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# Fuel Cycle and Waste Newsletter

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# Conversion of Research Reactors from HEU to LEU Fuel

For nearly 30 years the Reduced Enrichment for Research and Test Reactors (RERTR) Programme – managed by the US Department of Energy and supported by the IAEA – has worked to develop technology necessary to enable the conversion of civilian facilities using high enriched uranium (HEU) to the more proliferation resistant low enriched uranium (LEU) fuels and targets. More recently in 2004 the IAEA welcomed the US Secretary of Energy's announcement of the Global Threat Reduction Initiative (GTRI). The initiative aims to minimize the amount of nuclear material available that could be used for nuclear weapons by securing, removing, relocating or disposing of relevant materials and equipment. The IAEA continues to support RERTR and GTRI through projects aimed at LEU fuel technology development, fresh and irradiated fuel repatriation, and HEU/LEU core conversions.

To facilitate Romanian support of GTRI and RERTR, the Technical Cooperation project ROM/4/024 was initiated to enable the safe operation of a TRIGA 14-MW reactor during the gradual and complete conversion from HEU to LEU fuel. The Agency is providing its management and technical experience in terms of technical advice, procurement, contract drafting and negotiations, fuel quality control and acceptance, safeguards inspections, and application of safety standards (transport) to ensure the safe and complete conversion of the reactor to LEU fuel.

**Conversions are being made at the 14-MW TRIGA research reactor in Pitesti, Romania**. It is the highest-powered TRIGA reactor ever built. Its fuel material is zirconium-uranium hydride, and the fuel assembly has a unique geometry. Initially, the fuel used was 93% enriched HEU from the USA; it will be replaced by LEU under the RERTR programme.

Romanian, IAEA, and French project team members inspect LEU fuel at the CERCA fabrication plant.

This project is part of a national programme enjoying strong government support, expressed also in terms of significant financial resources. The Agency's financial contributions were secured in 2003 and 2004 by voluntary contributions made by Romania and the United States totalling $3,700,000.

In November 2003 the Board of Governors approved (GOV/2003/16) the project and supply agreement for the transfer of USA origin LEU to a manufacturer in France for the fabrication and delivery to the Pitesti Research Reactor of 400 TRIGA fuel rods with LEU fuel and other related hardware and services. The fuel rods, which will fuel the Pitesti reactor until 2013, were contracted by the Agency for fabrication and delivery by the Compagnie pour l'Etude et la Réalisation de Combustibles Atomiques (CERCA). The project will be completed ahead of schedule and on budget.

The reactor is used to produce radioisotopes for cancer diagnosis and treatment and to test materials, in particular the behaviour of certain irradiated fuels. The development of appropriate techniques and expertise will be encouraged to attract sufficient customers, including government-supported research and training, in order to improve the use of the reactor and attract outside commercial funding and international cooperative projects.

The following outcomes have been achieved:

1. In January 2004, the first 50 fuel rods (2 fuel assemblies) were manufactured and shipped to ICN, Pitesti and loaded into the reactor.

2. In October 2005 the second shipment of 175 fresh LEU fuel rods (7 fuel assemblies) was inspected, accepted, and shipped to ICN, Pitesti and loaded into the reactor.

3. The third shipment of 175 fresh LEU fuel rods was inspected and accepted at CERCA in Romans, France 15-17 March 2006 and is to be shipped to ICN Pitesti in late March 2006.

4. Upon loading into the reactor, the TRIGA will have been fully converted to LEU fuel. Romania plans to hold a ceremony in late May 2006 to mark the event.

The Agency is currently supporting similar HEU/LEU conversion projects in Portugal and Poland.

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# Message from the Director

Dear Reader,

The transfer of nuclear knowledge and technology to all Member States is an important component of the work of the IAEA. This is done within the Technical Cooperation (TC) programme, which is supported by the TC Fund. The projects are implemented in close cooperation between the Technical Officers (TOs) in the Technical Departments, e.g. Nuclear Energy, the TC staff and the national counterparts. The TOs in our Division dedicate a substantial part of their work to these projects, which are complementary to the activities performed under the regular budget.

In this issue of the Newsletter we present the wide spectrum of support activities that are performed within the TC programme by the TOs of the Division of Nuclear Fuel Cycle and Waste Technology. They range from uranium exploration to the management of spent nuclear fuel and disposal of radioactive waste. As the staff of the Division has been involved in 76 TC projects during the 2005-2006 budget cycle, it is not possible to present all. We can only give some typical examples.

The TC programme is of course not limited to the work of our Division, but is much wider. In the following article Ms. Ana Maria Cetto, the Deputy Director General for the Department of Technical Cooperation, provides an overview of the many areas covered by the TC programme.

I personally find this work very impressive and it gives a flavour of the many positive uses of nuclear science and technology.

The activities of a TC project differ from project to project. They have to be adapted to the specific requirements of each Member State and each project and range from training courses and fellowships, through expert advice to providing equipment and actual implementation of physical projects. The planning and implementation of the projects builds on the expertise of the TOs and their network of experts around the world. It is obvious that this work cannot be performed by the Agency’s staff alone. The success of the projects is highly dependant on the dedicated work performed by experts from many countries with long experience in the topics covered. On an average more than 200 expert missions are carried out annually to support the TC projects operated by our Division. We hope for a continued good cooperation with all of you in this important and demanding task also for the future. It is a very important component in ensuring that the nuclear fuel cycle and the radioactive waste is managed in a responsible way all around the world.

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# Technical Cooperation Projects – Purposes and Interactions

The Technical Cooperation (TC) programme arises from the IAEA's mandate *"to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world"*. As a scientific and technical agency, the IAEA is contributing to sustainable development goals of Member States through the transfer of nuclear science and technology. This support takes place primarily through the provision of training, expert advice and equipment. TC activities are underpinned by the Agency's technical expertise, quality control capabilities and information networks

Within the overall mandate, the strategic goal of the TC programme is *"to increasingly promote tangible socio-economic impact by contributing directly, in a cost-effective manner, to the achievement of the major sustainable development priorities of each country"*.

