

Nuclear Fuel Cycle and Materials Technologies

Objective

To strengthen the capabilities of interested Member States for policy making and strategic planning, technology development and implementation of safe, reliable, economically efficient, proliferation resistant and environmentally sound nuclear fuel cycle programmes.

Uranium Production Cycle and Environment

The latest update of the biennial 'Red Book', *Uranium 2003: Resources, Production and Demand*, was published jointly by the Agency and the OECD/NEA in 2004. Reviewing data from 44 countries, the Red Book's main conclusion is that the uranium market is very uncertain in the medium term. This is due to the limited information on what might be available in the future from secondary supplies, which include civilian and military stockpiles, uranium reprocessing and re-enrichment of depleted uranium. At the beginning of 2003, these sources provided 46% of the world's uranium needs for civilian power reactors, but they are expected to decline in importance as stockpiles diminish. After 2015, reactor requirements will have to be met increasingly by the expansion of existing production capacity, the development of additional production centres or the introduction of alternative fuel cycles. Moreover, such disparate factors as market uncertainty, improved global prospects for nuclear energy, and the lingering effects of low mining investments in the past have combined to fuel the recent rise in spot market prices, which have increased more than 100% since the end of 2002 (Fig. 1).

Other work on the uranium production cycle and the environment was reported in four publications issued in 2004:

- *Recent Developments in Uranium Resources, Production and Demand with Emphasis on In Situ Leaching* (IAEA-TECDOC-1396);
- *Treatment of Liquid Effluents from Uranium Mines and Mills* (IAEA-TECDOC-1419);
- *Recent Developments in Uranium Resources, Production and Demand and the Environment* (IAEA-TECDOC-1425);

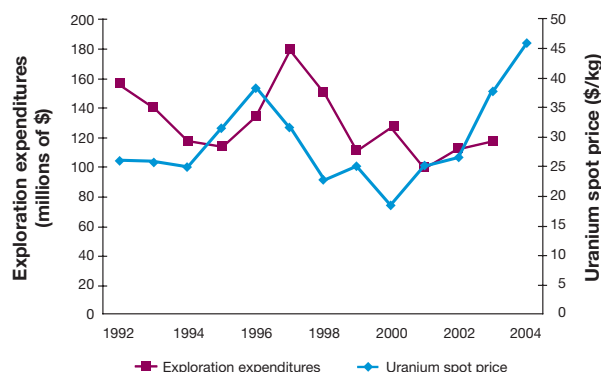


FIG. 1. Uranium market price and exploration expenditures, 1992–2004.

- *Guidebook on Environmental Impact Assessment for In Situ Leach (ISL) Mining Operations* (IAEA-TECDOC-1428).

Within the framework of the Agency's technical cooperation programme, expert teams visited Romania to review the status of a project on restructuring the uranium mining industry. Another team visited Argentina for a project on prospecting for uranium and other elements using gamma ray spectrometry surveys.

Nuclear Fuel Performance and Technology

To assist Member States in enhancing the performance and reliability of zirconium alloy clad fuel, the Agency initiated a CRP on delayed hydride cracking (DHC) in zircaloy fuel cladding material. Participating laboratories will receive guidance in deriving reproducible measurements of DHC, after which they will share experimental results to obtain a better understanding of the phenomenon.

One of the recommendations of an earlier CRP on Fuel Modelling at Extended Burnup (FUMEX) was that information meetings should be held on outstanding issues in fuel modelling. As part of this agreement, a meeting was held by the Agency and the OECD/NEA in Cadarache, France, on the issue of pellet-clad interaction. Other work dealing with fuel modelling included the provision of data to the IAEA-OECD International Fuel Performance Experimental Database (IFPE), which contains

experimental data to allow modellers to test and validate their codes. The IFPE is the data source for the second FUMEX CRP, which is investigating fuel modelling at high burnup and is currently in progress.

A database on post-irradiation examination (PIE) facilities and techniques was made available on the Agency's web site (<http://www-nfcis.iaea.org>) in February 2004. It includes information on techniques from 33 hot labs from 19 countries. The database complements, and is run cooperatively with, the database on hot cell design developed by the European working group on hot laboratories and remote handling as part of the 6th European Conference framework programme.

