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Euratom FP7 Research & Training Projects

Volume 2

PROJECT INFORMATION

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INTRODUCTION

This brochure provides an outline of the second batch of nuclear research and training activities funded by the Seventh Framework Programme of the European Atomic Energy Community (FP7 Euratom, 2007-2011). The projects described here all address major issues and challenges in nuclear fission research, such as the management of high-level/long-lived radioactive waste, nuclear safety, advanced nuclear systems, radiation protection (e.g. risks from low doses) and horizontal activities, such as research infrastructures and human resources (e.g. training and mobility).

The primary goal is to generate and exploit knowledge and develop scientific and technical competences and know-how in applied nuclear science and technology, especially in the areas of safety, reliability, sustainability and cost-effectiveness of nuclear energy systems. Importantly, these projects contribute to the further consolidation of the European Research Area (ERA) in the nuclear energy and radiation protection sectors. Euratom activities on research and development for nuclear fusion are not covered in this publication.

World energy demand is increasing rapidly. Over the next 50 years, global energy use is expected to double (at the very least), with electricity demand growing the fastest. Security of energy supply and climate change are both high on the political agenda, and the European Union (EU) has set clear targets for drastically reducing greenhouse gas emissions: 20 % by 2020, and between 60 and 80 % by 2050.

Electricity requires reliable, efficient and clean generation systems. Nuclear fission, which contributes more than 30 % of the EU's electricity generation and represents two-thirds of its carbon-free electricity production, can provide a constant base-load electricity supply, thereby reducing dependence on fossil fuels. As a reliable and indigenous source of energy, nuclear power can also contribute to the EU's energy independence and security of supply.

Therefore, nuclear energy is a viable option for countries wishing to use this technology as part of a balanced energy mix. Furthermore, emerging advanced fission technologies offer the potential of significant improvements in the efficiency and sustainability of nuclear energy, while minimising production of the most hazardous radioactive waste, and the possibility of nuclear energy use in areas other than electricity production (e.g. process heat for industrial processes such as hydrogen production).

The EU is currently a world leader in the areas of nuclear technology and waste management. Maintaining Europe's competitiveness over the next decade is key to ensuring that it meets its 2020 energy targets. Over the longer term, the new generation of nuclear fission reactors can contribute significantly to realising the EU's 2050 vision of a low-carbon economy.

Initiatives such as the Strategic Energy Technology Plan (SET-Plan) to accelerate the development and deployment of low-carbon technologies, and the Sustainable Nuclear Energy Technology Platform (SNE-TP) coordinating research and development in nuclear systems and safety in Europe, have highlighted the importance of nuclear energy to Europe's transition to a low-carbon economy. The Euratom Framework Programme seeks to support these initiatives to the extent possible.

Informing and protecting the public

Nuclear safety is top priority. The EU has an outstanding nuclear safety record; however, research continues in order to maintain this high level of safety and to understand better the risks and hazards associated with the use of radiation in medicine and industry. In all uses of radioactive materials, the overriding principle is to protect citizens and the environment.

Nuclear fission is a major contributor to Europe's carbon-free energy mix, but it is not a technology that is widely understood outside scientific circles. High on the list of public concerns are operational reactor safety and the management of long-lived radioactive waste.

Managing radioactive waste safely is a concern for all countries, whether it relates to the waste from electricity production or from radiation use in research, industry and medicine. At present, all irradiated fuel and associated wastes from nuclear reactors are safety managed according to very strictly enforced regulatory requirements.

Low-hazard waste is disposed of at the industrial scale, while the most hazardous waste (e.g. spent nuclear fuel or the residues from the recycling of this fuel), which exists in much smaller volumes, is safely stored temporarily in surface or near-surface facilities. At the same time, research and development (R&D) into final disposal in deep geological repositories is also progressing. The study of various host rocks and barrier systems has come a long way, and there is consensus within the technical community that there is now sufficient acquired scientific and engineering knowledge to progress towards actual implementation. The R&D associated with this final phase is becoming an increasing focus of the Euratom programme.

Euratom and its EU Member States are also committed to maintaining a high level of safety of nuclear installations, both for currently operating reactors and future innovative reactors, in which the emphasis will be on passive rather than active safety systems that are designed into the fundamental concept at a very early stage. Upholding this commitment also relies on supporting the ongoing training of a highly skilled workforce, and ensuring that a steady stream of new and highly skilled scientists and engineers adds to its numbers.

In all these areas, effective communication is needed between the public and industry, researchers, engineers and policy makers. The nuclear community needs to explain relevant scientific facts clearly and dispassionately, particularly in relation to safety and waste. As part of this process, the European Commission takes its role in disseminating and communicating the results of Euratom programmes very seriously.

There is a growing EU dimension to all environmental and energy-related issues, though the decision to use nuclear power remains essentially a political one taken at the national level. Many considerations, ranging from socio-economic to technical, must be taken into account. Crucially, such decisions need to be supported by good quality science; they must be taken from a position of knowledge, not one of ignorance. Research, such as that supported by FP7 Euratom, is supplying this knowledge.

The programme

FP7 Euratom was formally adopted at the end of December 2006, and covers the five-year period 2007-2011. The legislative basis of the FP7 Euratom programme is described in the Decision of the Council of the EU No. 2006/970/Euratom. Of FP7 Euratom's total budget of EUR 2.75 billion, EUR 287 million has been earmarked for the programme on nuclear fission and radiation protection research and training activities, and the second batch of supported projects are described in this brochure. This programme is implemented through calls for proposals followed by evaluations carried out by independent experts. A range of funding schemes (see box) are available, promoting cooperation and synergy through multi-partner consortia. The basis for financial support is shared cost and non-profit.

Many of the activities in FP7 Euratom will be a continuation of long-term research supported in previous Euratom programmes. In addition, FP7 is capitalising on the progress made during the Sixth Framework Programme (FP6) towards establishing the ERA in nuclear science and technology, particularly as a result of new funding instruments such as Integrated Projects and Networks of Excellence.

A significant development in this respect has been the creation of technology platforms, initiated as proposals from the stakeholder community and studied in pilot actions supported during FP6. During the first half of FP7, this strategy has been actively pursued and has culminated in the successful launch of SNE-TP (www.snetp.eu) and the Implementing Geological Disposal Technology Platform (IGD-TP; see below). These forums have been established around agreed visions for future scientific and technical development in the respective fields, and members collectively define the platform's Strategic Research Agenda (SRA) and Deployment Strategy in order to realise these visions. This includes R&D in nuclear systems and safety as well as in geological disposal. Such strategic planning will enable FP7 Euratom to remain as effective as possible by focusing on priority activities.

Similarly, with regard to the research on radiation protection and the risks from low doses and protracted exposures, the Multi-Disciplinary European Low Dose Initiative (MELODI; see below) is defining its own SRA. This agenda will also help prioritise Euratom support.

FP7 Euratom encourages greater cross-fertilisation between the various areas of the Euratom programme and between nuclear and non-nuclear disciplines. This cross-cutting approach is evident in a number of projects in the present batch, for example those covering numerical simulation and multi-scale modelling, or on gas production and migration in geological repositories, which has important links with the field of carbon capture and storage.