TC staff, in partnership with Technical Officers (TOs), support the application of nuclear and related technologies to a variety of development needs, such as the following:

**Improving human health**: nuclear medicine and radiation therapy are used to diagnose and treat cancer; radioisotopes are used to identify drug-resistant strains of malaria and TB; and nuclear techniques are used to optimize nutrition studies.

**Providing sustainable agricultural practices**: radiation-induced mutations develop new plant varieties resistant to drought and disease; and the sterile insect technique helps to control insect pests, allowing for greater food production and a lower prevalence of disease carried by the pests.

**Managing water resources**: isotope hydrology is used to map underground aquifers, leading to improved groundwater management; and it is used to improve the safety of dams.

**Protecting the environment**: nuclear techniques are used to conduct surveys of pollution in the marine environment and in the atmosphere.

**Building radiation protection infrastructures**: concerted effort is taken to ensure that radiation protection skills and infrastructures are established in each and every one of the Member States. This infrastructure must be in compliance with the requirements of the international Basic Safety Standards.

**Developing sustainable energy options**: expertise is provided for comparative assessments of different sources of electricity generation; and for capacity building to improve performance and quality assurance for Member States that use or intend to use nuclear energy for electricity generation, desalination or research.

**In the area of fuel cycle and waste technology**, the TC programme is supporting 76 projects during the 2005–2006 budget cycle. On average, more than 200 international and national experts are fielded in this area per year. Fellowships and scientific visits play important parts in developing a sustainable capacity in the area of fuel cycle and waste technology. Looking at the past five years, some 3300 scientists and technicians have participated in the TC programme in the area of fuel cycle and waste technology. The high-quality of these programmes is ensured by the dedicated partnership between the Technical Divisions, TC programme staff and the counterparts in Member States.

A TC project starts with a concept. A team is formed with the counterpart, TO, National Liaison Officer, and TC Programme Management Officer and Assistants. The team develops the project, plans its implementation, and monitors its progress. The TOs are required to review initial project concepts submitted by the counterpart for technical feasibility and assist in the design of the project. During implementation, TOs provide technical content for training courses and support lecturer recruitment, summarize training needs and evaluate fellows and host institutions, and recruit experts and determine their duties. Assistance in the final evaluation of the project is provided.

*"Throughout the formulation and implementation of the TC project activities, we rely on our team members in the Technical Divisions to help provide the expertise and experience that will create an environment for sustainable scientific and technical competence in the counterpart institutions."* – Ana María Cetto, Deputy Director General of the Department of Technical Cooperation

The success of the TC programme relies on the dedicated network of experts, institutions hosting fellows, and lecturers participating in TC activities.

More information about the TC programme, publications, and ways to participate in the programme is available on the TC web site, http://tc.iaea.org. Questions and comments regarding the TC programme can be addressed through TCWEB.Feedback@iaea.org

# TC Projects and Nuclear Fuel Cycle and Materials (NFC&M)

## Repatriation, Management and Disposition of Fresh and/or Spent Nuclear Fuel from Research Reactors

The Board of Governors approved the TC project (RER/4/028) in 2005 to assist Member States to repatriate, manage or dispose of research reactor (RR) fuel. This endeavour supports the tripartite (IAEA-US-Russian Federation) initiative known as the Russian Research Reactor Fuel Return (RRRFR) programme as well as the Global Threat Reduction Initiative (GTRI) by facilitating the return of relevant fuel to the country of origin. Fuels of interest include fresh or irradiated highly enriched uranium (HEU) or spent low enriched uranium (LEU) fuel that could be used in radioactive dispersal devices (RDDs). The scope also includes the possibility of contracting the manufacture of transport casks. The anticipated project duration is 5 years and its budget is approximately $10 million.


A Spent Nuclear Fuel Transport and Storage System including cask, ISO container and all related tooling; purchased through RER/4/028.

The Agency is providing management and technical experience in terms of technical advice, training, contract drafting and negotiations, Safeguards inspections, and application of safety standards (transport) to ensure efficient and secure preparatory steps are taken in the country and the transfer is managed safely and securely. In addition, the Agency is providing expert advice, organizing training or technical workshops in areas relevant to safety, security or transport, where needed. For the spent fuel, it will also help with pre-transport activities such as environmental impact assessment (ecological expertise), assessment and possible contracting of the manufacture of transport casks, assessment of transport routes, and any relevant engineering advice which might be needed in particular cases of older spent fuels.

The following outcomes were achieved in 2005:

1. Fresh HEU fuel was shipped from the Latvian Academy of Sciences and the Czech Technical University training reactor VR-1 to the Russian Federation.

2. Spent fuel transport and storage systems have been ordered. These casks will enable future shipments of the spent research reactor fuel.

3. Fuel monitoring equipment was purchased for the Tajoura research reactor and critical assembly in the Libyan Arab Jamahirya to monitor the performance of replacement LEU fuel.

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## Uranium Exploration

The Nuclear Fuel Cycle and Materials Section (NFC&MS) has, and continues to implement Technical Cooperation (TC) projects in the uranium production cycle under the IAEA subprogramme B.1. In 2005, technical missions and field visits were made to China, Egypt and Pakistan, primarily for training and for providing technical support in uranium exploration. The revival of the uranium industry in recent years has led to the receipt of several TC project concepts on uranium geology, exploration, mining and production from Asia, Europe and Latin America. These are being reviewed for implementation in 2007.

