This relates to operative paragraphs 96 and 113 of resolution GC(65)/RES/8.

¹¹⁶ This relates to operative paragraphs 3 and 97 of resolution GC(65)/RES/8.

¹¹⁷ This relates to operative paragraphs 97 and 114 of resolution GC(65)/RES/8.

¹¹⁸ This relates to operative paragraph 97 of resolution GC(65)/RES/8.

¹¹⁹ This relates to operative paragraphs 96, 98 and 101 of resolution GC(65)/RES/8.

121. The Agency conducted a virtual Knowledge Management Assist Visit (KMAV) mission to Indonesia in September 2021 and a KMAV mission to Hungary in December 2021.¹²⁰

K. Safety Management of Radioactive Sources



The disused sealed radioactive source packed in the licensed container ready for international transport. (Photo: IAEA Contractor)

122. In June 2022, the Agency organized the International Conference on the Safety and Security of Radioactive Sources: Accomplishments and Future Endeavours in Vienna, where participants discussed experiences and anticipated future developments related to establishing and maintaining a high level of safety and security of radioactive sources throughout their life cycle.¹²¹

123. The Agency hosted two Regional Workshops on the Development of Regulatory Infrastructure for Radiation Safety and Security of Radioactive Material in Vienna in April 2022, one for the Caribbean region and another for the Africa region, to review and discuss regulatory responsibilities over the control of radiation sources and the needs for establishing and enhancing national regulatory infrastructure for countries in the Caribbean and Africa regions.¹²²

124. In August 2021, the Agency held an Open-ended Meeting of Legal and Technical Experts on the Implementation of the Guidance on the Management of Disused Radioactive Sources virtually to share with Member States the results of four virtual regional meetings on the management of disused radioactive sources, as recommended by the Code of Conduct on the Safety and Security of Radioactive

¹²⁰ This relates to operative paragraph 98 of resolution GC(65)/RES/8.

¹²¹ This relates to operative paragraphs 1, 20 and 107 of resolution GC(65)/RES/8.

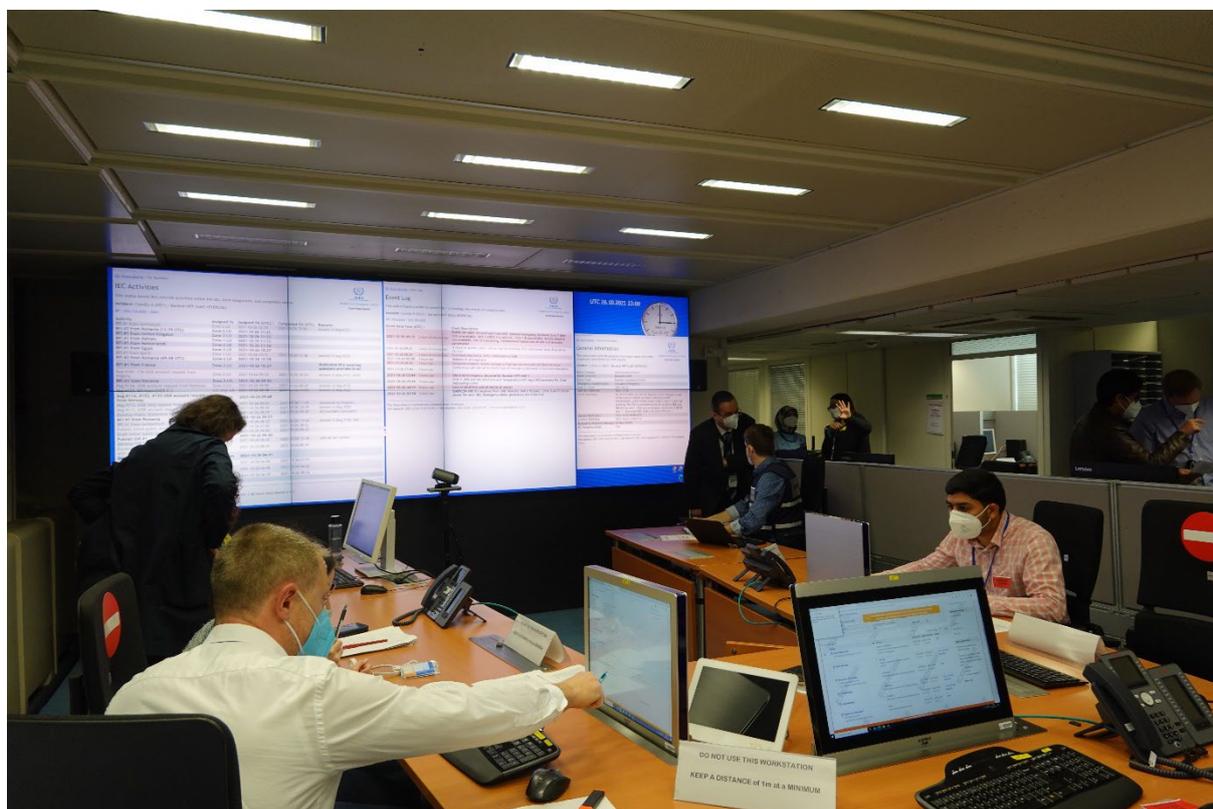
¹²² This relates to operative paragraphs 7, 12 and 104 of resolution GC(65)/RES/8.