On the administrative side, and in common with the much larger EC FP7, the European Commission has also put in place simplified and standardised procedures to facilitate access to and implementation of the programme (e.g. managing calls and evaluation, project management, as well as administrative and financial guidelines and requirements).

Regarding key EU policy objectives, FP7 Euratom continues to contribute to:

▶ PROTECTION OF SOCIETY AND ENVIRONMENT

This principle lies at the heart of all EU policy making, and is reinforced in the founding treaties for both Euratom and the European Community.

▶ ENERGY SUPPLY AND CLIMATE CHANGE

Securing the EU's energy supply, establishing sustainable economic growth, and fighting climate change are essential. The Commission's energy policy for Europe entitled 'Energy for a Changing World' (published in January 2007), and the comprehensive 'climate and energy package' (approved by the Council of Ministers in April 2009) support a strategy based on a diverse mix of low-carbon energy sources. The Community's Strategic Energy Technology Plan (SET-Plan) is an integral part of this policy and through a technology neutral approach is promoting research and innovation in all low-carbon energy sources that can help to respond to the EU's energy challenges.

▶ EUROPE'S 2020 STRATEGY

The key headline targets of Europe's 2020 strategy for 'smart, sustainable and inclusive growth' include the energy objectives already expressed in EU energy policy (i.e. targets for CO2 reduction, efficiency measures, growth of renewables) together with the goal of 3% of the EU's GDP to be invested in R&D. These will therefore be key policies of the EU over the next decade and are of clear relevance to research in all low carbon energy systems.

▶ INTERNATIONAL COOPERATION

The Euratom Framework Programme is making full use of the opportunities offered through multilateral (e.g. Generation IV International Forum – GIF) and bilateral agreements on nuclear R&D cooperation and peaceful uses of nuclear technology between Euratom and third countries. It is also working with other international organisations and bodies such as OECD/NEA, IAEA or ISTC and STCU. Third-country partners are welcome in Euratom projects, though normally they would receive no funding from the Euratom programme. Increasingly, Euratom is adopting a structured dialogue approach with key third countries that will lead to specific topics of mutual interest being included in the calls for 2009 and 2010.

FP7 research activities

The overall aims of the programme are to establish a sound scientific and technical basis to advance practical developments for the safe management of long-lived radioactive waste, to promote the safe, resource-efficient and competitive exploitation of nuclear energy, and to ensure a robust and socially acceptable system of protection of man and the environment against the effects of ionising radiation.

Research activities are proposed under five main themes: management of radioactive waste, reactor systems and safety, radiation protection, and the key cross-cutting areas of research infrastructures and human resources, mobility and training. The latter activities are increasingly embedded within the projects funded under the thematic priorities.

The 22 FP7 Euratom projects listed below are described in greater detail within this brochure. These projects represent the second batch of FP7 Euratom Nuclear Fission and Radiation Protection projects to be funded,

and were proposed following the call for proposals published on 30 November 2007 with deadline of 15 April 2008. Their presentation here follows the format and structure of the 2008 Work Programme, which was the basis for the call. Similar calls take place during each of the five years of the programme, though the detailed structure of the Work Programmes may differ.

Management of radioactive waste

This area of research is dedicated to the geological disposal of highly active and long-lived radioactive waste, and the reduction in volume and toxicity of the most hazardous component of this waste through partitioning and transmutation (P&T). P&T involves the separation of the more hazardous isotopes and their conversion to less hazardous ones. These latter activities are increasingly being integrated with the research on advanced nuclear systems.

FORGE: Fate of Repository Gases

- Radioactive waste must be disposed of carefully as it may remain hazardous for thousands of years. The long-term management of radioactive waste usually involves deep underground disposal, where the surrounding rocks and man-made structures work together to prevent radioactivity from escaping into the environment. Over the millennia, some gases will be produced in repositories: hydrogen is released as metals corrode, and the decomposition of organic materials found in some nuclear waste generates methane and carbon dioxide. The aim of FORGE is to understand where and how these gases form and how they move through the repository and surrounding rocks.

MoDeRn: Monitoring Developments for Safe Repository Operation and Staged Closure

- Spent nuclear fuel and long-lived radioactive waste must be contained and isolated for very long periods, and current schemes for its long-term management involve disposal in deep geological repositories. The successful implementation of a repository programme for radioactive waste relies on both the technical aspects of a sound safety strategy and scientific and engineering excellence as well as on societal aspects such as stakeholder acceptance and confidence. Monitoring is considered key in serving both ends. It underpins the technical safety strategy and quality of the engineering, and can be an important tool for public communication, contributing to public understanding of repository behaviour and raising confidence in this field.

CDT: Central Design Team for a Fast-Spectrum Transmutation Experimental Facility

- The materials testing reactor referred to as Belgian Reactor 2 (BR2) and located in Mol, Belgium, is used for nuclear research and production of medical isotopes. It will eventually be replaced by the Multi-purpose Hybrid Research Reactor for High-tech Applications (MYRRHA), an experimental accelerator-driven system (ADS). MYRRHA will represent a new kind of research reactor, also capable of demonstrating the technical feasibility of efficient transmutation, which can significantly reduce the toxicity and quantity of the long-lived components of nuclear waste. The Central Design Team (CDT) for such a Fast-Spectrum Transmutation Experimental Facility (FASTEF) is a multi-disciplinary European team representing experts from both industry and research organisations. Working on the premises of the Belgian Nuclear Centre (SCK-CEN) in Mol, CDT is advancing the design of the MYRRHA-FASTEF concept to make it ready for demonstration. The new system will be able to function in two configurations: initially in subcritical mode (i.e. using spallation neutrons produced by a particle accelerator) and, in the next phase, in critical mode.

FAIRFUELS: Fabrication, Irradiation and Reprocessing of Fuels and Targets for Transmutation

- The FAIRFUELS project paves the way towards more efficient use of fissile material in nuclear reactors and seeks to reduce the volume and toxicity of high-level, long-lived radioactive waste. By closing the nuclear fuel cycle through increased recycling and transmutation of nuclear waste, FAIRFUELS contributes to the sustainability of nuclear energy.

Nuclear installation safety and advanced nuclear systems

This refers to the continued safe operation of current reactor systems and investigations into the potential of future advanced systems, including the safety, waste-management and anti-proliferation aspects.

SARNET 2: Severe Accident Research Network of Excellence

- To enhance the safety of existing and future water-cooled nuclear power plants (NPPs), the SARNET2 project pools the expertise of 42 organisations to resolve key remaining scientific and technical uncertainties regarding severe accidents. Furthering work initiated under the previous Euratom Framework Programme, SARNET2 will optimise resources by establishing research groups whose work may continue beyond the scope of the project. The network will

help researchers share experience and knowledge, reducing fragmentation in European severe accident research and development (R&D).