The China National Nuclear Corporation (CNNC) has launched an active uranium exploration project in order to develop indigenous uranium resources to fuel their ambitious nuclear power programme. Prior to 1990, the exploration efforts were into 'hard rock' (metamorphic and igneous rocks) uranium, primarily located in south-east China. However, the recent focus has been to develop sandstone-hosted deposits amenable to In-Situ Leach (ISL) mining located in northern and north-west China between Mongolia, inner Mongolia and Trans Baikal, particularly in the Ordos Basin. These deposits are of low grade with $U_3O_8$ in the range of 0.02 to 0.05% with maximum of 0.235% and the uranium is present in the form of 'pitchblend' in most places and as 'coffnite' in some locations. The TC activity has been assisting China to explore and develop sandstone-hosted ISL amenable uranium deposits. IAEA experts have trained several geologists, scientists and engineers from the Bureau of Uranium Geology, Beijing and East China Institute of Technology (ECIT), Fuzhou on state-of-the-art geological and geophysical exploration techniques. Field visits were made in the Dongsheng Basin (inner Mongolia) where active drilling and pump tests of the aquifer are underway. The Agency has procured the Stratagen, EH-4, a geophysical instrument which measures electromagnetism to help determine basal structures in the host sandstone.

The TC mission in Egypt was mainly to review the documents prepared earlier by the Nuclear Materials Authority (NMA), Cairo on uranium occurrences in Egypt and to train the NMA staff on Rockware Software and particularly the 'logger'. The uranium occurrences in Egypt are in the Sinai and the eastern and western Deserts. The known uranium occurrences are mostly in granitic terrane and to a limited extent in sandstone, shales and limestones. Most of Egypt's known uranium occurrences were discovered by using airborne gamma ray surveys which can only detect anomalous radioactivity within the top 0.3 meter of soil/rock. With the judicious utilization of 'rock works' and 'logger' software, it should be possible for the Egyptians to digitally document the information from the drill holes yielding 3-dimentional plots. The Egyptians have also requested the IAEA to fund a project for evaluation of the environmental aspect of mining the black sands which are being utilized for recovery of titanium and zirconium but leaves behind radioactive uranium residue.

The TC mission to Pakistan was primarily for training staff members from the Pakistan Atomic Energy Commission on uranium geochemistry and mineralogy and to a limited extent for investigation of uranium sources in sedimentary, igneous and metamorphic environments. Pakistan has three active uranium mines, all employing ISL with an average grade of 0.02 - 0.03% $U_3O_8$. The field visit was made to the uranium sites in the north and north-west of Peshawar in Ahl in the Mansehra granite complex and Landai near Rustam in the Ambela granite complex. The uranium mineralization in Landai occurs in five Breccia zones and the uranium occurrences are associated with thorite, monazite and other minerals which are difficult for uranium recovery. The TC mission advised Pakistan to place more emphasis on looking for uranium in stable cratonic areas.

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## Spent Fuel Management for Pakistan

Assistance was requested in 2004 by Pakistan for development of a national system for radioactive waste management including spent fuel storage. An urgent component of the requested assistance was to provide an additional spent fuel storage facility at the Kanupp plant, a small CANDU plant built in 1971, where the at reactor (AR) spent fuel pool was projected to be full within a few years.

From a review of the situation at the site, an away from reactor (AFR) pool type facility was recommended as an interim storage solution, with a capacity to accommodate spent CANDU fuel arising from the lifetime operation of the Kanupp plant which was recently extended to 2017 (projected 40,000 bundles total).

Actions were taken for the assistance throughout 2005, including the organization of a TC meeting held in May in Bucharest to get the design concept reviewed by international experts appointed by the Agency. This meeting also served as a good opportunity to identify unresolved technical issues. A later visit to an AFR pool storage facility at Bohunice in Slovakia, initiated by the TO, was another occasion to provide solutions to some of the open questions from the review meeting. While some issues still remain to be resolved before finalizing the design, the AFR facility incorporated significant improvements with respect to the earlier design.

The design work is reported to be progressing in preparation for licensing of the AFR facility that is to be built.

TC concept design review meeting 4-7 July 2005

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## Irradiation Devices for Nuclear Fuel Elements

The objective of TC project ARG/4/087 is to support the Comision Nacional de Energia Atomica (CNEA) of Argentina in design, installation and operation of an irradiation device (pressure loop) that will simulate the operational conditions of commercial nuclear power fuel elements in the RA-3 research reactor. Completion of this project will better enable Argentina – and specifically the RA-3 facility to contribute to the development and testing of advanced fuel designs in support of expanding nuclear deployment.

Since 2003, the IAEA has facilitated the investment of over US $ 51,000 for human resources support and development (including expert missions, fellowships and scientific visits) and procured over US $110,000 worth in related technical equipment.

The project is currently challenged to meet an aggressive schedule. The work-plan will be revised in the second quarter of 2006 following an on-site monitoring visit to consider – among other issues – technical and safety requirements to enable further project implementation.

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## The IAEA International Symposium on 'Uranium Production and Raw Materials for the Nuclear Fuel Cycle'

Recently, the uranium raw material industry has revived after a slump of nearly two decades. Uranium exploration activities have been enhanced; outputs from operating uranium mines and mills are being expanded and new mines and uranium production centers are to be opened. There is an increased demand for well qualified and trained personnel and the IAEA has been requested to organize national and regional meetings and training programmes in appropriate subject areas.

The first of these on "Aerial and Ground Geophysical Techniques for Uranium Exploration and Advanced Mining and Milling Methods and Equipment" was hosted by the Uranium Corporation of India Limited (UCIL), Jharkhand, India, from 20 to 24 March 2006. Subjects covered included ground and airborne geophysical techniques, advanced drilling and mining techniques and acid/alkali leaching and production of uranium concentrates. The lessons learned from practical experiences were shared. The host country was represented by scientists and engineers from UCIL and the Atomic Minerals Directorate (AMD). The Chairman of the Atomic Energy Commission inaugurated the Symposium and the keynote lecture was delivered by the President and CEO of the Cameco Corporation. The TC Department facilitated the participation of 5 individuals from Member States.

