IAEA International Atomic Energy Agency

Fuel Cycle and Waste Newsletter

A newsletter of the Division of Nuclear Fuel Cycle and Waste Technology
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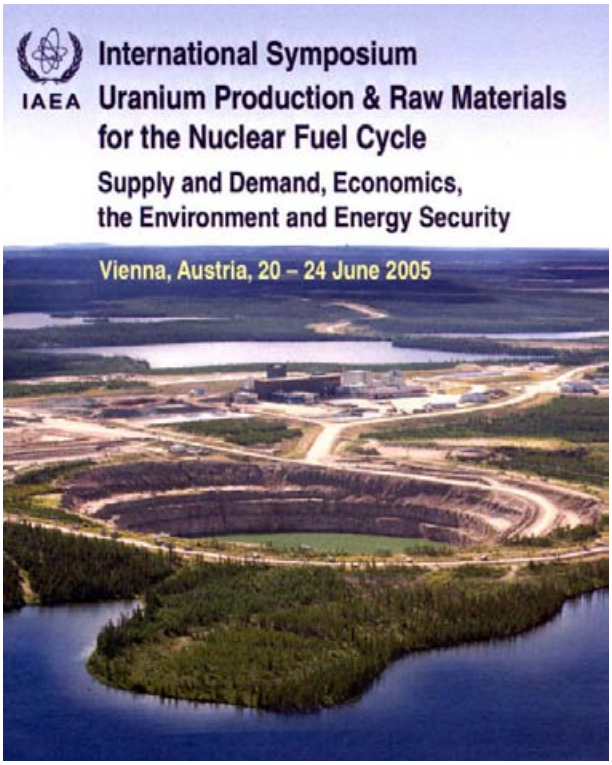
International Symposium on Uranium Production and Raw Materials for the Nuclear Fuel Cycle – Supply and Demand, Economics, the Environment and Energy Security



This Symposium was organized by the IAEA in co-operation with the OECD-NEA, the World Nuclear Association, the Nuclear Energy Institute (NEI) and the United Nations-Economic Commission for Europe (UNECE). The Symposium took place at a most opportune time when the uranium industry is poised for a take-off after nearly two decades of slump and extremely depressed markets for natural uranium, characterized by low prices and mine closures. The demand for uranium has increased in recent years because of expansion of nuclear power programmes all over the world. There has been a near tripling of the uranium price in the last three years, new exploration and mining activities have been initiated and the major uranium producers have increased their annual production. The Symposium was attended by nearly 200 participants from 30 countries and 4 international organizations. Some 100 technical papers were presented and an exhibition on uranium exploration, mining and production was organized.

The highlights of the Symposium included the keynote lecture "The Nuclear Renaissance – and Challenges" given by Mr. Gerald Grandey, President and CEO of Cameco Corporation and "Invited Presentations" by leading experts from the uranium industry and the panel discussion on 'How to Fill the Gap' between uranium demand and supply. The topics of the technical sessions were: Uranium Supply and Demand; Uranium Geology and Deposits; Uranium Exploration; Ura

nium Production; Waste Management; and Environment and Regulations.

The consensus at this Symposium was that uranium resources, including both, primary and secondary supplies, are adequate to meet the immediate projected demand of uranium for fuelling the expanding nuclear power programmes. However, the gap between uranium in the ground and yellow-cake (uranium concentrate) in the can has to be narrowed. Airborne and ground exploration based on new geophysical techniques could pave the way for discovering deep and more obscure uranium deposits that do not have a surface expression. New mines and mills need to be opened. Expansion of *in situ* leaching (ISL) activities, development of smaller but more efficient equipment to perform better in deep underground mining, radiometric ore scanning and sorting, high pressure filters for efficient solid/liquid separation are some of the technological pathways that need to be further developed to ensure timely delivery of uranium concentrate to the market place in an environmentally acceptable way. Contact: C.Ganguly@iaea.org

Message from the Director

Dear Reader,

You have in front of you the first issue of the Newsletter from the **Division of Nuclear Fuel Cycle and Waste Technology** (NEFW). With this Newsletter we would like to inform a wider audience about the broad range of activities performed within the programme of the Division.

NEFW is a part of the **Department of Nuclear Energy**. We are dealing with all aspects of the nuclear fuel cycle from uranium exploration and mining to management and disposal of radioactive waste in the Nuclear Fuel Cycle and Materials Section and the Waste Technology Section. Our work primarily concerns the technology necessary to ensure that fuel cycle activities are undertaken in an economic way, that at the same time fulfills the requirements on safety, security and non-proliferation. Our work is thus complimentary to the work performed in other departments of the IAEA, e.g. **Nuclear Safety and Security** and **Safeguards**.

The key ambitions of NEFW are to help:

- enhance uranium exploration, mining and milling activities, with due regard to the environment;
- improve fuel design and performance in power and research reactors and develop innovative and more proliferation resistant fuels and fuel cycles;
- share experiences and develop technology for management of spent fuel and radioactive waste, including treatment, conditioning, storage and disposal, and
- share experiences and develop technology for decommissioning of nuclear facilities and restoration of contaminated sites.

Our work is implemented by:

- exchanging information on the state of the art in the areas concerned and compiling (incl. databases) and disseminating the information;
- fostering cooperation on R&D activities, through coordinated research programmes, and
- providing, on request, technical services and advice to individual Member States.