NURISP: Nuclear reactor integrated simulation project

- To enhance the effectiveness of nuclear science and engineering, a new generation of simulation tools is needed. The nuclear industry, technical safety organisations, research centres and universities would benefit greatly from simulation tools that can perform more accurate modelling of physical phenomena, offer more capacity to quantify uncertainties and allow increased integration of different computer codes. Such tools would ideally operate in an environment that provides common functions for pre- and post-processing as well as for testing 'multi-physics coupling' (i.e. interactions between different physical fields such as thermal hydraulics and structural mechanics, which may affect the response of a system). NURISP is developing an informatics platform that addresses these needs.

PERFORM 60: Prediction of the effects of radiation for reactor pressure vessel and in-core materials using multi-scale modelling – 60-year foreseen plant lifetime

- The materials used to construct nuclear power plants (NPPs) are exposed to extremely high levels of radiation. Over time, this causes the materials to undergo degradation and may limit their operational lifetime. PERFORM 60 is developing virtual tools to predict the effects of radiation and corrosion on power station components. The tools will help Europe's nuclear industry ensure that its power plants remain safe as they age.

CP-ESFR: Collaborative Project for a European Sodium Fast Reactor

- Among the next generation of nuclear reactors (i.e. Generation IV systems), those with fast spectra promise to operate sustainably, generating energy in a 'closed fuel cycle' that allows them to use natural resources more efficiently and to produce less waste. One such reactor is the sodium-cooled fast reactor (SFR). This concept has the most comprehensive technological basis, and under the previous Framework Programme a research roadmap was set out identifying and organising research and development (R&D) efforts. The collaborative project for a European Sodium Fast Reactor carries on this work and implements significant R&D activities in this important area.

Radiation protection

These projects aim to establish a more thorough understanding of the mechanisms of radiation carcinogenesis and to better quantify the risks from exposure to radiation at low and protracted doses. This has important implications for the use of ionising radiation in both medicine and industry, including nuclear energy. Another aim is to improve the coherence and integration of emergency management in Europe through the development of common tools and strategies and demonstrate their efficacy in operational environments. The main goal in radiation protection research as a whole is to provide the scientific basis for a robust, equitable and socially acceptable system of protection that will not unduly limit the use of radiation in medicine and industry.

STORE: Sustaining access to tissues and data from radiobiological experiments

- STORE is establishing a platform to facilitate the storage and retrieval of data and corresponding biological material from past, current and future radiobiological studies. The platform will make it easier to share data and material across the radiobiology community.

ALLEGRO: Early and Late Risks to Normal/Healthy Tissues from the Use of Existing and Emerging Techniques for Radiation Therapy

- With an increasing population of surviving cancer patients treated with radiation therapy, the harmful effects of the radiation on normal tissue are becoming more evident. ALLEGRO is investigating many of the aspects of damage to normal, healthy tissues surrounding tumour sites that are not yet well understood. This applies to both conventional treatment techniques and emerging techniques that make use of protons and heavy ions.

DETECT: Design of optimised systems for monitoring of radiation and radioactivity in case of a nuclear or radiological emergency in Europe

- After the Chernobyl accident in 1986, many European countries installed systems to monitor radioactive contamination of the environment. These systems are linked together through a network and provide early warnings of nuclear accidents. Many of the older monitoring systems require updating, and some regions would benefit from new networks built with state-of-the-art technology. DETECT is developing a tool that will optimise the deployment of environmental radiological monitoring devices to be used during nuclear emergencies, in some cases in conjunction with portable devices. This will help to ensure that nuclear regulators and emergency

response organisations can quickly detect any accidental releases of radioactivity into the environment.

Support and access to infrastructures

Euratom support in this field serves to facilitate access by European research workers to key nuclear R&D infrastructures, such as material test reactors, hot labs, underground research laboratories, tissue banks and radiobiology facilities, which are crucial for reinforcing and developing knowledge and services at the European level. The design and construction of new infrastructures or the refurbishment of existing facilities can also be supported in this part of the programme, subject to budget limitations.

ACTINET-I3: ACTINET Integrated Infrastructure Initiative

- Actinides are heavy elements, some of which are created during the production of energy from nuclear fuel, and remain as a component of radioactive waste. Research in actinide sciences is essential for managing nuclear waste and for developing future nuclear fuel, representing an important field of research that is supported by several European infrastructures. The ACTINET-I3 consortium aims to reinforce the networking of these infrastructures and facilitate their efficient use by the European scientific community. This will help maintain Europe's leading position in the field of nuclear energy research.

Human Resources, Mobility and Training

Retaining human competences and know-how in the nuclear disciplines and ensuring a high level of education and training are essential if Europe is to maintain its exemplary record in nuclear safety and its peerless nuclear safety culture. The Euratom programme has a key coordinating role to play in this area, and an important innovation in the 2008 call was the introduction of the Euratom Fission Training Scheme (EFTS) following close consultation with the stakeholder community across the sector. Proposals were requested from networks of organisations looking to better structure and coordinate training capacities in research in particular thematic areas within scope of the Euratom programme. A strong synergy with the ENEN (European Nuclear Education Network) approach and the participation of industry was encouraged, with emphasis on multidisciplinarity and/or transnational and intersectoral mobility.

ENEN-III: European Nuclear Education Network Training Schemes

- The nuclear industry relies on highly trained people to safely run and maintain existing installations, as well as to build new ones. The ENEN-III project will help to preserve nuclear knowledge and skills in Europe by creating a range of training schemes designed to suit the needs of different professions in the nuclear sector. Special attention is devoted to the training of professionals in the areas of Generation III and IV nuclear reactors. The ECVET system will be applied (European Credit systems for Vocational Education and Training).

ENETRAP-II: European network for education and training in radiation protection – Part II

- Nuclear technology is playing an increasingly visible role in society: the nuclear industry is flourishing, medical applications involving ionising radiation are growing in number and radioactive materials are being used in a wide range of research and non-nuclear industrial activities. Maintaining a high level of competency in radiation protection is therefore crucial to ensuring the safe use of ionising radiation into the future, across all applications. However, the number of experts in radiation protection is decreasing. ENETRAP-II is developing European standards for training schemes that support students and professionals in their efforts to gain and maintain high-level radiation-protection knowledge and skills. These training schemes will comply with the recommendations of the European Basic Safety Standards. They will also focus specifically on vocational training for radiation protection experts (RPEs) and radiation protection officers (RPOs).

PETRUS II: Towards a European Training Market and Professional Qualification in Geological Disposal

- Building expertise in the specific areas of engineering and science to address the geological disposal of radioactive waste requires a unified European effort over the next several decades. The PETRUS II project aims to ensure the continuation, renewal and improvement of the professional skills of European specialists in this field. Close collaboration between key training providers, universities and radioactive waste management agencies is central to the project. PETRUS II is committed to developing common frameworks for the implementation and delivery of education and training (E&T) programmes that can endure well into the future.

Cross-cutting topics

SNETP Office: Secretariat of the Sustainable Nuclear Energy Technology Platform

- The European Sustainable Nuclear Energy Technology Platform (SNETP), launched in September 2007, is a forum supporting technological developments in nuclear fission as part of a sustainable, low-carbon energy mix. SNETP members share a common vision and work together to make the most of European scientific and engineering resources. The purpose of SNETP Office is to provide professional support for the ongoing management of SNETP's many operations.