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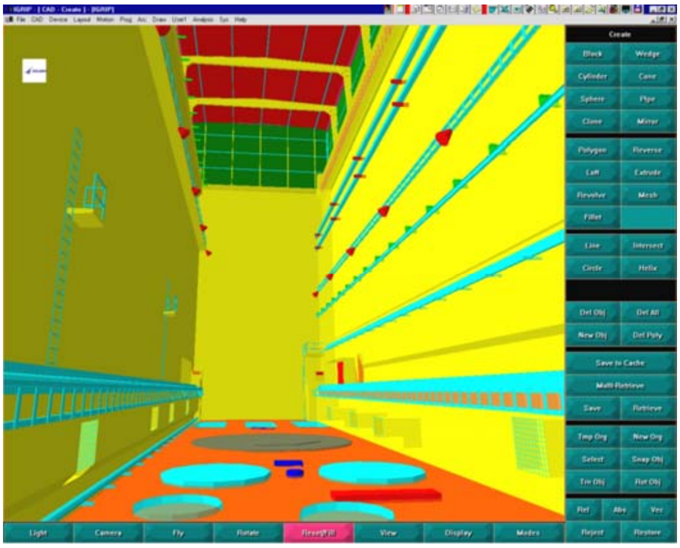
Participants in the Symposium on Aerial and Ground Geophysical Techniques for Uranium Exploration and Advanced Mining and Milling Methods and Equipment

# TC Projects and Waste Technology (WTS)

## Remote Viewing and Robotics for Decommissioning at A-1 NPP, Slovakia

The A-1 NPP was shut down after an accident in 1977 and as a result of this accident, a lot of the main components of the NPP became contaminated. The contamination level of several facilities, rooms, tanks and other equipment is high. As a consequence, inspection, decontamination and dismantling tasks require the use of advanced computer-aided and remote handling technologies. Many of these state-of-the-art technologies have been obtained with significant help of the IAEA within the frame of the TC project SLR/4/008.

The primary goals of this project include the design of a system(s) for (a) the acquisition and representation of 3D geometrical data: and (b) radiological (gamma) data in order to describe the actual state of hostile nuclear environments. The goals are being accomplished using existing infrastructure and advanced technology transfer e.g. laser scanning and gamma camera. The Figure below shows a simulated image of the A-1 reactor hall (software EUCLID). Advanced simulation software is being provided through France (EDF and CEA). Together with computer-aided tools and software, several manipulators have been developed and used for various decommissioning tasks.



Simulated reactor hall A-1

The MT-15 Universal Mobile Manipulator has been developed and used mainly for collection of radioactive samples, measurement of contamination level and radiation rate, light duty tasks like drilling, cutting, vacuum cleaning of floor, equipment insulation cutting and removal of material pieces and other objects from contaminated rooms.

DENAR-41 long reach manipulator

In addition the following 3 items have been developed and provided:

- MT-80/MT-80A general purpose manipulator, used for various decontamination and dismantling tasks; above all for cutting pipes and equipment and removing large pieces of contaminated material;
- DENAR-41 long-reach manipulator (see plate above), used mainly for decontamination of underground storage tanks, pipe cutting, cutting of tank surface coating layer, high-pressure washing of surfaces and pumping off radioactive sludge; and
- Remotely controlled tool carrier, used for treatment of liquid sludge from the underground storage tanks of A-1 NPP.

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## Upgrading Waste Processing Capacities at Centralized Facilities for Management of Radioactive Waste in Europe

This TC project was initiated in response to a request from Member States of Central and Eastern Europe to improve the technical capacity, efficiency, and safety of their existing waste management facilities. The focus was also to assist in the definition of the most efficient ways to improve waste management practices, to upgrade technical knowledge of key operational personnel, and to introduce integrated approaches to waste management planning and implementation, waste minimization requirements, recycling and reuse options, quality assurance (QA), and quality control (QC).

Towards this end, the Agency organized nine training workshops for transferring knowledge in the area of waste processing experiences to approximately 183 managers, responsible operators, and regulators. The training covered:

- radioactive waste classification, sorting, characterization and processing;
- management of liquid radioactive wastes;
- improvement of old storage and disposal facilities for radioactive waste;
- management of spent sealed radioactive sources;
- education and training of personnel for collection, processing and storage of radioactive waste;
- improvements of operational safety and security of waste processing and storage facilities;
- QA and operational stability of facilities for centralized processing and storage of radioactive waste;
- management of radioactive waste from nuclear applications; and
- demonstration and training on predisposal radioactive waste management methods and procedures.

Additionally, this project supported the participation of two professionals in the International Symposium on Disposal of Low Activity Radioactive Waste. These experts presented an example of a NORM-waste management system development, based on a real case, and a paper on the estimation of amounts of very low level radioactive waste arising during dismantling of technological installations. The participation of eleven additional professionals was supported through other TC projects.

Expert services were arranged for the preparation of lecturing materials for the "Management of Spent Sealed Radioactive Sources: Conditioning, Storage and Disposal". Furthermore, the the possibility of utilizing former nuclear weapon storage facilities for the management NPP radioactive waste was considered. This analysis concluded that in present conditions, the facilities could not be used directly for any waste management related activities. To use these facilities substantial renovation work would be necessary.

As a result of this project, the capacities and general knowledge of personnel (operational and managerial) working on radioactive waste management were improved through training and by making available working materials, information on methods & procedures for conditioning, storing and disposal of radioactive waste. Also, meetings and discussions at workshops enabled the exchange of expertise and information among professionals from 15 eastern and central European countries providing for improving basic knowledge and operational culture for waste processing and disposal. These results have enhanced substantially the safety, efficiency, and the general performance of waste processing facilities in these countries.