In this and coming issues of the Newsletter we will give some highlights from the work, recent developments and publications and near-future plans. We will also have topical articles. In this issue we describe the IAEA Network of Centres of Excellence in Training and Demonstrations of Waste Disposal Technologies, which involves underground research laboratories in five countries.

I joined the IAEA as director for NEFW in April this year. During my first five months at the IAEA I have been struck by the breadth of the activities covered within NEFW and the professionalism of the staff and the experts and consultants that assist us. These are the things we will write about in the Newsletter. I do hope that you will find the content interesting. Your feedback on the Newsletter will be highly appreciated.

H.Forsström@iaea.org

Nuclear Fuel Cycle and Materials Section (NFCMS)

The 37th Technical Meeting of the Joint OECD-NEA/IAEA Uranium Group

This meeting was held in Vienna from 27 to 28 June 2005 and was attended by 37 representatives from 25 Member States of which 23 were from OECD Member States and from 14 non-member states. The large number of attendees was a welcome reflection of the renewed interest in the uranium production industry.

One the main tasks was to review the status of preparation of the ***Uranium Redbook 2005***. Some 41 countries have already submitted data, mainly on-line. The 'Red Book' is expected to be published in Spring 2006 and for the first time also an on-line version will be introduced.

The current uranium market was discussed and analysed. There has been an increase of uranium prices by nearly 300% over the past three years. This increase has stimulated re-opening and the development of new mines. The tight supply-demand relationship, however, is likely to persist in the near term. The increase in uranium exploration over the past two years is a clear indication of the need to expand uranium supply.

A report titled 'The Red Book Retrospective' is scheduled to be published in mid-2006, summarizing the Red Book database between 1965 and 2003, to gain *inter alia* insights into trends in the uranium industry and to understand the relationship between exploration expenditures and uranium price, evolution of the resource base, production (supply) compared to demand, and capacity projections compared to actual requirements.

Utilities are beginning to reduce demand by increasing enrichment efficiencies Enrichment is a major supply bottleneck and increasing its efficiency will transfer some of the uranium price pressure to the enrichment market. However, it will take about five years to add 10 000 tU of new enrichment capacity.

Contact: C.Ganguly@iaea.org

Technical Working Group Meeting On Fuel Performance And Technology (TWGFPT)

The meeting held in Vienna from 25-27 April 2005 was attended by 30 representatives from 24 countries, the EC and the OECD-NEA. National programmes on water-cooled nuclear reactor fuels with emphasis on high burn-up operation experience, fuel failure and use of Mixed Uranium Plutonium Oxide (MOX) fuel were presented. The Group recognized the valuable work by the IAEA in the area of water-cooled nuclear power reactor fuel performance and technology. It considered that relevant IAEA Coordinated Research Projects (CRP) had been very successful, with completion of the CRP on *Data Processing Technologies and Diagnostics of Water Chemistry and Corrosion Control in Nuclear Power Plant* (DAWAC) and the continuing CRP *Fuel Modelling at Extended Burnup* (FUMEX II). The Group made recommendations for several technical meetings (TMs) for the 2006-2007 and 2008-2009 budget cycles, e.g. on on improved fuel pellet materials and designs, mixed core issues and high burnup fuel experience and economics. Other TMs were recommended on advanced water reactor fuels, PIE and poolside examination, advanced fuel fabrication and QA/QC, water chemistry, fuel failures and PHWR fuel modelling. There was strong support for new CRPs in the areas of delayed hydride cracking, water chemistry in older plants and fuel modelling at high burn-ups and transient conditions. Expert Reviews on UO_2 and failed fuel were also recommended.

Contact: J.Killeen@iaea.org

Spent Fuel Performance Assessment and Research

The CRP on spent fuel performance assessment and research (SPAR-II) was approved in 2004 for implementation through 2008. This CRP builds on results from related CRPs (see TECDOC 1343, 944) by developing a technical knowledge base on long term storage of power reactor spent fuel through evaluation of operating experience and research. Representatives from 13 organizations met at the European Commission's Joint Research Centre in Karlsruhe 6-10 June 2005 for the 1st Research Co-ordination Meeting (RCM) to exchange information on the proposals and the project structure, to review the status of national activities in the area of long term spent fuel storage, and to discuss plans for subsequent documentation of SPAR-II results. Meeting results included a preliminary table of contents for the expected CRP technical document, a matrix identifying contributors to the principal topics, as well as a number of general conclusions based on participant presentations and subsequent discussions. Participants also had the opportunity to tour the ZWILAG interim storage facility in Wuerenlingen (photo attached) as well as the EC's laboratory facilities

at their Institute for Transuranium Elements in Karlsruhe. Contact: W.Danker@iaea.org

Technical Working Group Meeting on Nuclear Fuel Cycle Options And Spent Fuel Management (TWGNFCO)

The 4th meeting (23-25 May 2005, Vienna) of the TWGNFCO was convened with 24 participants from 14 countries, the OECD-NEA, the EC and the International Science and Technology Centre (ISTC). Member States representatives gave an overview of their respective national programmes on current and future nuclear fuel cycle activities. The presentations focused on emerging national trends and technologies for the back-end of the fuel cycle including spent fuel storage, dry and wet routes for reprocessing of spent fuel and manufacturing experience of MOX and non-oxide fuels. OECD/NEA, EC and ISTC as well as IAEA staff gave presentations on related fuel cycle activities.