TENEB: Towards a European Network of Excellence in biological dosimetry

- In the highly unlikely event of a large-scale radiological accident or a terrorist attack involving a nuclear facility, levels of radiation exposure can vary considerably. An important initial step in the medical response is the triage of patients according to the severity of exposure using biological dosimetry. In Europe, there are several competent laboratories, but each can perform dose assessments for incidents involving only a few people. TENEB will perform a small study to determine the feasibility of creating a network of laboratories that are better prepared for a radiological mass casualty event.

EU-NMR-An: Towards a European Competence Centre for Nuclear Magnetic Resonance on Actinides

- Valuable information about actinide elements can be obtained using techniques based on nuclear magnetic resonance (NMR). EU-NMR-An is a small project that builds European competence in NMR while identifying future trends and promising applications in NMR actinide research. By so doing, the project ultimately supports the establishment of a European Competence Centre for NMR on Actinides.

EUROPAIRS: End-user requirements for industrial-process heat applications with innovative nuclear reactors for a sustainable energy supply

- To reduce the greenhouse gas (GHG) contribution of industrial heat applications such as hydrogen and transport-fuel production, an innovative technology, the (Very) High Temperature Nuclear Reactor ((V)HTR), could provide an alternative to fossil-fuel boilers. The (V)HTR is able to cogenerate electricity and large amounts of low-carbon process heat, and promises both high efficiency and advanced safety features. Its modular design provides the flexibility needed for efficiently powering energy-intensive processes. Nuclear cogeneration has the potential to significantly contribute to a low-carbon economy and reduce the demand for fossil fuels. EUROPAIRS unites the nuclear community and conventional industries to address the challenges of coupling the nuclear heat source with the end user, and to assess the viability of this new technology in a crucial step towards demonstration.

NUCL-EU: Reinforcing the networking of FP7 National Contact Points (NCP) and third country contacts in the Euratom Fission Programme

- Research and technology development in the area of nuclear fission and radiation protection under the Euratom programme is booming. However, there is a clear need for greater coordination of research activities at both European and global levels in order to further stimulate innovation and improve the EU's competitiveness worldwide. NUCL-EU aims to create an efficient, proactive and sustainable National Contact Point (NCP) network with a view to stimulating closer cooperation among all the NCPs in the Euratom Programme.

Other actions (not part of the call for proposals)

EBSSYN: A Joint European Commission/ Nuclear Energy Agency Engineered Barrier System Project Synthesis Report

- Geological disposal of long-lived radioactive waste requires several 'man-made' or engineered barriers between the waste and the accessible environment. EBSSYN will synthesise a multi-year project – sponsored through theEuropean Commission (EC) and Nuclear Energy Agency/Organisation for Economic Co-operation and Development (OECD/NEA) – on the engineered barrier system (EBS) to be used in geological disposal. The EBS project has examined how to design, characterise, model and assess the performance of the EBS, and how to integrate EBS issues in the safety case for disposal.

HLEG: Report of the high-level and expert group on European low dose risk research

- Although there has been a decline in scientific and regulatory expertise in radiobiology and radiotoxicology during the past decades, plans to establish new nuclear plants and the increasing application of ionising radiation in medicine now accentuate the need to revitalise the field of low dose risk research. It is necessary to address these issues at a strategic level in Europe. The European High Level and Expert Group (HLEG) produced a report that identifies key policy issues, assesses the state of science and proposes a European research strategy. The report outlines the way forward for implementing this strategy and addresses overarching policy questions.

Implementing Geological Disposal Technology Platform (IGD-TP)

Safe long-term management of radioactive waste is a concern of governments and citizens alike. The Euratom programme has funded R&D on this topic for many years, and in FP7 the emphasis is increasingly on implementation-oriented activities. On 12 November 2009, with the support of the European Commission, a group of European radioactive waste management organisations launched IGD-TP. Other platform members include key research institutes, organisations and industrial players, and membership is growing all the time. All endorse the common vision that by 2025 the first geological disposal facilities for nuclear waste will be operating safely in Europe. IGD-TP will facilitate pooling of critical European resources and co-ordinate future R&D in support of this vision, which also responds to the technology challenges laid out in the SET-Plan. Though this crucial development has come too late to influence the research undertaken in the projects described in the present brochure, the Euratom work programmes for successive calls for proposals are increasingly oriented to the IGD-TP strategy. More information on IGD-TP is available at www.igdtp.eu.

Multidisciplinary European Low-Dose Initiative (MELODI)

For many years the Euratom programme has been concerned with the fundamental question of the risks from low and protracted exposure to ionising radiation, and has recognised the need for improved structuring of the research effort across Europe in this field. The creation of the 'High-Level and Expert Group', with support from the HLEG project above, was the decisive step enabling the establishing of MELODI in 2009. This 'joint-programming initiative' brings together the major national funding agencies supporting radiation protection research in Europe. The growing use of radiation in medical diagnostic and therapeutic techniques is responsible for a significant rise in doses to the public, and MELODI will ensure the necessary multidisciplinary approach across the medical sector to understand and mitigate the risks involved. As with IGD-TP, this strategic initiative will have an increasing effect on the choice of topics for inclusion in future Euratom work programmes. For further details on this major initiative, visit www.melodi-online.eu.

Looking forward

The third FP7 Euratom call for proposals in the area of Nuclear Fission and Radiation Protection was published on 19 November 2008, with a closing date of 21 April 2009; the projects are starting during the first half of 2010. The fourth call for proposals was published on 13 November 2009, with a closing date of 8 April 2010. For further information, please visit http://cordis.europa.eu/fp7/euratom-fission

Funding Schemes

Collaborative Projects (CPs) foster collaborative R&D activities amongst European partners (e.g. industry, research institutes and organisations, academia). Both small/medium-scale focused projects and large-scale integrating projects can be funded.

Coordination and Support Actions (CSAs) promote networking and coordination type activities or provide support for such aspects as dissemination of programme results or pilot studies for possible future collaborative projects. CSAs cannot fund R&D activities per se.