## Environmental Remediation

**Resource or residue?** – Various extraction techniques for metals have a dual use: they can be used for removing contaminants and they can be used for recovering metal value. One low-technology, low-cost option is the application of biological techniques. Certain microbes produce acid in the course of their metabolical activity that then helps to dissolve metals, including radionuclides such as uranium, from the ore or the contaminated material. This technique is usually carried out in the form of heap leaching, where the material is placed on an impermeable pad, sprinkled with a nutrient-containing solution and the resulting leachates are collected to be further processed. South America has a long tradition of metal mining with the resulting problem of NORM (naturally occurring radioactive material) containing residues. In the context of several TC projects both the resources as well as the residue management aspect are being addressed.

Through project **ARG/3/009** the Agency is helping Argentina to develop and optimize techniques to treat uranium mining residues by removal of the residual radionuclides. Eventually this technique can also be applied to environmentally friendlier milling of low-grade ores in the country. At the CNEA laboratories in Ezeiza near Buenos Aires experiments to select suitable bacteria strains and to optimize the procedure before upscaling to industrial scales are being undertaken.

**At 4600 m –** Peru is well-known for the extensive and widespread mining activities that have ben undertaken since the arrival of the Spanish 500 years ago and continue until today. These mining activities have left behind a legacy of unremediated heaps of residues and tailings stacks and ponds all over the country. Under the TC project **PER/8/014** the use of various biological techniques to stabilize or remediate such legacy sites will be explored. The fact that many mining sites are located at high altitudes in the Andes will make the application of these techniques very demanding. A test sites in the Province of Huancavellica has been selected. Here a tailings stack, located immediately at the Laguna San Francisco (4600 m above sea level) is contaminating the surface water resources of the valleys below. The Agency is helping with training the scientists at IPEN and providing conceptual advice as well as providing specialized equipment.

**Uranium from the Sahara**

Niger is the third-biggest uranium producer in the world. The mining site is located at Arlit in the north-east of the country, just inside the Sahara. Where once only Touaregs roamed, two towns with together some 70,000 inhabitants have developed over the past decades around the mining operation. The mining company built two townships with the entire necessary infrastructure for their workers. Around these, however, a vast informal settlement with very little infrastructure developed. The mining companies supply all the drinking water to the people. Recently local residents, with the support of European NGOs, have expressed concern over possible environmental and human impacts of the mining operation. Under the TC project NER/9/008 the Agency is helping with a programme to build capacity in the Ministry of Mines and Energy to independently assess possible radiological impacts of the mining in the region of Arlit. Another important element of the project is to help building trust between all stakeholders to ensure the sustainability of the mining operation, which is the single most important earner of foreign revenue for the country.

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## Systematic Assistance to the Islamic Republic of Iran to Establish a Radioactive Waste Management System

The Iranian radioactive waste management programme has been supported by 3 consecutive and partially overlapping TC projects to systematically develop the country's capability to manage institutional radioactive waste and to dispose of all low and intermediate level waste.

The assistance started in 1999 with the TC project IRA/4/028 on "Treatment of Low- and Intermediate-Level Radioactive Wastes". This was aimed at setting up a waste processing and interim storage facility for institutional low- and intermediate-level liquid waste and at training the involved staff in waste management safety.

The following project, IRA/4/033, was initiated in 2001 and concentrated on the "Development of National Waste Management Strategy". Its goal was to prepare a waste management strategy commensurate for the national authorities with the requirements of the national programme for nuclear power use and radioisotope applications.

The last, still active project, IRA/4/034, launched in 2003, on "Characterization of Candidate Sites for Low- and Intermediate-level Radioactive Waste Repository" assists the Iranian authorities in the site selection and completion of its characterization, preliminary safety assessment, and in developing a reference conceptual design for a near-surface repository for low- and intermediate level radioactive waste. A proposal for continuation of this project which will be intended to confirm the appropriateness of the selected site and establish a detailed design of the disposal facility is being assessed.

Treatment of liquid wastes

Radium conditioning

Within the mentioned projects the counterpart received 41 expert missions, sent 11 fellows for training abroad and 10 staff members to scientific visits in a number of developed countries. The IAEA procured and provided 23 items of different kinds, including technical publications, software and hardware, measuring devices, and technological equipment.

The technical cooperation support has allowed the responsible Iranian institutions to create a national strategy for radioactive waste management. Based on this, basic legislative and technical infrastructures have been developed serving for collection and conditioning of liquid and solid institutional waste. The new storage facility provides enough capacity for safe keeping all conditioned waste till the repository is available. Finally, the repository development programme has been initiated and is progressing reasonably towards the goal of resolution of the requirement to solve the country's needs with regard to the safe management of low and intermediate level waste and disused sealed sources.

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# Projects on Disused Sealed RadioactiveSources

## Background

Nuclear technologies have contributed to solving many difficult problems and enhanced quality in many areas of human activities. Tracer techniques have made understanding of complicated biological, industrial and agricultural processes easyer. Ensuring the quality of a weld for a gas pipeline was simplified utilizing a radioactive source that can be used in the field during the construction work. But this enthusiasm overshadowed the need to properly take care of the generated waste in the form of radioactive material or spent sealed radioactive source. For a considerable time that spanned over decades the main focus was to be able to master the utilization in the field of interest. The back end of the process to take care of the waste was played down. In many cases it was entirely forgotten.

Sealed sources being prepared for conditioning

Given the global nature of these applications and the time span involved, the problem became multidimensional and chronic. In most cases, radioactive waste and disused sources were left where they were last used causing a significant safety hazard and environmental concerns. Accidents in Brazil, Morocco, Thailand, USA, Spain and the UK occurred. Member States with both developed and developing nuclear infrastructures were at risk. While in developed countries the risk could be mitigated through the response of national agencies and the application of proper and well established procedures for waste management, an Agency programme was needed for the less well developed countries.

## Member States Requirements

Apart from the lack of required funds, some countries do not have the technical facilities and other capabilities to properly manage such waste. Lack of human resources, proper physical infrastrucutre for waste processing and technical "know how" made it virtually impossible to solve the waste problem in a reasonable, cost effective and sustainable manner. In certain cases, some initially considered and applied solutions enhanced the difficulties being faced by the Member States and accidents contiued to occur. Initial attempts to provide "know-how" and relevant technical information to reduce the consequences of the legacies of improper management of the sealed sources proved not to be totally effective.

