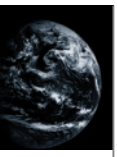
# NUCLEAR FUEL CYCLE AND WASTE TECHNOLOGY

## PROGRAMME OBJECTIVE

**To facilitate the transfer and exchange of information and technology among Member States; to provide assistance and guidance, when requested, on the formulation and implementation of strategies in nuclear fuel cycle related activities and radioactive waste management programmes with due regard to efficiency, safety, environmental soundness and sustainability, and consistency with internationally accepted norms, where applicable, and good practices.**







## OVERVIEW

The Agency's activities in the nuclear fuel cycle area focused on: uranium supply and demand and the environmental issues related to uranium mining and milling; immediate challenges in reactor materials and fuel technology, such as those associated with increased burnup; spent fuel management; and nuclear fuel cycle issues and databases. A symposium on MOX fuel cycle technologies for medium and long term deployment was held in Vienna in May.

The radioactive waste technology programme covered: sources of radioactive waste (with emphasis on inventories, minimization and decommissioning of facilities); implementation of waste management activities (with a greater focus on disposal issues); and technology transfer and exchange. The experience gained in implementing technologies to manage radioactive waste from nuclear power plants and the back end of the nuclear fuel cycle was reviewed at a symposium in Taejon, Republic of Korea. The progress of work, including the status of national radioactive waste management programmes, was discussed at the fourth meeting in September of the Radioactive Waste Technology Advisory Committee.

## NUCLEAR FUEL CYCLE AND MATERIALS

A report addressing the impact on the environment and mitigation of any adverse environmental effects from uranium mining and milling operations was prepared jointly by the Agency and the OECD/NEA. This is the first report on the subject and underlines the importance of good environmental practices if uranium is to be a sustainable fuel source in the 21st century. The report includes a profile of environmental activities and issues related to uranium production, based on responses from 29 countries to a survey.

At a symposium on MOX fuel cycle technologies for medium and long term deployment, organized in co-operation with the OECD/NEA and held in Vienna in May, issues such as the design, technology, utilization, performance, safety, safeguards, transportation and management of separated civil and weapons origin plutonium and potential advanced cycle options were discussed. There was agreement that with more than 2000 MOX assemblies fabricated from 85 tonnes of plutonium and loaded into power reactors, the recycle process was at a mature stage. The technology is well understood, the facilities, institutions and procedures are in place, and capacities are available or are being made available to meet the anticipated increase in the quantities of separated civil plutonium from the production of nuclear power. It was noted that the number of countries engaged in plutonium recycle is expected to increase in the near future, the aim being to reduce stockpiles of separated plutonium from existing reprocessing contracts. While projections of the extended use of MOX fuel in the future depend on the commercial introduction of advanced reactor systems, such as fast power reactors, there was consensus that this would be the optimal method to close the nuclear fuel cycle and to utilize separated plutonium, as well as to burn long lived radioactive actinides accumulated in spent fuel.

Support to technical co-operation activities included the holding of a workshop for users of the TRANSURANUS code, in Pamporovo, Bulgaria, following the Third International Seminar on WWER Fuel Performance, Modelling and Experimental Support. This code, developed by the European Commission's Institute for Transuranium Elements, was modified in order to model the behaviour of WWER fuel. These modifications were then validated by the joint OECD/NEA–IAEA–IFPTE Database. This code will help Member States license this fuel using data on fuel behaviour under different conditions.

The increasing importance of the long term storage of spent fuel was illustrated at a Technical Committee meeting in Vienna in November on good practices for the long term storage of spent fuel, including advanced, high burnup and MOX fuel. Issues associated with materials behaviour, reliability and the safety of different storage technologies for long periods of time were major items of discussion. In addition, the activities of a number of Member States who have embarked on detailed fuel performance programmes for dry storage technologies were reviewed.

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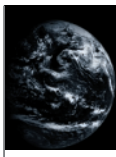
A Technical Committee meeting/workshop on spent fuel management for WWER/RBMK reactors was held in October. Hosted by PURAM and the Paks nuclear power plant at Balatonfüred, Hungary, the workshop was part of the Extrabudgetary Programme on the Safety of WWER and RBMK Nuclear Power Plants and was supported by the Government of Japan. Information on operation, monitoring and maintenance of spent fuel storage facilities, fuel degradation mechanisms, damaged/failed fuel, and economic considerations was exchanged.