The Working Group reviewed IAEA's fuel cycle activities, evaluated activities of the 2004-2005 budget cycle and those planned for 2006-2007, as well as proposed new activities for the 2008-2009 budget cycle. In the area of spent fuel storage it was recommended to continue current activities with a view to better understand the long-term behaviour, dry and wet storage and burnup credit applications. In the area of innovative and advanced fuel cycles, the Group proposed new activities on: a) fuel cycle of super critical water reactors; b) in-pile and out-pile properties of advanced fuels and structural materials for fast reactors; c) thorium fuel cycle options for the advanced innovative reactor systems; d) synergism between fuel cycles of different reactor systems; and e) structural materials and their performance in the back-end of advanced nuclear fuel cycles. The Group appreciated the progress of IAEA's nuclear fuel cycle related databases and information systems and proposed to initiate activities on the distribution of world thorium deposits.

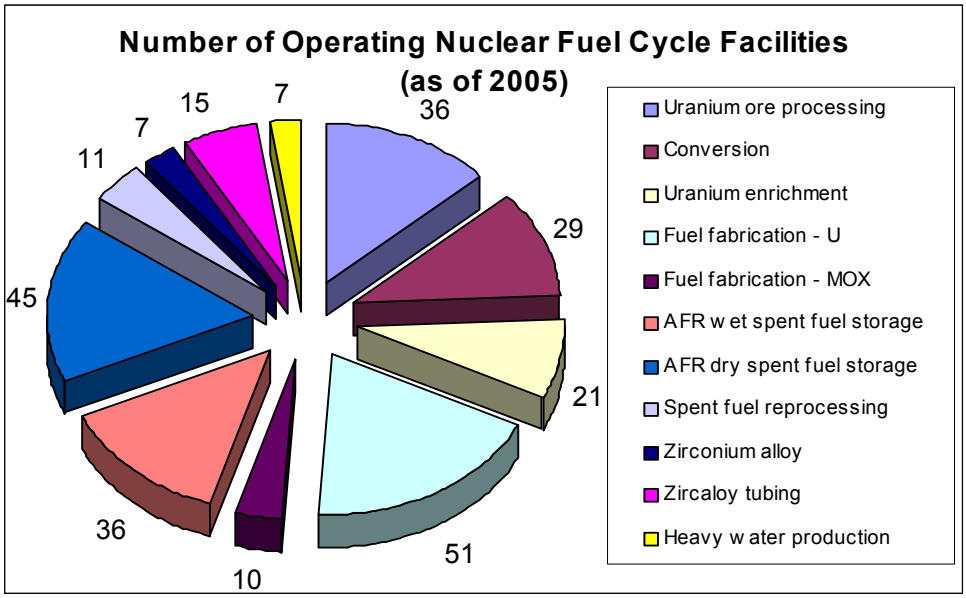
Contact: C.Ganguly@iaea.org

Integrated Nuclear Fuel Cycle Informtion Systems (iNFCIS)

The IAEA has been maintaining a number of fuel cycle databases and a simulation system for assisting Member States and in-house activities. They provide up-to-date and reliable information on the status of international nuclear fuel cycle activities and accurate estimates of nuclear fuel cycle material and service requirements as well as the material arisings. As of 2003, a new project named Integrated Nuclear Fuel Cycle Information Systems (iNFCIS) was launched with a view to integrate the databases as much as possible and to disseminate their information from one source: http://www-nfcis.iaea.org/.

iNFCIS currently includes three main databases and one simulation system:

- Nuclear Fuel Cycle Information System (NFCIS): Directory of civilian nuclear fuel cycle facilities worldwide from shutdown to planning stages, from laboratory to commercial scales;
- World Distribution of Uranium Deposits (UDEPO): Technical and geological database on worldwide uranium deposits;
- Post Irradiation Examination Facilities (PIE): Catalogue of worldwide post irradiation examination facilities;
- Nuclear Fuel Cycle Simulation System (VISTA): A simulation system to estimate the nuclear fuel cycle materials and service requirements as well as the material arisings.



It will be gradually expand to other related databases as they become available.

Contact M.Ceyhan@iaea.org

Joint Study (JS) on the Assessment of Innovative Nuclear Energy Systems (INS) Based on Closed Nuclear Fuel Cycles with Fast Reactors and using the INPRO Methodology

The 2nd Technical Meeting on the JS was held in Vienna from 4 to 6 July 2005. The main objective of the JS is an international assessment of the role of INS based on a closed nuclear fuel cycle with fast reactors in a sustainable energy supply in the 21st century, identification of R&D needs for further development and deployment of INS, as well as to foster joint research projects. The JS

was initiated by the Russian Federation in December 2004 and was joined by China, India, the Republic of Korea, and France as participants, and Japan as an observer. At the first meeting held in Obninsk, 16-17 March 2005, the JS concept was developed. This concept calls for closed fuel cycle fast reactors INS applicable on global and national levels, but also for exploring of regional specifics. The INS must satisfy the requirements set out in IAEA-TECDOC-1434. The participants presented information on the state-of-the-art of fast reactor fuel cycles in their countries and stressed the need for collaborative R&D activities.

