Nuclear Power, Fuel Cycle and Nuclear Science

over **650** **on-line training** and **education courses** hosted on **CLP4NET**

33 **coordinated research projects**

4 **Nuclear Knowledge Management** Schools

6 **Nuclear Energy Management** Schools

33 **Integrated Nuclear Infrastructure Training activities**

INPRO

international collaborative projects

15 **completed**

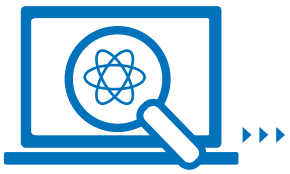
5 **ongoing**

39 **publications**

2019

Internet Reactor Laboratory

4 host institutions



9 guest institutions

18 professional networks

8 missions

5 IAEA-designated International Centres based on Research Reactors

in **5** countries

181 consultancy meetings

2 conferences

74 technical meetings

Nuclear Fuel Cycle and Waste Management

Objective

To raise awareness and promote the implementation of a safe and sustainable fuel cycle and life cycle management for nuclear energy programmes and nuclear applications users, and contingency planning for post-incident situation. To support Member States in strengthening their own capabilities and trained human resources, or having access to the best available knowledge, technologies, services.

Uranium Resources and Processing

The Agency issued two publications on uranium resources and processing. *Uranium Production Cycle: Selected Papers 2012–2015* (IAEA-TECDOC-1873) serves as a record of the work done in Member States and presented at a series of UMREG (Uranium Mining and Remediation Exchange Group) and other technical meetings relating to the uranium production cycle. *Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2014)* presents the outcomes of an Agency symposium covering all areas of the uranium production cycle.

There is also continued interest in the possible use of thorium as a nuclear fuel. A new Agency publication, *World Thorium Occurrences, Deposits and Resources* (IAEA-TECDOC-1877), provides a brief account of the worldwide occurrence of thorium resources based on current knowledge of thorium geology and mineralization. *Thorium Resources as Co- and By-products of Rare Earth Deposits* (IAEA-TECDOC-1892) provides information on the natural occurrence and geology of thorium and an overview of thorium production as a by-product of commodities produced for non-nuclear purposes.

Nuclear Power Reactor Fuel

The new Agency publication *Reliability of Advanced High Power, Extended Burnup Pressurized Heavy Water Reactor Fuels* (IAEA-TECDOC-1865) presents a comprehensive summary of the technical work carried out under a CRP and provides an overview of Member State approaches to mitigating the challenges of deploying advanced fuels for extended burnup to achieve enhanced reliability, sustainability and safety.

In Shenzhen, China, meeting participants discussed national capabilities in modelling and the behaviour of nuclear fuel under accident conditions. Participants in a meeting held in Aix en Provence, France, discussed the latest information on nuclear fuel design, operation, research and development, and licensing in support of flexible operation of nuclear power plants, as well as possible future research and development activities. In Toronto, Canada, meeting participants evaluated the impact on fuel 'fitness for service'

of hot conditioning, refurbishment, outage, operation and normal design life extension of pressurized heavy water reactors.

Two new Agency publications address fuel performance and technology. *Review of Fuel Failures in Water Cooled Reactors (2006–2015)* (IAEA Nuclear Energy Series No. NF-T-2.5) summarizes fuel failure occurrences, their mechanisms and root causes, and fuel failure prevention and management for 97% of light and heavy water cooled nuclear power units operated worldwide between 2006 and 2015. *Fuel Modelling in Accident Conditions (FUMAC): Final Report of a Coordinated Research Project* (IAEA-TECDOC-1889) compiles the results of the research carried out as part of a CRP on the modelling of fuel behaviour in accident conditions.

Management of Spent Fuel from Nuclear Power Reactors

The question of how the management of spent fuel can be affected by the decisions taken in the rest of the nuclear fuel cycle was a focus of the International Conference on the Management of Spent Fuel from Nuclear Power Reactors: Learning from the Past, Enabling the Future, held in Vienna in cooperation with the European Commission, the Nuclear Energy Agency and the World Nuclear Association. The event also gave 35 young professionals the opportunity to participate in a Young Generation Event. Four finalists, who developed the most innovative projects, presented their papers and co chaired various conference sessions (Fig. 1).

At a Technical Meeting on Strategies and Opportunities for the Management of Spent Fuel from Power Reactors in the Longer Timeframe, hosted by the Global Centre for Nuclear Energy Partnership in Bahadurgarh, India, participants identified fuel cycle options and opportunities for recycling valuable fission products for inclusion in guidance on minimizing the waste burden.

The Agency issued four publications on spent fuel management. *Storing Spent Fuel until Transport to Reprocessing or Disposal* (IAEA Nuclear Energy Series No. NF-T-3.3) identifies issues and challenges in developing and implementing options, policies, strategies and programmes for ensuring safe, secure and effective storage of spent fuel. The proceedings of the International Conference on the Management of Spent Fuel from Nuclear Power

FIG. 1. Four finalists selected for having the most innovative projects out of 35 applicants presented their papers during the International Conference on the Management of Spent Fuel from Nuclear Power Reactors.