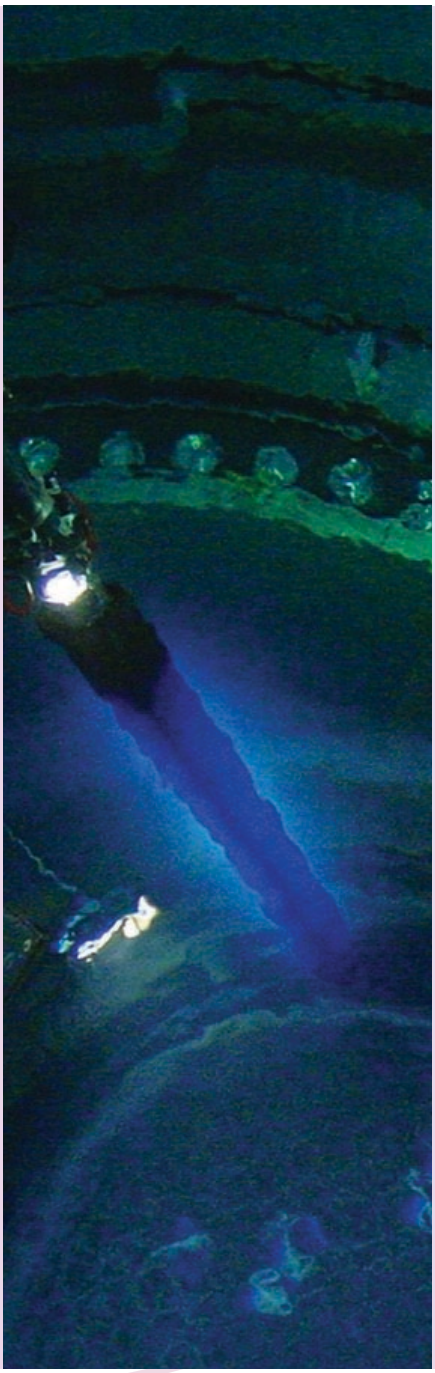
Networks of Excellence (NoEs) aim to strengthen the European Community's scientific and technological excellence through developing sustainable capacities at national and regional level. Each NoE will advance knowledge in a particular research area by assembling a critical mass of expertise and organising activities targeted towards long-term, multidisciplinary objectives. A joint programme of activities is developed and implemented that covers three key aspects: joint research, sustainable integration, and the spreading of knowledge.

Combinations of schemes are also possible. For each scheme, rules apply regarding minimum numbers of consortium partners from different Member States and associated countries. Apart from the 27 EU Member States, there is currently only one other country – Switzerland – fully associated to FP7 Euratom. Partners from all these countries can be reimbursed by the programme.

The European Research Area (ERA) and Euratom

The 'Euratom experience' during previous Framework Programmes has been one of support in pursuing excellence in research across a broad range of nuclear topics: waste management, reactor technology and safety, radiation protection, and associated training activities. During the Sixth Framework Programme (FP6), with its new funding instruments, the emphasis was also on facilitating the restructuring of these sectors in line with the objectives of the ERA (e.g. reduced fragmentation, increased critical mass, and more investment in research).

These efforts to establish the ERA in nuclear fission science and technology are continuing under the Seventh Framework Programme (FP7). Technology platforms in Sustainable Nuclear Energy and Implementing Geological Disposal as well as joint programming with Member States in the area of low-dose risk are a central aspect of this strategy. This research effort is needed to retain and improve competences and know-how, thereby improving the efficiency and effectiveness of European research in these fields. This in turn contributes to maintaining high levels of nuclear safety and industrial competiveness in these fields. By enabling a coordinated effort, the Euratom Framework Programme ensures the development of a common European view on scientific issues, the harmonisation of approaches and standards, and the promoting of a safety culture across the European Union and beyond.



FORGE

FATE OF REPOSITORY GASES

Radioactive waste must be disposed of carefully as it may remain hazardous for thousands of years. The long-term management of radioactive waste usually involves deep underground disposal, where the surrounding rocks and manmade structures work together to prevent radioactivity from escaping into the environment. Over the millennia, some gases will be produced in repositories: hydrogen is released as metals corrode, and the decomposition of organic materials found in some nuclear waste generates methane and carbon dioxide. The aim of FORGE is to understand where and how these gases form and how they move through the repository and surrounding rocks.

Keeping radioactive waste in its place

The FORGE project's overarching goal is to generate data that will aid in the design of waste repositories and be of use to both regulatory authorities and organisations responsible for the safe management of nuclear waste.

Understanding how gas is generated and how it moves through the repository and surrounding rocks is key to predicting how effectively the radioactivity will be contained within a facility. All proposed schemes for the underground disposal of radioactive waste centre on the multiple-barrier concept, in which a series of engineered and natural barriers is placed between the waste and the surface.

Of particular interest is the long-term performance of buffers made of a type of clay called bentonite. Bentonite buffers are likely to be used in many proposed European repositories to help isolate the waste from the surrounding rocks. The researchers are also investigating the performance of plastic clays, types of mudrock, and crystalline formations.

Getting to grips with repository gas

The mechanisms governing both gas generation and its movement through natural and engineered barriers are poorly understood. FORGE will carry out laboratory and field-scale experiments to improve knowledge of these highly complex processes. Data from FORGE will add to our understanding of the rates of corrosion and gas generation in repository environments as well as issues relating to the migration and fate of repository gases.

The partners will also develop theoretical frameworks for the movement of gas in repository environments and develop methods to allow upscaling from the laboratory and field scales to the repository scale. In addition, data arising from the project should optimise repository concepts.

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Project details

Project type // Large-scale integrating project
Project start date // 01/02/2009
Duration // 50 months
Total budget // EUR 11 658 902
EC contribution // EUR 5 988 647

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Expected results

The experimental programme will shed new light on the processes governing gas migration in repository materials and candidate host rocks. By reducing the uncertainties associated with repository gas migration, FORGE will yield improvements in the modelling approaches used for understanding gas migration by radioactive waste-disposal programmes worldwide.

A major FORGE output will be a series of reports summarising the project results, highlighting key achievements and explaining the implications of the project's findings for assessing the performance of repositories.

The involvement in the project of regulatory authorities as well as national radioactive waste management organisations ensures that the project's results will be swiftly applied to national radioactive waste management programmes.

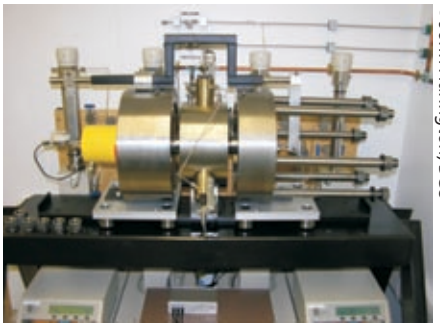
While FORGE focuses on the issue of gas migration in a radioactive waste repository context, many of the project's results will also be applicable to the petroleum and carbon-dioxide storage sectors.

Societal impact

FORGE will enhance European expertise in repository-gas migration issues and establish the EU as a global centre of excellence for this important topic. Scientists working on the project are expected to communicate the results of their work through relevant international conferences. Furthermore, the FORGE partners are planning themed workshops to communicate the project outcomes to a wider audience, including groups working on related subjects such as gas storage and carbon dioxide sequestration.

Important public events

The issues covered by FORGE, namely the safety of geological repositories, are of great interest to the general public. With this in mind, partners hope to promote public engagement by making high-level information widely and easily accessible via the FORGE project website. FORGE partners are present at many international conferences, for example the Clays in Natural and Engineered Barriers for Radioactive Waste Confinement conference held every two to three years, in France e.g. Nantes, 2010.



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Triaxial stress path permeameter for subjecting samples to complex,long-term stress paths while measuring gas and water flow.

© Richard Shaw, BGS

The Lasgit experiment at a depth of 420 m in the SKBs Aspo underground research laboratory, Sweden.