Contact: Y.Bussurin@iaea.org

Conversion of Slowpoke and Miniature Neutron Source Reactors (MNSR)

Technical Meeting on this subject was held 23-25 May 2005 in Vienna. It was the first gathering of virtually all the national operators of this class of low-power research reactors used primarily for education, training, and neutron activation analysis. The meeting conclusions call upon the IAEA

- to establish an international working group for SLOWPOKE and MNSRs,
- to consider preparation of a technical document on generic designs for SLOWPOKE and MNSR core conversion, and
- to assist in the clarification of issues related to repatriation or other secure disposition of MNSR spent fuel.

It also called upon the respective USDOE programme to expand to include conversion to low-enriched uranium (LEU) of MNSRs.

Contact P.Adelfang@iaea.org or I.Goldman@iaea.org

1st Research Coordination Meeting (RCM) on Delayed Hydride Cracking (DHC) of Zirconium Alloy Fuel Cladding

Ten participants from ten countries attended the meeting in Nyköping, Sweden, 6-10 June 2005. The CRP will run from 2005 to 2009. Its main purpose is to

- develop and validate, through round-robin tests carried out in the participating laboratories, reproducible experimental procedures to measure crack growth rate in samples with standard geometry and containing known amounts of hydrogen,
- collect data from the participants to improve the knowledge of secondary failures in zirconium alloy cladding, and
- to contribute to the understanding of the mechanism of delayed hydride cracking in zirconium alloys.

The meeting mapped out the experimental programme for the first stage of the CRP and a practical demonstration of the techniques available at the host laboratory.

Contact P.Adelfang@iaea.org or J.Killeen@iaea.org

Preparatory Meeting for a CRP on Developing Techniques for Small-Scale Indigenous Mo-99 Production Using Low Enriched Uranium (LEU) Fission or Neutron Activation (NA)

The Co-ordinated Research Project will run from 2005 to 2009 with the initial year funded from extrabudgetary resources. The purpose is to provide information on the Mo-99 production and supply processes to potential CRP contract holders in order to assist them in preparing their CRP proposals. Information presented during the workshop held from 17-20 May 2005 in Buenos Aires, Argentina, on the Mo-99 related requirements, plans, and resources of the CRP potential participants has been used in the selection of contract holders. Participants toured the Mo-99 production facility at Ezeiza of the Comision National Energia Atomica (CNEA). The First Research Co-ordination meeting is planned for 6-9 December 2005 in Vienna.

Contact I.Goldman@iaea.org

Waste Technology Section (WTS)

Pre-disposal Technologies

Several countries are facing the need to upgrade their older disposal or storage facilities for radioactive waste to comply with current safety requirements. In some cases, retrieval and reconditioning of radioactive waste from old, inadequate disposal or storage facilities is a complex task. The Technical Report on **Methodologies and technologies for retrieval, characterisation and processing of historic radioactive waste** currently in preparation identifies and outlines the methodologies and technologies for retrieval and reconditioning of radioactive waste from old disposal or inadequate storage facilities.

A new document in preparation on **Innovative Waste Treatment and Conditioning Technologies at Nuclear Power Plants** reviews waste treatment and conditioning technologies currently deployed at nuclear power plants around the world, and identifies those innovative technologies and approaches which might be more widely exploited to the benefit of the whole commercial nuclear power industry. Its purpose is to provide reactor designers and decision-makers at nuclear power plants (NPP) and other involved bodies with technologically oriented information on recent achievements in innovative processing of liquid, semi-liquid and solid wastes, and of their potential use.

Another Technical Report in progress on **Management of problematic waste and materials generated during decommissioning of nuclear facilities** outlines the management aspects of some problematic decommissioning wastes and materials. Materials such as asbestos, beryllium, cadmium, mercury, lead, PCBs, etc. which was widely used in the past for the construction of various nuclear facilities, require special approaches for their treatment and conditioning before ultimate disposal. Contact: J.L.Gonzales@iaea.org.

Radioactive Waste Disposal

Promoting international co-operation and confidence building on geological disposal remains a key objective of the IAEA through activities associated with its **Network of Centres of Excellence on Training and Demonstration in Underground Research Facilities**. Nineteen Member States were represented at the last Technical Meeting where a programme of work for the next two years was presented and unanimously agreed. The Member States strongly supported the continuation and if possible, the extension of the Network activities, even if all of the major European Underground Research and Development facilities are already available for the work of the Agency. A co-ordinated research project (CRP) involving ten Member States from four regions was initiated on aspects of the design for and selection of materials for engineered barriers. Training courses in geological disposal have been planned and resourced for the next two to three years. See also feature article below. Contact: M.Gray@iaea.org

A technical document under preparation on **Technological Implications of Safeguards Requirements for Waste Disposal** will describe the technological implications of safeguards requirements on geological repositories containing spent fuel or nuclear material subject to safeguards. The report assesses the technical implications for an operator to meet expected IAEA requirements during the design, construction, operation and post-operational phases. Contact: B.Neerdael@iaea,org

A technical document under preparation on **Technological implications of retrievability on geological disposal of radioactive waste** will explore the technological implications of incorporating retrieval options into geological repository concepts. The assessment includes the identification of design parameters and construction features that might facilitate waste retrieval at a later stage. The implications (including the feasibility) of retrievability depend also on the properties of the host rock. Contact: B.Neerdael@iaea,org