Reactors: An Integrated Approach to the Back End of the Fuel Cycle, held in June 2015, summarize the conference presentations and session discussions. *Behaviour of Spent Power Reactor Fuel during Storage: Extracts from the Final Reports of Coordinated Research Projects on Behaviour of Spent Fuel Assemblies in Storage (BEFAST I–III) and Spent Fuel Performance Assessment and Research (SPAR I–III) — 1981–2014* (IAEA-TECDOC-1862) provides a consolidated account of 30 years of experience in the storage of spent nuclear fuel from power reactors. *Demonstrating Performance of Spent Fuel and Related Storage System Components during Very Long Term Storage* (IAEA-TECDOC-1878) presents the work carried out during a CRP on safe and reliable management of spent nuclear fuel.

Radioactive Waste Management

Radioactive waste needs to be managed in a way that keeps people and the environment safe over long periods of time. As part of its ongoing support to Member States in this area, the Agency completed three Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) review missions, to Estonia, Germany and Latvia.

It also held a Training Workshop on the Roadmap for a Generic Deep Geological Disposal Programme in Gyeongju-si, Republic of Korea, and a Training Workshop on Planning and Implementing Site Investigations for Geological Disposal in Honorobe, Japan.

Agency networks continued to play an important role in training and communication. The International Predisposal Network provided a forum for experienced Member State representatives involved in industrial-scale utilization of bituminization technologies. Characterization to meet waste acceptance criteria was the focus of the 2019 meeting of LABONET, the Agency's International Network of Laboratories for Nuclear Waste Characterization. As part of the work of DISPONET, the Agency's International Low Level Waste Disposal Network, the Agency held a technical meeting in Cherbourg, France, on lessons in the disposal of low level waste.

At the Technical Meeting on Using Social Media for Public Communication and Stakeholder Involvement for Nuclear Programmes, held in Vienna, 130 participants from 66 Member States explored topics relating to social media and social networking sites (Fig. 2). Input received during the meeting will be used to update the social media section of the Agency's Nuclear Communicator's Toolbox.

FIG. 2. Participants in the Technical Meeting on Using Social Media for Public Communication and Stakeholder Involvement for Nuclear Programmes.

Management of disused sealed radioactive sources

At the request of Member States, the Agency completed assistance for the removal and recycling of three high activity disused sealed radioactive sources (DSRSs). In addition, 11 projects were initiated to support the removal of Category 1 and 2 (higher activity) DSRSs.

The Agency supported the training of 90 participants from 48 Member States in conditioning and safe and secure management of Category 3 to 5 DSRSs, and in searching for and securing orphan sources. Training in conditioning was held in Morocco for 12 participants from 11 Member States. In addition, expert missions were conducted to assist the establishment of national radioactive sealed sources inventories, and in support of nuclear security activities. The Agency launched the DSRS-Net, a web based platform for exchanging experiences in managing DSRSs.

The United States of America provided the Agency with a licensed 435-B Type B container (Fig. 3). The container will be used to support Member States in the transport and repatriation of DSRSs.

FIG. 3. A ribbon cutting ceremony marking the delivery of a 435-B Type B container donated by the United States of America for international transport of DSRSs.

Decommissioning and Environmental Remediation

Decommissioning

The Agency organized an International Workshop on Application of Sustainability and Circular Economy Principles to Nuclear Decommissioning held in Rome and hosted by SOGIN. Participants explored how the principles of a circular economy — based on minimizing waste by design, thus increasing sustainability — can be applied to decommissioning and waste management.

The new Agency publication *Decommissioning after a Nuclear Accident: Approaches, Techniques, Practices and Implementation Considerations* (IAEA Nuclear Energy Series No. NW-T-2.10) describes differences in post accident situations compared with decommissioning after a planned final shutdown under normal conditions and identifies significant factors relevant for decision making.

Environmental remediation

The Agency provides information and training on available remediation strategies and technologies, and management options. It held three technical meetings on different aspects of environmental remediation. Participants in a technical meeting of the CIDER (Constraints to Implementing Decommissioning and Environmental Remediation) Project held in Vienna assessed the results of previous activities of the project and made suggestions regarding strategy development, stakeholder engagement and capacity building.

At a Technical Meeting on the Remediation of Legacy Trenches Containing Radioactive Waste — The LeTrench Project, held in Sydney, Australia, participants shared information and knowledge regarding legacy trench sites. Topics included use of assumptions and constraints, definition of options, and selection of assessment factors and scoring approach.

The Agency held a Technical Meeting on Achieving the Site End State: Characterization Strategies and Instrumentation for Land Contamination, in Dounreay, United Kingdom (Fig. 4). Among the issues discussed were information and data management, the regulatory framework for remediation, modern standards for historical problems, characterization, and statistics and technical support for the selection and use of instrumentation.

FIG. 4. Participants in the Technical Meeting on Achieving the Site End State: Characterization Strategies and Instrumentation for Land Contamination learn about beach monitoring equipment.

Two Agency publications on environmental remediation were issued: *Developing Cost Estimates for Environmental Remediation Projects* (IAEA Nuclear Energy Series No. NW-T-3.8) and *Environmental Impact Assessment of the Drawdown of the Chernobyl NPP Cooling Pond as a Basis for Its Decommissioning and Remediation* (IAEA-TECDOC-1886).

At its annual meeting, held in Vienna, the Agency's Network on Environmental Management and Remediation (ENVIRONET) marked its tenth anniversary by reviewing the achievements and the remaining challenges in environmental remediation.