Inappropriate storage of disused sealed radioactive sources

Discussions on the international level established that effective solutions to these chronic difficulties would require efforts that can deal with several problems simultaneously. It was obvious that enhancing the technical capabilities of the technical staff from developing countries would require more than just conventional training. It would go beyond that and include "on-the-job" training. The enhancement of the physical infrastructure would require more than just procurement of certain physical items of equipment. Software to ensure the reliability of all management processes within the broad framework of the disposal activities was needed and, last but not least, proper quality assurance and quality control procedures needed to be established.

## Technical Solutions and Implementation

It was understood that it is not possible to cut corners when effecting work that requires years of experience. This problem has also been resolved through regional cooperation and pooling technical capabilities and experience through the establishment of regional expert teams. These teams can operate within their regions and solve many of the problems that would not have a solution otherwise.

Technical solutions and facilities were not established easily. Procedures that are well established and tested, facilities that are *a-priori* established with well qualified experts and staff are pre-requisite for the success of such a programme. Extensive training was required.

To advance the resolution of some issues, the Technology Support Unit of WTS established operational requirements for facilities that can lead to functional disposal systems on the regional level. Where these facilities were not up to the required standards it was upgraded according to recommendations of carefully conducted review missions. Well established and tested technical procedures were developed to be used for the demonstrations of all relevant pre-disposal procedures. Demonstration centers were established in all regions for this task. The inter-regional TC project INT/4/131 played an instrumental role in the establishment and running these demonstrations. The course participants were kept to a practical maximum to ensure the participation of the trainees in all activities in an appropriate manner and to ensure that the procedures were mastered by the participants. During this phase of the programme a total of between 100 and 110 experts from 55 Member States received practical “on-the-job” training in processing of solid and liquid waste as well as the conditioning of sealed radioactive sources. Relevant processes such as the preparation and testing of concrete to be used for waste immobilization were also part of the practical exercises. This activity was further developed to include practical work on quality management systems and establishment of specific work plans to deal with very specific problems of given Member States and according to a well established schedule. Work plans for 10 countries were developed to address specifically identified waste management issues.

In the case of the disused sealed radioactive sources, management procedures require special expertise and unique skills that are difficult to transfer to practitioners with even moderate experience. On the other hand, the solutions for many types of the sealed sources cannot be postponed and there was some urgency to proceed. The strategy to deal with these sources was established on the basis of a regional expert team qualified for conducting the work according to established and written procedures. A mobile set of equipment was established to allow the work to be conducted in least developing countries where the sources were last used. It was identified that Radium sources pose one of the most chronic and long lasting problems. Again, INT/4/131 provided the instrument to recover the sources and condition them for long-term storage.

Apart from providing acceptable packages for storing the sources for the next 50 years it has provided a unified database of the status for the sources worldwide. Under the programme nearly 13,000 individual sources (approximately 1,600 GBq) were recovered, conditioned and rendered safe in 45 Member States.

A waste-container with shielded waste ready for sealing


A sealed container ready for transport

The interregional TC project INT/4/131 was established in 1997 and has been extended to operate for 10 years. The project has significantly contributed to establishing and strengthening national infrastructure in many developing countries. The project was successful in combining the technical development with the international cooperation to deliver the needed assistance in IAEA Member States. While the TC project is now coming to an end, its tangible outcome has initiated the creation of similar projects on regional levels to utilize the establishged methodology to address similar problems in the new TC cycle.

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A.Kahraman@iaea.org

# IAEA International Conference on the Safety of Radioactive Waste Disposal

## TOKYO, JAPAN, 3-7 OCTOBER 2005

The International Conference on the Safety of Radioactive Waste Disposal was organized by the IAEA and hosted by the Government of Japan through NISA, JNES and in cooperation with NEA/OECD, in Tokyo, Japan, 3-7 October 2005. Its main objective was to foster information exchange in the area of radioactive waste disposal including the choice of appropriate waste disposal options, the elaboration of safety cases, the development and application of safety assessment methodologies, the regulatory review and decision making process, the communication of safety issues to all interested stakeholders and confidence development. The conference was directed to a broad range of participants interested in radioactive waste disposal: governmental authorities, regulators, developers, operators and other experts and specialists involved in the development of national radioactive waste disposal strategies, involved in the implementation and operation of disposal facilities, in safety assessment and authorities responsible for the licensing of such facilities.

The conference was attended by more than 300 participants from 51 countries and 4 international organizations, approximately a third of them were from developing countries.

The programme consisted of eight topical sessions, each followed by a panel discussion, covering the following issues: (i) global safety regime, (ii) national strategies to ensure the safe disposal of radioactive waste, (iii) safety case and confidence building, (iv) geological disposal facilities, (v) near-surface disposal facilities, (vi) options for intermediate depth disposal, (vii) new facilities, reassessment of existing facilities and decision making on upgrading safety of RW disposal facilities, and (viii) communicating the safety of radioactive waste disposal facilities.

Each topical session was complemented by a poster session. The contributed papers, 106 in total and mostly from developing countries, were presented as posters and summarized by each session rapporteur in the plenary as an input to the panel discussion. Session summaries of topical sessions and conference findings are posted on the IAEA Tokyo Conference web page:

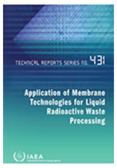
http://www-ns.iaea.org/meetings/rw-summaries/tokyo-2005-rad-waste-safety-disposal.htm

The following major recommendations were made:

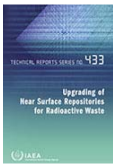
The IAEA should:

- collect and analyze the experience gained during the last 30-40 years in all facets of the disposal of radioactive waste, with emphasis on documenting the lessons learned;
- become an international archive for waste disposal knowledge and information;
- pursue the development of borehole disposal technology for disused sealed sources;
- provide guidance on how to optimize utilization of decision aiding techniques and other approaches in the context of NORM remediation;
- provide in a form suitable for public communication, explanations and justifications for the guidance that the Agency provides on Waste Safety;
- pursue its efforts to provide further education of professionals in the waste management area through the IAEA Network of Centres of Excellence for Training in Geological Disposal Technologies; and
- set a high priority on the education of young professionals and of the public at all levels in the radioactive waste management area.