At a symposium on research reactor utilization, safety and management, held in Lisbon,



Portugal, in September, the focus was on: the management of spent fuel and of waste from operation and utilization; refurbishment, decommissioning and dismantling of facilities; the transfer of aluminium clad research reactor fuel from wet to dry storage; repatriation of spent fuel to the country where it was originally enriched; and the implementation of regional or international facilities for the interim storage and eventual disposal of spent fuel. Urgent issues in the area of spent fuel management that were identified at the symposium included: the need for realistic spent fuel management plans at each facility; the preparation and continuation of the repatriation of spent fuel to its country of origin; and the need for regional solutions for countries with research reactors but no power reactor programme.

An interregional course organized by the Agency and the USA at Argonne National Laboratory in May examined the technical and administrative preparations required for shipping spent fuel from research reactors, particularly in developing Member States, back to the fuel's country of origin. The course also covered the preparations for the repatriation of Russian origin spent research reactor fuel in the expectation that a take-back programme by the Russian Federation would be implemented in the near future.

It was announced at the General Conference session in September that the US Government was prepared to work with the Russian Federation and the Agency to manage and dispose of Russian origin research reactor fuel and to support a tripartite meeting on the issue. At this meeting, which was held in December, the status worldwide of Russian origin research reactor fuel, and priority areas requiring more study were reviewed.

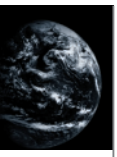
Issues associated with the nuclear fuel cycle, especially those related to the back end, were major topics of discussion at the second meeting in June of the International Working Group on Nuclear Fuel Cycle Options. Many of the back end fuel cycle issues identified at this meeting were topics of further discussion at a Technical Committee meeting in November on the factors determining the long term back end nuclear fuel cycle strategy and future nuclear systems. The meeting concluded that regardless of the fuel cycle options (once-through or reprocessing/recycling), it was important to demonstrate that the back end of the nuclear fuel cycle could be completed.

The objective of an Advisory Group meeting in October was to formulate a strategic plan for international R&D projects on innovative nuclear fuel cycles and power plants. A major recommendation was that the role of the Agency in the implementation of innovative fuel cycles and reactor designs should be defined so as to facilitate co-ordination of R&D on: safeguards friendly technologies; high level waste reduction; non-aqueous reprocessing; natural circulation phenomena; and accelerator driven systems.

## SOURCES OF RADIOACTIVE WASTE

Radioactive waste results from the generation of electricity using nuclear energy and from nuclear applications in medicine, research and industry. One of the fundamental principles of radioactive waste management is minimization, which includes both the reduction of waste being generated and of the volumes of waste already generated. Waste minimization has benefits through the more efficient use of resources and through reduced waste processing and disposal costs. A technical document, *Minimization of Waste from Uranium Purification, Enrichment and Fuel Fabrication*, was published that reviews existing practices and experience gained in the minimization of operational and decommissioning waste from the front end of the nuclear fuel cycle. This information can help Member States when making investment decisions and planning facility improvements.

An important element of waste minimization is the recycle and reuse of valuable materials from different arisings at nuclear fuel cycle facilities (such as byproducts, spent and unused process materials, plant components and equipment), which would otherwise be



considered waste. The economic advantages, coupled with the reduced environmental impact, are strong incentives to choose the recycle and reuse option. Recognizing the importance of this subject and the interest of Member States, a technical document was prepared that analyses different recycle and reuse options in relation to various areas of the nuclear fuel cycle and different nuclear applications. This will allow the recycle and reuse option to be properly implemented as a part of national, site and plant specific waste management policies.

The subject of waste minimization during decommissioning has assumed great importance because of the large number of facilities that have to be retired from service in the near future in many Member States. A technical report on this issue was prepared that discusses various stages and components in the decision making and implementation of waste minimization programmes during decommissioning operations.

A technical report on the estimation of wastes arising from various nuclear fuel cycles was completed. The literature describing these arisings is mostly oriented towards the individual steps of the nuclear fuel cycle, while more detailed information summarizing and assessing the potential impact of waste generation from the entire fuel cycle is virtually non-existent. This report was thus aimed at providing information (i.e. of quantities and basic characteristics) on waste generation in various nuclear fuel cycles and the subsequent steps in its management.

On-site disposal (i.e. the permanent disposal of a nuclear facility or parts thereof within the site where the facility was erected and operated) was proposed some years ago and implemented in a few cases. A technical document was published to present the experience gained, and the prospects for national approaches to on-site disposal. This document should also meet the needs of developing countries that have research reactors and other small nuclear installations.