Decommissioning of Nuclear Installations

Being aware of and planning for re-use options for decommissioned sites is an important aspect of the decommissioning process. Early planning for site re-use can facilitate the operation-to-decommissioning transition, reduce the financial burden associated with decommissioning, re-employ workers and specialist staff, and alleviate the overall impact of decommissioning on the local community. A report close to publication on **Post Decommissioning Re-Development of Nuclear Facilities provides** an overview of completed decommissioning projects worldwide followed by successful strategies for re-use of decommissioned sites for new purposes as soon as the nuclear facility is de-licensed. Lessons learned from these projects and practical guidance on factors creating re-use opportunities are highlighted. Operators of nuclear facilities, decision-makers at government level, local authorities, environmental planners are important stakeholders in the site re-development process. Contact: M.Laraia@iaea.org

Similar to industrial sites, a feature of nuclear sites such as nuclear power plants, nuclear fuel cycle facilities or research centres is elevated ventilation stacks. Several options have been developed including preliminary decontamination prior to dismantling and direct dismantling of contaminated structures. Relevant aspects of a report close to completion on the **Dismantling of Contaminated Ventilation Stacks** include project planning and management, health and safety, public relations, and the management and disposal of wastes resulting from dismantling. Contact: M.Laraia@iaea.org

Environmental Remediation

It is increasingly recognized that many contaminated sites cannot be remediated to a free-release end-point. This holds in particular for uranium or thorium mining and milling sites, where spoils heap and tailings disposal cells will remain. For such sites a land-use that is compatible with the selected remediation solution has to be found and maintained over practically unlimited periods of time. A new Technical Report submitted for publication aims to identify possible solutions to these **Stewardship Challenges in the Long-Term Management Radiological Liabilities**. Contact: W.E.Falck@iaea.org

The economic situation in many Member States requires a re-orientation towards less technology-driven remediation solutions. It has also been recognized that some of the classical techniques, such as pump-and-treat, are much less efficient than anticipated earlier. This is particularly true for radionuclides. **Monitored Natural Attenuation** is being discussed as an alternative in this context and its applicability to radiological contamination is explored in a Technical Report to be published shortly. Contact: W.E.Falck@iaea.org

Management of Radioactive Sources

The IAEA activity in this area concentrates on the dissemination of comprehensive technical know-how through compilation of technical reports, the development of innovative technologies that can be applied effectively to recover and ensure the safety of sources in the least developed countries, assisting Member States in building their infrastructure, and through the provision of direct assistance. The building of infrastructure and national capabilities is an important factor to make the direct assistance programme effective and sustainable.

A number of issues emerged that required special attention:

- Improved characterization procedures and systems for historic wastes containing disused sealed radioactive sources.
- Methods to retrieve and verify old waste inventory data. Contact: A.Kahraman@iaea.org

Radioactive Waste Management Registry (RWMR) is a waste inventory record keeping system developed by the IAEA for use in the Member States.

Contact: A.Kahraman@iaea.org

International Catalogue of Sealed Radioactive Sources and Devices. The Agency's International Catalogue of Sealed Radioactive Sources and Devices is progressing continuously through comprehensive review and update. The Catalogue includes an automatic tracking system to be able to identify a source from a limited set of information available. The Catalogue currently contains information on 6200 source models, 5100 device models and 1260 manufacturers/distributors. This information has been obtained through contacts with more than 70 commercial companies and national organizations. The first official presentation of the Catalogue by the IAEA will take place at the International Conference on the Safety and Security of Radioactive Sources: Towards a Global System for the Continuous Control of Sources throughout their Life Cycle, 27 June-1 July 2005, Bordeaux, France. The service of identification of sealed sources and devices is provided upon request. Contact: A.Kahraman@iaea.org

Disposal of disused sealed radioactive sources. Security concerns related to radiological dispersion devices, so-called 'dirty bombs', prompted other important activities towards the safe and secure long-term management of spent sealed sources. In this regard, a technical report currently in press has been prepared on the assessment of potential **Disposal Options for Disused Radioactive Sources**. An Africa-wide regional project is currently underway to assess the long-term safety and technical feasibility of borehole technology for the disposal of disused radioactive sources. In this context, an International Peer Review of the borehole disposal concept developed by the Nuclear Energy Corporation of South African (NECSA) was held in April 2005. A number of IAEA Member States from diverse regions of the world have expressed their interest to implement the borehole concept for the disposal of their disused radioactive sources.

Field activities and related preparations included:

Radium. Recently, conditioning operations for disused radium sources were carried out in Barbados, Congo, Iran, Malaysia and Romania. To date several hundreds of needles, tubes and special-shape sources were conditioned with a total activity of about 1300 GBq.

Sealed High Activity Radioactive Sources (SHARS). While the development of technical capabilities for direct assistance for recovery and conditioning of high activity sources is continuing, the option to return sources to suppliers had been taken with every opportunity. One mission to Haiti were undertaken in 2004.

Neutron sources. The first neutron source recovery and conditioning has taken place in Uruguay in May 2005, where a 100 g Plutonium-Beryllium source was conditioned for shipment back to the original supplier. Contact: M.Al-Mughrabi@iaea.org

Contact Expert Group (CEG)

A number of countries and international organizations provide assistance to the Russian Federation in the field of handling accumulated radioactive waste and spent nuclear fuel in order to resolve the most severe problems caused by past activities in production of nuclear weapons, use of nuclear energy for peaceful and military purposes, and as a result of nuclear arms reduction. In order to promote and coordinate these efforts, a special Contact Expert Group (CEG) for International Radwaste Projects in the Russian Federation was established under the auspices of the IAEA in 1996.