Sources and its supplementary Guidance on the Management of Disused Radioactive Sources, and to further discuss the challenges faced by regulatory bodies and other stakeholders in this area.¹²³

125. A virtual technical briefing for Member States on the exchange of information related to the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources was conducted by the Agency in October 2021.¹²⁴

126. The Agency continued promoting the Scrap Metal Tool Kit, a web-based collaboration and information exchange platform related to the control of radioactive material inadvertently incorporated into scrap metal or semi-finished products of the metal recycling industries, as well as an e-learning course on the topic. In the reporting period, 1100 participants registered for the e-learning course.¹²⁵

L. Nuclear and Radiological Incident and Emergency Preparedness and Response



*75 Member States and 12 International Organizations participated in the 36-hour international nuclear emergency exercise, ConvEx-3, coordinated by the IAEA's Incident and Emergency Centre
(Photo: IAEA)*

127. Six Level 2e Convention Exercises (ConvEx-2e) were conducted by the Agency, in July, August, September and October 2021 and in February 2022, based on full-scale national emergency exercises in

¹²³ This relates to operative paragraphs 6, 104 and 107 of resolution GC(65)/RES/8.

¹²⁴ This relates to operative paragraphs 20 and 107 of resolution GC(65)/RES/8.

¹²⁵ This relates to operative paragraph 108 of resolution GC(65)/RES/8.

Canada, the United Arab Emirates and the United States of America. The three participating Member States reviewed the emergency information exchanged and determined appropriate actions to be taken to protect the public.¹²⁶

128. A ConvEx-3 exercise was organized by the Agency and hosted by the United Arab Emirates in October 2021 to test the international arrangements for response to a major nuclear emergency. The two-day emergency exercise tested the response to a simulated accident at Barakah NPP in the United Arab Emirates and included several firsts: an Agency assistance mission, composed of experts from the Secretariat, as well as from France, the Republic of Korea and the United States of America, was deployed, integrated to the United Arab Emirates national response and provided radiation monitoring data from the area around Barakah NPP; 112 laboratories worldwide provided rapid gamma spectrum analysis results, thus testing not only the capability to measure but also the capability to operatively transmit results; and the Agency's social media simulator was used, allowing the participants to test responses to simulated crises on social media. The Agency also held a virtual Technical Meeting to Evaluate the ConvEx-3 (2021) Exercise in May 2022, to evaluate the exercise and consolidate the exercise report.¹²⁷

129. The Agency held an in-person, a hybrid and four virtual Workshops on Developing a Protection Strategy for a Nuclear or Radiological Emergency, in July and August 2021 and in January, May and June 2022, to train personnel of relevant response organizations on how to develop, justify and optimize the protection strategy for a nuclear or radiological emergency as required by *Preparedness and Response for a Nuclear or Radiological Emergency* (IAEA Safety Standards Series No. GSR Part 7).¹²⁸