Environmental restoration is an important source of radioactive waste as sites which do not meet current standards for release are cleaned up. A CRP on site characterization techniques used in environmental restoration was completed, with the final Research Co-ordination meeting being held in Brazil. The technical document resulting from this project gives a comprehensive overview of the various on-site, in situ and laboratory techniques used to deal with contamination problems from various origins. The importance of proper and thorough site characterization, and the need for reverification as work proceeds as a basis for efficient cleanup were also stressed in this document.

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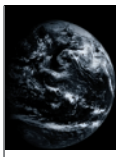
## IMPLEMENTATION AND APPLICATION OF RADIOACTIVE WASTE MANAGEMENT TECHNOLOGIES

An important method to help evaluate performance and engender confidence in the safety of geological disposal systems is to carry out analogue studies. A technical report was issued that presents the current status of natural analogue information in evaluating models of transport by groundwater for those planning to develop a research programme in this field. Similarly, to help evaluate and provide confidence in the models and data used in the assessment of the long term behaviour of geological disposal systems, a new CRP on anthropogenic analogues will allow comparison of the behaviour of various components of a repository system with the behaviour of similar systems that either occur or have occurred on Earth. Migration processes related to ancient artefacts and building materials used in archaeological times are the main topics of study in this CRP.



## WASTE MANAGEMENT INFORMATION AND TECHNOLOGY TRANSFER

A symposium was held in Taejon, Republic of Korea, to review experience gained worldwide in implementing technologies to manage radioactive waste from nuclear power plants and the back end of the nuclear fuel cycle. Organized in co-operation with the OECD/NEA, the Korea Atomic Energy Research Institute, the International Union of Producers and Distributors of Electrical Energy, and the Nuclear Energy Institute, the symposium documented that proven technologies do exist for managing radioactive wastes in ways that are safe, economical and environmentally sound, and that considerable experience exists with these technologies in many Member States. Over the life of the commercial nuclear industry, technologies for managing operational wastes from nuclear power plants have improved substantially and continue to improve in response to economic and environmental considerations. More attention to waste minimization and volume reduction technologies has led to substantial reductions in the volumes of solid wastes. Improvements continue to be made in the technologies and methods that are used to investigate and select sites for waste disposal, and in the construction and operation of the disposal facilities themselves.

A number of activities were undertaken to support developing Member States build up their capacity to safely manage radioactive wastes. For example, regional demonstrations of pre-disposal waste management methods and procedures were held in operating waste processing and storage facilities in Chile, Philippines, the Russian Federation and Turkey. The demonstrations provided hands-on experience in the processing and storage of, for example, low level solid and liquid waste.

Member States were also assisted in the safe management of spent sealed radiation sources, particularly unused radium sources. For example, spent radium sources were conditioned and transferred into long term storage in China, Costa Rica, Jamaica, Pakistan, Peru and the United Republic of Tanzania with the assistance of expert teams from Brazil (for Latin America), South Africa (for Africa) and national expert teams in China and Pakistan. In addition, the team from Pakistan will assist in conditioning spent radium sources in other Member States in Asia.

The Contact Expert Group (CEG) for International Co-operation in Radioactive Waste Management with the Russian Federation agreed at its meeting in Norway to approach the leaders of the G-7/G-8 countries directly with information on nuclear waste and spent fuel issues in the Russian Federation, and appeal for assistance in solving these problems. The final text of the CEG's communication was forwarded thereafter to the Chairman of the G-7/G-8 Nuclear Safety Working Group and by several CEG members to their national representatives.

In May, the Hungarian Atomic Energy Authority requested the Agency to organize an international peer review of the research on site selection and suitability of the Üveghuta candidate site for low and intermediate level waste disposal, within the framework of the Agency's Waste Management Assessment and Technical Review Programme. Specifically, an evaluation was requested of: (a) the screening process, including the associated regulatory framework, that led to the selection of this site; (b) the scientific investigations that were conducted to determine if they were carried out in accordance with international requirements and guidance; and (c) whether good scientific and engineering practices were used. The Agency team conducted the review in November and concluded that the process leading to the selection of the site appeared both reasonable and appropriate and took into account both the geology and the question of public acceptance. The team also concluded that the Üveghuta site appeared potentially suitable for a safe repository for low and intermediate level operational and decommissioning wastes from nuclear power plants.