# Recent Publications

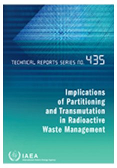


Technical Reports Series No. 431
Application of Membrane Technologies for Liquid Radioactive Waste Processing (2005)

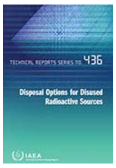


Technical Reports Series No. 433
Upgrading of Near Surface Repositories for Radioactive Waste (2005)

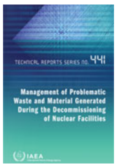
Technical Reports Series No. 434
Methods for Maintaining a Record of Waste Packages During Waste Processing and Storage (2005)



Technical Reports Series No. 435
Implications of Partitioning and Transmutation in Radioactive Waste Management (2005)

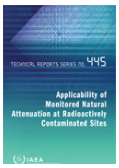


Technical Reports Series No. 436
Disposal Options for Disused Radioactive Sources (2005)



Technical Reports Series No. 441
Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities (2006)

Technical Reports Series No. 442
Remediation of Sites with Mixed Contamination of Radioactive and Other Hazardous Substances (2006)



Technical Reports Series No. 445
Applicability of Monitored Natural Attenuation at Radioactively Contaminated Sites (2006)

IAEA-TECDOC-1433
Remote Technology Applications in Spent Fuel Management (2005)

IAEA-TECDOC-1450
Thorium Fuel Cycle – Potential Benefits and Challenges (2005)

IAEA-TECDOC-1452
Management of High Enriched Uranium for Peaceful Purposes: Status and Trends (2005)

IAEA-TECDOC-1454
Structural Behaviour of Fuel Assemblies for Water Cooled Reactors (2005)

IAEA-TECDOC-1463
Recent Developments in Uranium Exploration, Production and Environmental Issues (2005)

IAEA-TECDOC-1467
Status and Trends in Spent Fuel Reprocessing (2005)

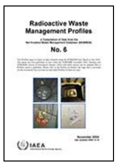
IAEA-TECDOC-1476
Financial Aspects of Decommissioning (2005)

IAEA-TECDOC-1481
Anthropogenic Analogues for Geological Disposal of High Level and Long Lived Waste (2006)

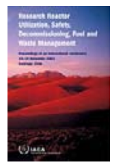
IAEA-TECDOC-1482
Technical, Economic and Institutional Aspects of Regional Spent Fuel Storage Facilities (2005)

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 Managem. Profiles No. 6
A Compilation of Data from the Net Enabled Waste Management Database (NEWMDB) (2005)



STI/PUB/1212
Research Reactor Utilization, Safety, Decommissioning, Fuel and Waste Management. Proc. of an International Conf., Santiago, Chile, November 2003 (2005)

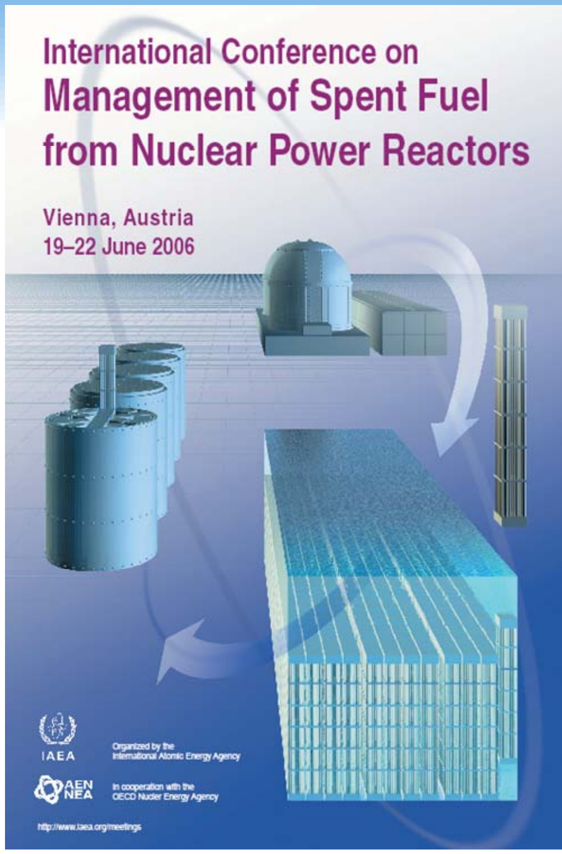
STI/PUB/1228
Environmental Contamination from Uranium Production Facilities and their Remediation Proceedings of an International Workshop, Lisbon, Portugal, February 2004 (2005)