Spent Fuel Management

During the Scientific Forum held in conjunction with the 48th regular session of the General Conference in September, a meeting on waste and spent fuel management issues concluded that safe and robust interim storage technologies are available to provide flexibility in addressing longer term options and issues (Fig. 2). Also, reprocessing of irradiated power reactor fuel was noted to be a mature technology, demonstrating compatibility with all applicable requirements while reducing the resulting waste volumes. With regard to geological disposal, the participants reviewed the progress to date. The majority of technological issues have been satisfactorily addressed, but non-technical issues, including public acceptance and political endorsement, still remain unresolved. On multinational repositories, the session noted that having operating national repositories first would facilitate progress on multinational geological repositories. Further information on the Scientific Forum is available at [http://www.iaea.org/About/Policy/GC/GC48/Scientific Forum/index.html](http://www.iaea.org/About/Policy/GC/GC48/Scientific%20Forum/index.html).

A new CRP on spent fuel performance assessment and research (SPAR-II) was approved. This project builds on results from preceding CRPs by developing a knowledge base on the long term storage of power reactor spent fuel through the evaluation of operating experience and research by participating Member States.

At a technical meeting on the storage of spent power reactor fuel, held in Ljubljana, Slovenia, in October, participants focused on system deployment, operating experience and cooperative initiatives. There was agreement among the experts that significant progress had been made in Bulgaria,

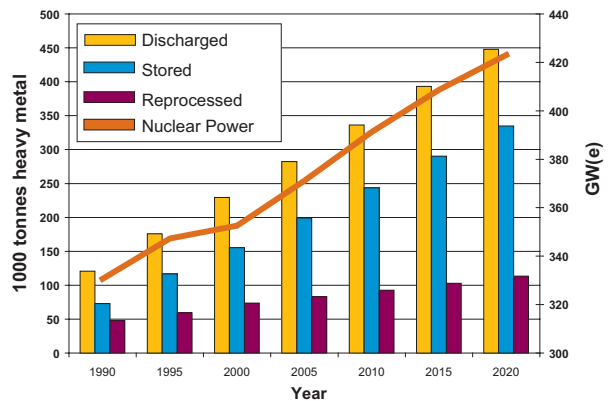


FIG. 2. Cumulative spent fuel discharged, stored and reprocessed between 1990 and 2020.

Croatia, Czech Republic, Hungary, Lithuania, Romania, Slovakia, Slovenia and Ukraine over the last few years in arrangements for interim spent fuel storage.

Nuclear Fuel Cycle Issues and Information Systems

In addition to its work on the front and back ends of the fuel cycle, the Agency carries out activities on selected topics of special interest to Member States. For example, in 2004 the Agency completed a technical document, *Thorium Fuel Cycle – Potential Benefits and Challenges*, that summarizes the issues and challenges at both the front and back ends of the thorium fuel cycle, highlighting fuel fabrication, implementation scenarios, data needs, reprocessing and waste management.

A technical meeting was held in June on the current status and future prospects of gas cooled reactor fuels to address key aspects of coated particle fuel development. The meeting reviewed progress in Member States, examined current development needs, studied the capabilities and limitations of coated particle fuel models, and reviewed applicable safety criteria, high temperature fuel performance, transuranic incineration and particularly promising new directions for research.

The proliferation potential of high enriched uranium (HEU) is such that its management, control and disposition have assumed great importance in nuclear non-proliferation efforts worldwide. In this context, a technical document was drafted that addresses both HEU management and the economic and technical impacts of LEU derived from HEU.

To support programmes within the Agency and as a general service to Member States, the Agency

maintains a number of databases to provide information on all dimensions of the nuclear fuel cycle, and on nuclear fuel cycle activities around the world. Currently, three databases and one simulation system are available on-line at <http://www-nfcis.iaea.org>: the Nuclear Fuel Cycle Information System; World Distribution of Uranium Deposits; Post-Irradiation Examination Facilities; and the Nuclear Fuel Cycle Simulation System (VISTA).

In 2004, the Agency began a new CRP on partitioning and transmutation (P&T) in response

to broad interest among Member States. These technologies use pyrochemical or advanced aqueous processes to reduce the radiotoxicity of spent fuel and to utilize fissile materials efficiently. Since progress in developing and implementing successful P&T systems will be facilitated by easily accessible information on the properties of the minor actinides, work began on developing a Minor Actinide Database for the thermochemical and thermophysical properties of these actinides. ■