130. The Agency conducted 14 in-person and 18 virtual training courses, on transport incidents and emergencies, drafting protection strategies, developing and evaluating emergency exercises, establishing EPR arrangements and capabilities, sharing radiation monitoring data through the International Radiation Monitoring Information System (IRMIS), EPR medical response, public communication in emergencies, first response to a radiological dispersal device-triggered emergency during a major public event, preparing for combined emergencies, drafting national emergency plans, drafting EPR regulations, EPR self-assessment using the Emergency Preparedness and Response Information Management System (EPRIMS), and response to port and maritime emergencies.¹²⁹

131. The Agency developed a Database of Source Terms, which is hosted on the Agency's assessment and prognosis tools website. This database aims at collecting accident scenarios and associated source terms, which will be shared by Member States on a voluntary basis.¹³⁰

132. A side event was conducted by the Agency during the 65th regular session of the General Conference to raise awareness of the prognosis methodology developed and implemented in the Reactor Assessment Tool, used as part of the response to nuclear emergencies at NPPs, and the newly developed Database of Source Terms¹³¹.

133. The First Annual Meeting of the International Network for Education and Training on Emergency Preparedness and Response (iNET-EPR) took place virtually in May 2022 to discuss Member States' experience in capacity building activities related to EPR and to develop the action plan for iNet-EPR.

¹²⁶ This relates to operative paragraph 111 of resolution GC(65)/RES8.

¹²⁷ This relates to operative paragraph 111 of resolution GC(65)/RES/8.

¹²⁸ This relates to operative paragraph 112 of resolution GC(65)/RES/8.

¹²⁹ This related to operative paragraphs 112 and 114 of resolution GC(65)/RES/8.

¹³⁰ This relates to operative paragraph 113 of resolution GC(65)/RES8.

¹³¹ This relates to operative paragraph 113 of resolution GC(65)/RES8.

The Agency also held Consultancy Meetings for each of the three iNET-EPR Working Groups in July and August 2021 to revise work plans and to discuss the design and content of the iNET-EPR portal and related capacity building activities.¹³²

134. To promote the involvement of women in EPR, learn from experienced female leaders and encourage Member States to strive towards gender equality in the field, the Agency held a virtual webinar on the leadership of women in EPR in December 2021 to.¹³³

135. The Agency's Unified System for Information Exchange in Incidents and Emergencies (USIE) web portal was used by contact points of States Parties to the Early Notification Convention and the Assistance Convention and by Member States in all workshops on arrangements for notification, reporting and assistance, as well as in all ConvEx exercises. Member States shared information on events of interest via the USIE platform. The event notifications were viewed often by USIE users. Overall, the USIE Exercise site was used by the Secretariat and Member States for about 30 exercises within the reporting period.¹³⁴

136. In response to regular requests from the Secretariat, 13 Member States that were registered in the Agency's Response and Assistance Network (RANET) system provided updates on their RANET national capabilities, and 2 Member States registered national capabilities with RANET.¹³⁵

137. In October 2021, the Agency held a workshop on RANET in Abu Dhabi to enhance the capacity of participants to respond to a nuclear or radiological emergency in the specific context of a Joint Assistance Team Mission conducted as a part of the 2021 ConvEx-3 exercise.¹³⁶

138. The Agency organized the International Conference on the Development of Preparedness for National and International Emergency Response in October 2021, where participants discussed maintaining the preparedness to respond; the need to strengthen emergency operational arrangements aligned with the existing robust international EPR framework; and the need to provide a clear, easily understandable answer to the key question in emergencies: "Am I safe?".¹³⁷

139. The 11th Meeting of the Representatives of Competent Authorities Identified under the Early Notification Convention and the Assistance Convention was hosted by the Agency in Vienna (hybrid) in June 2022 to discuss the implementation of the Early Notification Convention and the Assistance Convention, and the safety requirements dealing with notification and information exchange; the provision of international assistance (in particular, in education and training on EPR); communication with the public, as outlined in the Agency's safety standards; information on national EPR arrangements and challenges; the latest EPR documents and tools; and arrangements and challenges involved in the Agency's assessment and prognosis process. It also enabled the participants to exchange information on international EPR cooperation and to learn from past emergencies and exercises.¹³⁸

¹³² This relates to operative paragraphs 8, 96, 99 and 114 of resolution GC(65)/RES/8.

¹³³ This relates to operative paragraphs 96 and 114 of resolution GC(65)/RES/8.