Partners

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MONITORING DEVELOPMENTS FOR SAFE REPOSITORY OPERATION AND STAGED CLOSURE

MoDeRn

CONFIDENCE AND ACCEPTABILITY THROUGH MONITORING

Spent nuclear fuel and long-lived radioactive waste must be contained and isolated for very long periods, and current schemes for its long-term management involve disposal in deep geological repositories. The successful implementation of a repository programme for radioactive waste relies on both the technical aspects of a sound safety strategy and scientific and engineering excellence as well as on societal aspects such as stakeholder acceptance and confidence. Monitoring is considered key in serving both ends. It underpins the technical safety strategy and quality of the engineering, and can be an important tool for public communication, contributing to public understanding of and confidence in repository behaviour.

A roadmap for monitoring

MoDeRn project members represent organisations responsible for radioactive waste management in the EU, Switzerland, the US and Japan as well as organisations having relevant monitoring expertise. Other partners offer substantial experience in researching how people interact with technology and finding ways to engage all stakeholders (e.g. civil society, experts, technical safety organisations, industry) in highly technical issues.

The main goal of MoDeRn is to establish a roadmap for developing and implementing various monitoring activities for deep geological repositories. This 'reference framework' will draw on experiences and lessons learned from waste-management programmes in different countries and will integrate new information from various stakeholder-engagement activities. It will cover all stages of the disposal process, from site selection to institutional monitoring after the repository is sealed, and will suggest ways of integrating monitoring results in the decision-making process.

Repository monitoring: a scientific and societal endeavour

As a core part of its proposed activities, MoDeRn will provide a clear description of monitoring objectives and strategies, taking into account a variety of physical and societal contexts, available monitoring technology, and feedback from both expert and lay stakeholder interactions.

The project will define the technical requirements of monitoring activities and assess the latest relevant technology. A technical workshop involving other monitoring research and technology development (RTD) projects will identify RTD techniques that enhance our ability to monitor deep geological repositories. In particular, innovative monitoring approaches specific to repository design requirements will be identified and tested within underground research laboratories. In addition, a case study will illustrate the process of mapping objectives and strategies onto the processes and parameters that need to be monitored in a given context, the potential design of corresponding monitoring systems and possible approaches to prevent and detect measurement errors. The case study will also show how unexpected repository evolutions may be handled.

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Project type // Collaborative project
Project start date // 01/05/2009
Duration // 48 months
Total budget // EUR 5 008 484
EC contribution // EUR 2 800 000

www.modern-fp7.eu

Expected results

MoDeRn is reviewing broadly accepted monitoring objectives and elaborating them to better reflect the actual implementation of disposal monitoring activities. The project also aims to verify whether they are likely to address both expert and non-expert stakeholder expectations. To that end, MoDeRn project partners seek to better understand repository monitoring activities and technologies and to provide recommendations for stakeholder-engagement activities. These accomplishments will form the basis of a 'roadmap for repository monitoring'.

The results of the project will be consolidated in a report that will present a shared international view on monitoring during the various phases of the disposal process.

Societal impact

MoDeRn is developing a 'reference framework' for monitoring geological radioactive waste repositories. The project will describe feasible monitoring activities, highlight remaining technological obstacles, illustrate the possible uses of monitoring results and suggest ways to involve stakeholders in the process of identifying monitoring objectives. This will substantially help radioactive waste management organisations in Europe and beyond to implement deep geological repositories that are safe and acceptable for all.

Important public events

Interaction with stakeholders is at the heart of the MoDeRn project. Workshops and conferences will provide opportunities to report and discuss results with the research community, experts (e.g. from technical safety organisations) and non-experts (e.g. from civil society) and to collect feedback. A website will provide updated information about progress and events as well as access to relevant publications.

MODERN
Monitoring Developments for Safe Repository Operation and Staged Closure

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CENTRAL DESIGN TEAM FOR A FAST-SPECTRUM TRANSMUTATION EXPERIMENTAL FACILITY

A TRANSMUTATION FACILITY IN BELGIUM

CDT

The materials testing reactor BR2 (Belgian Reactor 2), located in Mol, Belgium, is used for nuclear research and production of medical isotopes. It will eventually be replaced by MYRRHA ('Multi-purpose Hybrid Research Reactor for High-tech Applications'), an experimental accelerator-driven system (ADS). MYRRHA will be a new kind of research reactor, also capable of demonstrating the technical feasibility of efficient transmutation, which can significantly reduce the toxicity and quantity of the long-lived components of nuclear waste.

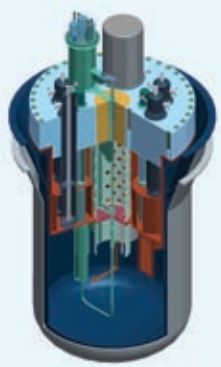
The Central Design Team (CDT) for such a Fast-Spectrum Transmutation Experimental Facility (FASTEF) is a multi-disciplinary, European team representing experts from both industry and research organisations. Working on SCK-CEN premises in Mol, CDT is advancing the design of the MYRRHA-FASTEF concept to make it ready for demonstration. The new system will be able to function in two configurations: initially subcritical (i.e. using spallation neutrons produced by a particle accelerator) and, in the next phase, in critical mode.

Scope of the project

With fast-neutron Generation IV nuclear reactors, spent fuel is reprocessed in a 'closed fuel cycle'. Each of these reactor systems uses a different type of coolant (e.g., sodium, lead or helium). Research infrastructures are essential for the development, design and construction of demonstrators of each new type of reactor.

MYRRHA is a flexible, fast-irradiation facility designed for the study of fuels, materials and high-level waste transmutation in both Generation IV systems and fusion reactors. It can work both as a critical system and as a subcritical ADS. It will be used to demonstrate the ADS concept, which is central to the design of dedicated radioactive 'waste burners'. MYRRHA, as the European Technology Pilot Plant for a Lead Fast Reactor, will also play a crucial role in the roadmap for the development of lead-cooled fast reactors.

Today's view of MYRRHA layout



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Project details

Project type // Small or medium-scale focused research collaborative project

Project start date // 01/04/2009

Duration // 36 months

Total budget // EUR 3 900 000

EC contribution // EUR 2 000 000

www.sckcen.be/myrrha

Activities

CDT builds on designs developed under previous Euratom Framework Programmes (most recently EUROTRANS). One major difference in the objectives of the current MYRRHA project is that the FASTEF needs to operate as both a subcritical and critical system. The design must include both operation modes from the start. CDT will carefully review design modifications to the MYRRHA ADS. A strategic objective of the project is to define specifications and design choices for FASTEF.

Once the specifications and design choices have been defined for the FASTEF's critical mode, the design of the facility's sub-critical mode will be further detailed and complemented. The necessary design changes for critical mode operation will be implemented. CDT will clearly define and develop conceptual designs for a limited set of experimental devices for the FASTEF (working in sub-critical or in critical mode).

CDT will also study all of the FASTEF facility infrastructures (auxiliaries and global plant layout). The result will be a comprehensive description of the characteristics and main technical requirements of the auxiliaries for both the subcritical and the critical options, as well as in an overall plant layout. Roadblocks in any of several key areas, such as fuel design and procurement can hinder the future realisation of the facility. CDT will address all of these issues.