The CEG Workshop on Dismantlement of Nuclear Service Ships and Surface Vessels with Nuclear Power Installations was held on 24-26 May 2005 in Murmansk, Russian Federation. Representatives from 10 countries and 3 international organizations attended the workshop (93 people in total). Technical visit to the Nerpa shipyard and construction site at Sayda Bay for the long-term storage facility for reactor compartments of dismantled nuclear submarines took place on 26 May 2005.

Waste Management Information Systems

Implementing the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management underlines the need for a coherent and consistent system of reporting on waste management. The IAEA has been developing for the past six years the Net Enabled Waste Management Database (NEWMDB) as a tool for data collection and dissemination. Recognizing the need for harmonization and consistency, both the European Commission and the OECD-Nuclear Energy Agency recently have expressed interest in NEWMDB data.

Based on a presentation of the NEWMDB at the 2004 Conference of the Nuclear Information and Records Management Association (http://www.nirma.org/), the IAEA and NIRMA agreed to co-operate on the 2005 conference in Orlando, Florida, USA. The IAEA will run a special two-day 'track' on national radioactive waste inventory record keeping systems (WIRKS): http://www.iaea.org/OurWork/ST/NE/NEFW/wts_l8_01_WIRKS.html.

NIRMA records management experts will provide records management training to all WIRKS workshop participants. Papers on national WIRKS were submitted by Belgium, Canada, Czech Republic, Hungary, Sweden, UK and USA.

Contact: G.Csullog@iaea.org

New Co-ordinated Research Project (CRP) on Accounting of Reactor and Fuel Cycle Related Material Flows

Understanding and quantification of material streams is a prerequisite for assessing and comparing options of nuclear energy systems and fuel cycles in terms of their use of resources. Consequently, all relevant materials flows in the system should be accounted for, as was laid down by INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles) as one of the major requirements to be complied with by innovative systems. Understanding of material flows may help in various corollary assessments such as cost/benefit analyses, environmental impact, reuse/recycling of materials, energy consumption, resource dependency and supply security.

The specific objectives of this new area of work are:

- to investigate and compare current Material Flow Analysis or Accounting (MFA) and Life Cycle Assessment (LCA) studies and methods used in Member States (MS) applicable to nuclear energy systems with a view to make this method more widely useable
- to develop and apply methods for assessing (innovative) reactor and fuel cycle related material flows that can be used in MS. The materials to be investigated include in addition to fissile and fertile materials, materials of critical importance due to their scarcity or competing users.

The result will be a set of methods that can be applied in the assessment for sustainability of innovative nuclear energy system.

Participation will be in the form of 'research agreements' whereby institutions will contribute with own work to the CRP. The duration of the CRP will be three years. The IAEA will provide financial support for attending the annual 'Research Co-ordination Meetings (RCMs).

Contact: W.E.Falck@iaea.org

The Promise of Underground Geological Repositories

Centres of Excellence Help Build Confidence Worldwide

Each year the world's 441 nuclear power reactors create enough spent fuel to fill a football field to a depth of 1.5 metres. That's about 10 500 tonnes of heavy metal. This waste is thermally hot and stays radioactive for thousands of years. Because it is solid and does not readily dissolve in water, the fuel waste is typically stored in water pools on site at the nuclear reactors for many years.

But permanent disposal places are needed. Scientists warn that the ongoing storage of spent fuel is not sustainable for the long years needed for the waste to decay and lose its radioactivity. Right now only one permanent disposal facility exists – in New Mexico where long-lived radioactive waste from US military programmes is carefully packaged and cocooned in tunnels deep underground, in what is called a geological repository.

Containing the Heavy Metal

Global scientific consensus is that disposal in these deep underground repositories is the best and safest option available to permanently separate this waste from humans and the environment. This consensus is backed by several decades of research and outlined in a position paper by international experts that the IAEA published on The Long Term Storage of Radioactive Waste Safety and Sustainability

Total Stored Spent Fuel (1 January 2003)	
Region	Amount (Tonnes of Heavy Metal)
West Europe	36 100
East Europe	27 700
America	83 300
Asia & Africa	23 900
World	171 000

Source: IAEA Overview of Global Spent Fuel Storage

Over the last thirty years many IAEA Member States have developed the methodologies for the disposal of radioactive wastes in underground 'geological' repositories. Underground Research Laboratories have been set up and used for this purpose. In 2002 a group of Member States offered the use of their underground rock labs and some associated surface facilities to help build confidence and capacity throughout the world in geological disposal of radioactive wastes.

This group, collectively known as the IAEA Network of Centres of Excellence (COE) in Training and Demonstrations of Waste Disposal Technologies, includes the following:

Canada with the Underground Research Laboratory of Lac-du-Bonnet, Manitoba;

Belgium with the Underground Laboratory in Mol, operated by EURIDICE;

Switzerland with the Grimsel Test Site;

Sweden with the Äspö Underground Research Laboratory, and the University of Kalmar;

Wales, United Kingdom, with the Geo-Environmental Research Centre in Cardiff; and

United States of America, with the WIPP facility near Carlsbad, New Mexico, the Yucca Mountain Project in Nevada, and Lawrence Berkeley National laboratory in California.

The Grimsel underground rock laboratory in the Swiss Alps. (Credit: Comet).