¹³⁴ This relates to operative paragraph 116 of resolution GC(65)/RES/8.

¹³⁵ This relates to operative paragraphs 106 and 118 of resolution GC(65)/RES/8.

¹³⁶ This relates to operative paragraph 118 of resolution GC(65)/RES/8.

¹³⁷ This relates to operative paragraphs 1, 110 and 119 of resolution GC(65)/RES/8.

¹³⁸ This relates to operative paragraph 119 of resolution GC(65)/RES/8.

140. The Agency delivered three virtual Workshops on Emergency Preparedness and Response Arrangements for Effective Communication with the Public, in September 2021 and January and May 2022.¹³⁹

141. In September 2021, the Agency held a virtual Training Course on Radiation Monitoring and Data Sharing through IRMIS in Nuclear and Radiological Emergencies.¹⁴⁰

142. A Workshop on Self-assessment of Emergency Arrangements and Use of Emergency Preparedness and Response Information Management System (EPRIMS) was held in Vienna in April 2022, to provide an overview of the Agency's safety standards in EPR, highlight the importance of self-assessment against Agency safety standards and present EPRIMS as a tool to support such self-assessment and sharing of information.¹⁴¹

143. The Agency published *Emergency Preparedness and Response Information Management System (EPRIMS): Guide for Authorized EPRIMS Users* (EPR-EPRIMS 2021) in March 2022 to provide EPRIMS users in Member States with an accessible and comprehensive guide to using the system and to supplement regular training and workshops.¹⁴²

144. The Agency organized three Workshops on Arrangements for Notification, Reporting and Assistance in Nuclear or Radiological Incidents and Emergencies, in November 2021 (hybrid) and in February and April 2022 (virtual) to assist Member States in developing national operational arrangements that are consistent with *Operations Manual for Incident and Emergency Communication* (EPR-IEComm 2019).¹⁴³

¹³⁹ This relates to operative paragraph 120 of resolution GC(65)/RES/8.

¹⁴⁰ This relates to operative paragraph 121 of resolution GC(65)/RES/8.

¹⁴¹ This relates to operative paragraph 122 of resolution GC(65)/RES/8.

¹⁴² This relates to operative paragraph 122 of resolution GC(65)/RES/8.

¹⁴³ This relates to operative paragraph 123 of resolution GC(65)/RES/8.

Annex Table of Concordance

Table of Concordance Between Resolution GC(65)/RES/8 Operative Paragraphs (OPs) Associated with Agency Action and Paragraphs of this Report

OP	Report Paragraph	OP	Report Paragraph	OP	Report Paragraph
1	2,12,97,122,138	51	60,62	93	83
2	2,8	52	61,62	94	106
3	9,10,11,49,68,117	53	60,63,64	95	107,108
4	4,12	54	65,66	96	109,110,111,112,113,115,116,120,133,134
5	14,15,19,53	55	67	97	6,7,10,114,117,118,119
6	13,37,59,124	57	68	98	120,121
7	9,49,123	58	69	99	16,17,18,133
8	16,17,18,43,44,59,115,133	60	70	101	120
9	19,20	61	71,72	104	123,124
12	14,15,50,109,114,123	62	73,74,75,76,77	106	136
17	21,22,24,25	63	78,79,115	107	28,29,56,122,124,125
19	3,5,6,7,21,22,23,24,26,27	64	80	108	126
20	28,29,122,125	65	81	109	69,77
22	30	66	82	110	112,138
25	8,31,32	67	79,83,84	111	127,128
26	31	68	85	112	74,77,97,129,130
28	33	69	86,87,88,89	113	116,131,132
32	34	70	89	114	118,130,133,134
33	35	71	90	116	135
36	36,37	72	91	118	136,137
37	38	73	92	119	138,139
38	36	74	93,94	120	140
39	39,114	75	92,93	121	141
40	40,41	76	95	122	142,143
41	42	79	96	123	144
43	43,44,45,46,47,48,49,50,51,53,55,56	80	96	124	58
44	43,44,45,46,47,48,49,50,51,52,53,54,55,56,57	81	98	126	4
45	43,44,46,52,54,57	83	97		
46	11,43,44,45,57	87	99,100,101,103		
47	58	88	102,103		
49	9,30,59	92	104,105		



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