# Meetings in 2006

| Date | Title | Place | Contact |
|---|---|---|---|
| 25-26 April | Technical Meeting on Status and Trends in Water Reactor Fuel Performance and Technology | Vienna, Austria | V.Inozemtsev@iaea.org |
| 25-28 April | Technical Meeting on Training in and Demonstration of Waste Disposal Techniques in Underground Research Facilities – an IAEA Network of Centres of Excellence | Oskarshamn, Sweden | M.Gray@iaea.org |
| 29-31 May | International Seminar on Minimization of the Use of Highly Enriched Uranium (HEU) in Civilian Nuclear Applications | Oslo, Norway | P.Adelfang@iaea.org I.Goldman@iaea.org |
| 30 May - 2 June | TEGDE Meeting – Technical Group on Decommissioning | Vienna, Austria | M.Laraia@iaea.org |
| 12-16 June | Technical Meeting on Technological Implications of Retrieveability on Geological Disposal of Radioactive Waste | Vienna, Austria | B.Neerdael@iaea.org |
| 19-22 June | International Conference on Storage of Spent Fuel from Power Reactors (Special Emphasis on Long Term Storage Issues) | Vienna, Austria | W.Danker@iaea.org |
| 19-23 June | Technical Meeting on Application of Thermal Technologies for Processing of Radioactive Waste | Vienna, Austria | J.Kelly@iaea.org |
| 3-7 July | Technical Meeting on Experience in Managing Disused Radioactive Sources | Vienna, Austria | J.Balla@iaea.org |
| 25-28 July | Technical Meeting on National Experiences on Repatriation of Research Reactor Spent Fuel to the Country of Origin | Vienna, Austria | I.Goldman@iaea.org |
| 28 Aug. - 1 Sep. | Technical Meeting on In-Situ Leaching of Uranium Deposits | Almaty, Kazakhstan | C.Ganguly@iaea.org |
| 18-22 September | Training Meeting/Workshop on the Role of Partitioning and Transmutation in Mitigating the Potential Environmental Impacts of Nuclear Fuel Cycle | ICTP Italy | H.Nawada@iaea.org C.Ganguly@iaea.org |
| 25-29 September | Training Meeting/Workshop on Designing and Planning of Geological Repositories | Vienna, Austria | B.Neerdael@iaea.org |
| 26-28 September | Technical Meeting on High Burnup Fuel Experience and Economics | Sofia, Bulgaria | J.Killeen@iaea.org |
| 9-11 October | Training Meeting/Workshop on Modernization and Refurbishment of Research Reactors | Delft, Netherlands | E.Bradley@iaea.org |
| 30 Oct. – 3 Nov. | Technical Meeting on Lessons Learned by Member States in Operating Low Level Waste Processing and Storage Facilities | Vienna, Austria | A.Kahraman@iaea.org |
| 20-22 November | Technical Meeting on Research Reactor Support Needed for Innovative Nuclear Power Reactors and Fuel Cycles | Vienna, Austria | E.Bradley@iaea.org |
| 27-30 November | Technical Meeting on Hot Cell Post Irradiation Examination Techniques and Poolside Inspection of Water Reactor Fuel Assemblies | Buenos Aires, Brazil | V.Inozemtsev@iaea.org |
| 4-8 December | Technical Meeting on Pressurized Heavy Water Reactor (PHWR) Fuel Modelling | Mumbai, India | J.Killeen@iaea.org |
| 11-15 December | International Conference on Lessons Learned from Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities | Athens, Greece | M.Laraia@iaea.org |

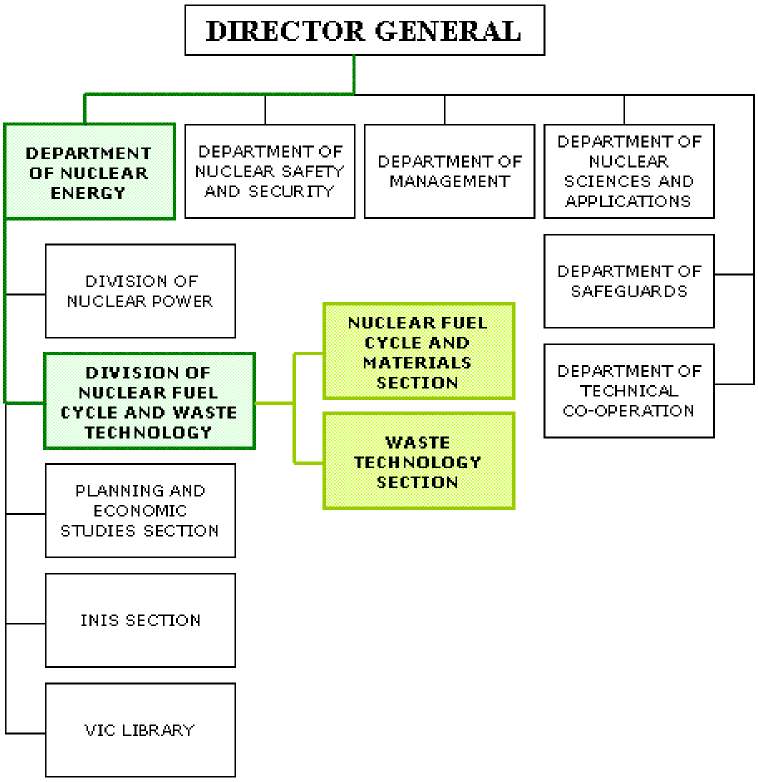
# IAEA International Conference on Management of Spent Fuel from Nuclear Power Reactors

## 19-22 June 2006
## Vienna, Austria




- The opening day features “breaking news” and emerging initiatives in the evolving international scene, such as the US Global Nuclear Energy Initiative, the Russian President’s Initiative relevant to spent fuel management and the relevance of multi-national approaches to spent fuel management.
- Sessions and panels on 20 June focus on nuclear safety, followed by spent fuel storage technologies on 21 June, while 22 June concludes with a look to the future including conclusions and recommendations for international activities.
- Conference President, Jacques Bouchard, France.
- Held in cooperation with the OECD/NEA. IAEA co-scientific secretaries are W. Danker (NE) and E. Warnecke (NS) with H. Schmid (MT) as administrative point of contact.
- The preliminary conference programme and related information are available at http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=144
- The previous spent fuel conference was held in June 2003 and attended by 125 participants from 35 countries…proceedings are available at http://www-pub.iaea.org/MTCD/publications/PDF/csp_020c/Start.pdf

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)

- Main activities
  http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_home.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_infcis.html

## Waste Technology Section (WTS)

- Main activities
  http://www.iaea.org/OurWork/ST/NE/NEFW/wts_home.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_information.html

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