The *in situ* laboratories in this network also provide the opportunity for hands-on training in waste disposal technologies for countries which do not have their own underground research facilities.

Spent Fuel - Global Overview, 2003

Spent fuel and high level waste makes up about 3% of the world's total nuclear waste but contains 95% of all the radioactivity.

Global spent fuel storage capacity is about 244 000 t HM (tonnes of heavy metal). This capacity will be filled by 2017 if no new facilities are built by that time.

Trends show that a storage shortage is not expected globally; however on a national level a shortage may occur – particular in some Eastern European countries.

The first national geological repositories for permanent spent fuel disposal are expected to be in operation around 2010.

Source: IAEA Overview of Global Spent Fuel Storage

Contact: M.Gray@iaea.org

Recent Publications

TRS No. 418

Corrosion of Research Reactor Aluminium Clad Spent Fuel in Water (2003).

TRS No. 419

Extent of Environmental Contamination by Naturally Occurring Radioactive Material (NORM) and Technological Options for Mitigation (2003)

TRS No. 420

The Transition from Operation to Decommissioning of Nuclear Installations (2004)

TRS No. 421

Management of Waste Containing Tritium and Carbon-14 (2004)

TRS No. 424

Remediation of Sites with Dispersed Radioactive Contamination (2004).

TRS No. 427

Predisposal Management of Organic Radioactive Waste (2004).

TECDOC-1385

WWER-440 fuel rod experiments under simulated dry storage conditions (2004).

TECDOC-1394

Planning, Organizational and Management Aspects of Decommissioning: Lessons Learned (2004).

TECDOC-1397

Long Term Behaviour of Low and Intermediate Level Waste Packages under Repository Conditions (2004).

TECDOC-1398

Records for Radioactive Waste Management up to Repository Closure: Managing the Primary Level Information Set (2004).

TECDOC-1410

Delayed hydride cracking in zirconium alloys in pressure tube nuclear reactors"

TECDOC-1413

Developing Multinational Radioactive Waste Repositories: Infrastructural Framework and Scenarios for Cooperation (2004).

TECDOC-1416

Advanced Fuel Pellet Materials and Designs for Water Cooled Reactors (2004)

TECDOC-1419

Treatment of Liquid Effluent from Uranium Mines and Mills during and after operation (2004)

TECDOC-1425

Developments in uranium resources and production, demand and the environment (2005)

TECDOC-1428

Guidebook on environmental impact assessment for in situ leach mining projects (2005)

TECDOC-1433

Remote Technology Applications in Spent Fuel Management (2005)

TECDOC-1450

Thorium Fuel Cycle – Potential Benefits and Challenges (2005)

IAEA-WMRA-29

Waste Management Research Abstracts, volume 29 (2004)

RWM Status and Trends

Radioactive Waste Management – Status and Trends, Report No. 4 (2005).

Radioactive Waste Management Profiles No. 6

A Compilation of Data from the Net Enabled Waste Management Database (NEWMDB) (2005)

IAEA-CSP-20

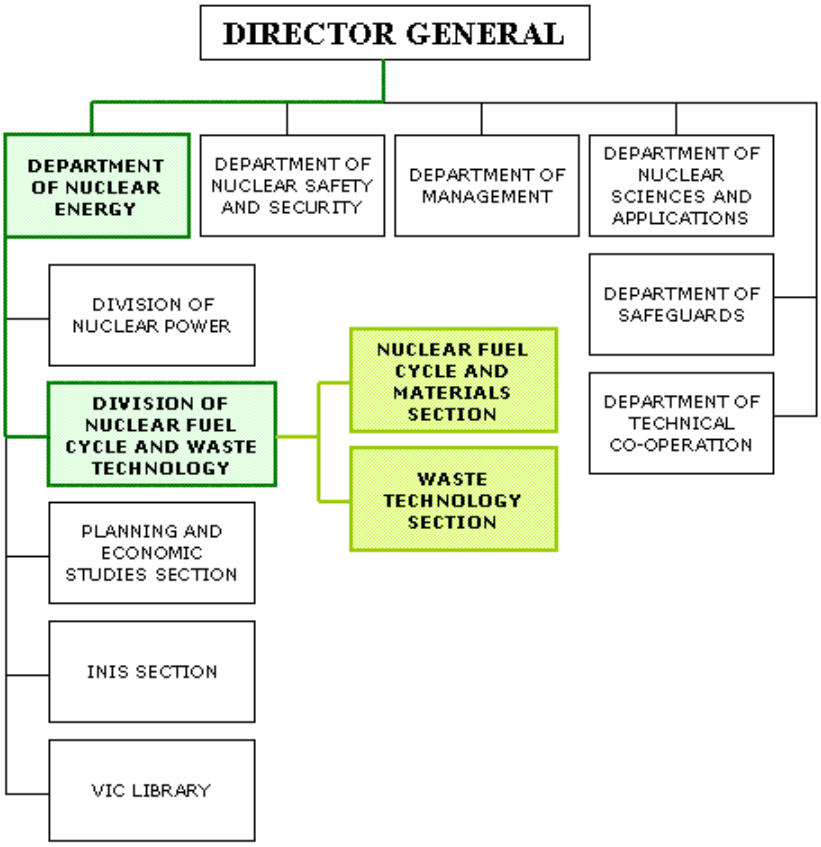
Storage of Spent Fuel from Power Reactors, Proceedings of an International Conference, Vienna, Austria, 2-6 June 2003