Expected results

The CDT team will bring the design of MYRRHA-FASTEF to an advanced level with a comprehensive and detailed set of specifications that will make it possible to start construction in 2016. MYRRHA-FASTEF will need to be able to host several experimental devices (to support material and fuel research), produce radioisotopes for medical purposes and make high-quality doped silicon for power electronics (necessary components of hybrid vehicles and renewable energy technologies). It must also demonstrate the ADS technology for transmutation, serving as test-bed for larger-scale transmutation efforts. MYRRHA-FASTEF will also contribute to the demonstration of lead-cooled fast-reactor technology.

MYRRHA is foreseen to be in full operation by 2023. It will initially operate as an ADS to demonstrate the efficient transmutation of long-lived radioactive-waste components in subcritical mode. Following this demonstration, the accelerator can be decoupled from the reactor allowing MYRRHA to be run as a critical, flexible, fast-spectrum irradiation facility. In both operation modes, MYRRHA will be used for fuel research for innovative reactor systems, material research for Generation IV systems and fusion reactors and other applications.

Societal impact

CDT addresses the need to find sustainable ways of managing high-level, long-lived radioactive waste. Separating the components of radioactive waste and transmuting them into less toxic, shorter-lived elements is highly desirable as it will reduce the amount and heat load of material going into deep geological repositories and keep the lifespan of such radiotoxic elements to manageable timescales. It is hoped that ADS can be used to achieve this on a large scale. A demonstration of the ADS concept in MYRRHA will make it possible to evaluate the viability and economics of concentrated transmutation via ADS in a double-strata fuel-cycle approach. MYRRHA will also support the development of Generation IV systems, particularly in the development and demonstration of a lead-cooled fast reactor.

Important public events

CDT will collect the different reports produced during the project, and its Coordination Committee will encourage publications in peer-reviewed journals as well as visibility at international conferences. An open workshop will be organised at the end of the project, and Master-level students will be welcomed in CDT through the European Nuclear Education Network. The project website will be used to disseminate information to the general public.

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- Centre national de la recherche scientifique (CNRS), FR
- Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), ES
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- Forschungszentrum Karlsruhe, DE
- Instituto Tecnológico e Nuclear, PT
- Nuclear Research and Consultancy Group, NL
- Oxford Technologies Ltd, UK
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FAIRFUELS

The FAIRFUELS project paves the way towards more efficient use of fissile material in nuclear reactors and seeks to reduce the volume and toxicity of high-level, long-lived radioactive waste. By closing the nuclear fuel cycle through increased recycling and transmutation of nuclear waste, FAIRFUELS contributes to the sustainability of nuclear energy.

FABRICATION, IRRADIATION AND REPROCESSING OF FUELS AND TARGETS FOR TRANSMUTATION

NEW FUELS TO REDUCE WASTE

Innovative fuels for sustainable nuclear energy

FAIRFUELS focuses on the transmutation of minor actinides, which are long-lived and highly radiotoxic components of nuclear waste. Reducing minor-actinide content significantly shortens the lifetime of nuclear waste. One way to do this is to reuse these elements in a new kind of fuel. The key challenge in this project is to incorporate the minor actinides (e.g. americium and curium) into innovative fuels and to assess the performance of these fuels and targets through a combination of experimentation and modelling.

From fabrication, irradiation to examination and modelling

Dedicated fuels containing minor actinides will be fabricated and an irradiation programme will be carried out in the High Flux Reactor in Petten, the Netherlands, to assess transmutation performance. The fuels and targets are designed for the application of transmutation in future Generation IV nuclear systems.

In parallel, FAIRFUELS will conduct Post Irradiation Examination (PIE) to obtain valuable information on irradiation behaviour. In this way, the results of the irradiation tests carried out in previous programmes can be studied in depth. Modelling aspects of these fuels will be developed in support of the PIE.

The focus of the experimental and modelling studies is to understand the behaviour of helium gas, which is formed abundantly during transmutation of minor actinides and is responsible for most of the irradiation damage.

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Project details

Project type // Collaborative Project
Project start date // 01/02/2009
Duration // 48 months
Total budget // EUR 7 655 144
EC contribution // EUR 3 000 000

www.fp7-fairfuels.eu

Results and impact

FAIRFUELS addresses all aspects of nuclear fuel fabrication and behaviour. Fabrication and characterisation will be undertaken at the Joint Research Centre – Institute for Transuranium Elements in Karlsruhe, Germany and in the CEA's Atalante facility in Marcoule, France. The experience will provide insights into the optimal fabrication route and establish the best ways to incorporate minor actinides into innovative fuels.

Irradiation behaviour will be tested in the High Flux Reactor in two dedicated experiments. The MARIOS irradiation test addresses the mobility of helium (produced during transmutation) at various temperatures. The results will establish the optimum irradiation temperature to optimise the design of transmutation fuels for Generation IV reactors. The SPHERE irradiation test compares innovative fuels in the classical pellet form with SpherePAC. The advantage of the latter is its ease of fabrication.

Post-irradiation examinations, performed in the High Flux Reactor and in the Phénix fast reactor, will address the behaviour of fuels and targets under irradiation. The results of these examinations will identify which fuel types are most suitable, and will help optimise the design of new types of fuels and targets. The experimental PIE will be complemented with computer modelling activities. Together, these activities will provide valuable insight into the basic physical and chemical properties of fuels and targets under irradiation.

Societal impact

The production of radioactive waste is generally considered to be the biggest drawback of nuclear energy. FAIRFUELS partners seek to reduce the environmental impact of nuclear waste by recycling its most problematic and long-lived components and reducing the lifetime to less than 1 000 years. FAIRFUELS project results can be applied in both dedicated nuclear-waste burners (i.e. accelerator-driven systems) and future Generation IV reactors. These new reactor systems are designed to make optimum use of natural resources and to generate minimal waste in a 'closed fuel cycle'. The transmutation of minor actinides is a fundamental component of this technology.

Important public events

FAIRFUELS includes a training and education programme that supports knowledge sharing within the actinide science community and fosters links with related partitioning and transmutation projects (e.g. ACSEPT and F-Bridge). The project will organise two joint workshops. In addition, the training and education programme will publish a comprehensive textbook on minor-actinide-bearing fuels and targets in order to disseminate new knowledge to students and researchers worldwide.

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Operators handling experiments at the High Flux Reactor

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SARNET 2

SEVERE ACCIDENT RESEARCH NETWORK OF EXCELLENCE

To enhance the safety of existing and future water-cooled nuclear power plants (NPPs), the SARNET2 project pools the expertise of 42 organisations to resolve key remaining scientific and technical uncertainties regarding severe accidents. Furthering work initiated under the previous Euratom Framework Programme, SARNET2 will optimise resources by establishing research groups whose work may continue beyond the scope of the project. The network will help researchers share experience and knowledge, reducing fragmentation in European severe accident research and development (R&D).