Meetings in 2005

Date	Title	Place	Contact
29 August – 2 September	TM on advances in applications of burnup credit to enhance spent fuel transportation, storage, re-processing and disposition	London, UK	W.Danker@iaea.org
4-8 September	10th International Conference on Environmental Remediation and Radioactive Waste Management, (ICEM'05/DECOM'05)	Glasgow, UK	
5-8 September	TM on fuel behaviour modelling under normal, transient and accident conditions, and high burnups	Kendal, UK	J.Killeen@iaea.org
12-16 September	Uranium Mining and Hydrogeology IV	Freiberg, Germany	W.E.Falck@iaea.org
12-15 September	TM on fissile material management strategies for sustainable nuclear energy	Vienna, Austria	K.Koyama@iaea.org
19-23 September	The 6th International conference on WWER Fuel Performance, Modelling and Experimental Support	Albena, Bulgaria	J.Killeen@iaea.org
26-30 September	TM on operational radioactive waste	Vienna, Austria	J.L.Gonzales@iaea.org
3-6 October	Water Reactor Fuel Performance Meeting 2005	Kyoto, Japan	J.Killeen@iaea.org
3-7 October	International Conference on the Safety of Radioactive Waste Disposal	Tokyo, Japan	J.M.Potier@iaea.org
3-7 October	TM on current status and future perspective of liquid metal-cooled reactor fuel cycle	Obninsk, Russian Federation	H.Nawada@iaea.org
4-6 October	19th Plenary Meeting of the Contact Expert Group	Ottawa, Canada	S.Bocharov@iaea.org
9-13 October	GLOBAL 2005	Tokyo, Japan	C.Ganguly@iaea.org
10-12 October	TM on the use of LEU ion accelerator driven subcritical (ADS) assemblies	Vienna, Austria	P.Adelfang@iaea.org
10-14 October	TM on design features and requirements to minimize operational and decommissioning waste generation of nuclear facilities.	Vienna, Austria	V.Efremenkov@iaea.org
10-14 October	TM on disposal approaches for long lived and intermediate level radioactive waste	Vienna, Austria	B.Neerdael@iaea.org
16-19 October	International Uranium Fuel Seminar 2005	Santa Fe, NM, USA	V.Inozemstev@iaea.org
17-20 October	TM/Workshop on spent fuel treatment options and applications	Daejeon, Republic of Korea	J.S.Lee@iaea.org
24-28 October	TM on behaviour of high corrosion resistance Zr-based alloys	Buenos Aires, Argentina	J.Killeen@iaea.org C.Ganguly@iaea.org
6-10 November	27th International Meeting on the Reduced Enrichment for Research and Test Reactors (RERTR) Program	New Orleans, La, USA.	P.Adelfang@iaea.org
7-11 November	Training Meeting/Workshop on socio-economic issues and public involvement practices and approaches for developing and operating repositories for low and intermediate level waste	Vienna, Austria	L.Nachmilner@iaea.org
9–11 November	International Conference on Characterization and Quality Control of Nuclear Fuels	Hyderabad, India	C.Ganguly@iaea.org
14-18 November	TM/Workshop on assessing factors affecting public and political acceptance for the implementation of the geological disposal concept.	Vienna, Austria	B.Neerdael@iaea.org
14-25 November	Training Meeting/Workshop on modelling and quality control for current, advanced and innovative fuel technologies	ICTP, Trieste, Italy	J.Killeen@iaea.org C.Ganguly@iaea.org
21-25 November	TM on license applications for low and intermediate level pre-disposal waste management facilities.	Vienna, Austria	A.Kahraman@iaea.org
28 November – 2 December	TM on handling, conditioning and storage of spent sealed radioactive sources	Vienna, Austria	J.Balla@iaea.org
30 November – 2 December	Training Meeting/Workshop on the Net Enabled Waste Management Database	Vienna, Austria	G.Csullog@iaea.org
5-9 December	TM on handling of damaged spent fuel	Vienna, Austria	W.Danker@iaea.org

Division of Nuclear Fuel Cycle and Waste Technology WebSite Links

Division Introduction : NEFW home: http://www.iaea.org/OurWork/ST/NE/NEFW/index.html



Nuclear Fuel Cycle and Materials Section (NFCMS)

http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_home.html

- Main activities
http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_activities.html
- Technical Working Group on Nuclear Fuel Cycle Options (TWGNFCO)
http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_twgnfco.html
- Technical Working Group on Water Reactor Fuel Performance and Technology (TWGFPT)
http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_twgfpt.html
- Databases (NFCIS, UDEPO, VISTA, PIE)
http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_databases.html

Waste Technology Section (WTS)

http://www.iaea.org/OurWork/ST/NE/NEFW/wts_home.html

- Main activities
http://www.iaea.org/OurWork/ST/NE/NEFW/wts_activities.html
- International Radioactive Waste Technical Committee (WATEC)
http://www.iaea.org/OurWork/ST/NE/NEFW/wts_watec.html
- Technical Group on Decommissioning (TEGDE)
http://www.iaea.org/OurWork/ST/NE/NEFW/wts_tegde.html
- Databases (NEWMDB, DRCS)
http://www.iaea.org/OurWork/ST/NE/NEFW/wts_l8_01_NEWMDB.html

http://www.iaea.org/OurWork/ST/NE/NEFW/wts_l6_02_DRCS.html

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