A virtual centre of excellence for severe accident research

SARNET2 brings together most of the European organisations involved in severe accident research with some from outside of Europe to reduce fragmentation between national R&D programmes. To that end, the project partners are defining common research programmes and developing shared computer tools and methodologies for NPP safety assessment. The ultimate aim is to ensure the long-term sustainability of the network by creating a legal entity to coordinate a 'virtual centre of excellence'. Some network partners cover a wide range of competencies in severe accident research while others effectively fill the gaps by specialising in specific areas. SARNET2 represents a critical mass of competencies for conducting small and large-scale experiments, analysing results, developing physical models and integrating them into a commonly used computer code.

Reducing fragmentation and managing knowledge

SARNET2 will periodically rank the priorities of research programmes, harmonising or reorienting existing priorities and jointly defining new ones. Joint experiments and analyses will elaborate the understanding of phenomena such as in-vessel core coolability, molten-core-concrete interaction, fuel-coolant interaction, hydrogen mixing and combustion in containment, impact of oxidising conditions on source term, and iodine chemistry.

SARNET2 will design education and training programmes together with educational institutions to render the field attractive to European students and young researchers. The network will also promote personnel mobility between participating European organisations.

A clear knowledge-management policy will preserve the interests of participating organisations. Reports on protected data will only be distributed to members who can significantly increase the value of the data through their interpretation.

The main outcome of SARNET2-coordinated programmes will be models, based on research results, which will be implemented in the ASTEC integral computer code, jointly developed by IRSN (France) and GRS (Germany) to predict the NPP behaviour during a severe accident. These models will be available to all network members and other organisations for use in NPP safety assessment or improvement.

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Project details

Project type // Network of Excellence
Project start date // 01/04/2009
Duration // 48 months
Total budget // EUR 38 937 670
EC contribution // EUR 5 750 000

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www.sar-net.eu

Expected results

European research capacities in severe accident research will be further consolidated under SARNET2. Periodic review of R&D priorities and co-programming of work amongst organisations will improve cost effectiveness, while researcher mobility will help optimise resources. Results will be implemented in ASTEC and stored in an experimental database to preserve knowledge and disseminate it to end-users. The SARNET2 researchers will validate the ASTEC computer code and increase its suitability for all types of water-cooled NPPs.

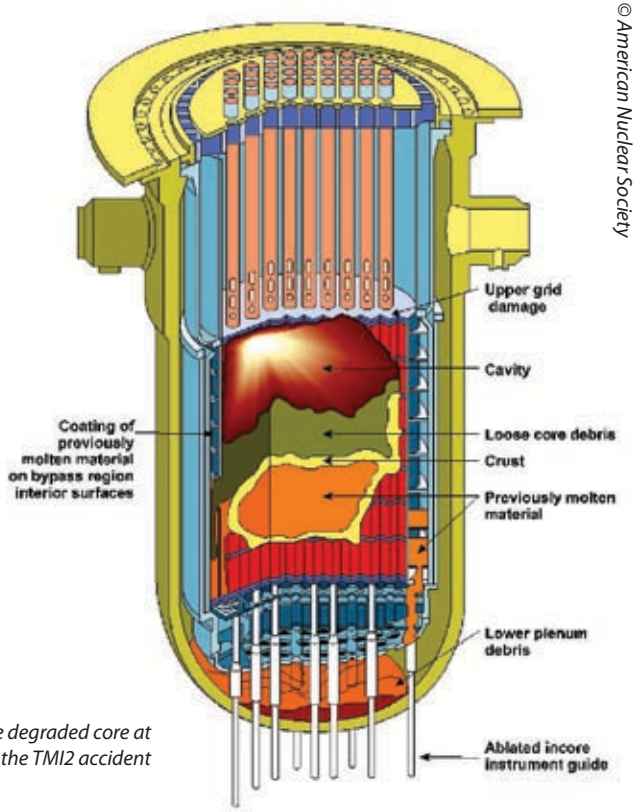
Societal impact

The ASTEC computer code and the experimental database make the most of the large amount of emerging knowledge in the area of severe accident research, contributing to the prevention and mitigation of severe accidents in existing and future European NPPs. Recently, most specialists have been using integral computer codes developed in the US; however, by fostering collaborative work on the ASTEC code, SARNET2 will help position Europe as world leader in the field.

SARNET2 education and training efforts can inspire young European scientists and secure European excellence in the SA domain over the long term. In addition, the network offers a broad range of expertise that can be used to support countries with new nuclear programmes.

Important public events

The work of SARNET2 will be presented at important nuclear energy events, for example the international conferences or workshops in the nuclear field and the EUROSAFE Forum. SARNET2 will organise periodically the European Review Meeting on Severe Accident Research, slated to become the major worldwide conference on severe accident research. The project website will present relevant up-to-date information.



State of the degraded core at the end of the TMI2 accident

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NURISP

To enhance the effectiveness of nuclear science and engineering, a new generation of simulation tools is needed. The nuclear industry, technical safety organisations, research centres and universities would benefit greatly from simulation tools that can perform more accurate modelling of physical phenomena, offer more capacity to quantify uncertainties and allow more integration of different computer codes. Such tools would ideally operate in an environment that provides common functions for pre- and post-processing as well as for testing 'multi-physics coupling' (i.e. interactions between different physical fields, such as thermal hydraulics and structural mechanics, which may affect the response of a system). NURISP is developing an informatics platform that addresses these needs.

NUCLEAR REACTOR INTEGRATED SIMULATION PROJECT

A PLATFORM FOR ADVANCED NUMERICAL MODELLING

Numerical simulations guide physical experiments

Many of the scientific theories explored in nuclear fission research are based on numerical simulations, which are less expensive and safer than physical experiments. These simulations also allow researchers to explore a wider range of conditions than can be covered by experiments. Conversely, numerical experiments can be used to guide the design of physical experiments. NURISP, building on results obtained under the previous framework programme in the NURESIM project, is developing a European 'reference simulation platform' that integrates simulation software in several key disciplines. The platform will be suitable for applications that are relevant to existing nuclear reactors (i.e. pressurised water reactors and boiling water reactors) as well as to future designs.

Many fields, one platform

The design, modification and operation of nuclear reactors require complex calculations, which are done using numerical codes. The NURISP project partners are using an open-source tool called SALOME to integrate numerical codes that are specific to core physics, thermal-hydraulics, multi-physics and uncertainty quantification.

Expected results

This collaborative project combines the efforts of teams working in several disciplines. One group is developing and validating codes (based on two numerical modelling methods, deterministic and Monte Carlo) that can simulate neutron kinetics. Specifically, the codes will enable researchers to simulate neutron energy at a very high resolution, allow for a range of spatial and time scales and provide consistent coupling of neutron kinetics with both thermal-hydraulics and fuel thermo-mechanics.

Another group is developing 'two-phase' models and codes that address the need to examine phenomena on several different scales. Their multi-scale approach spans direct numerical simulation, computational fluid dynamics and the system scale. These models are destined for use in applications for pressurised water reactors and boiling water reactors.

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Project details

Project type // Collaborative project
Project start date // 01/01/2009
Duration // 36 months
Total budget // EUR 10 304 075
EC contribution // EUR 5 998 466

www.nurisp.eu

NURISP is developing new generic methods and schemes for studying the coupling of neutronics (phenomena related to neutrons) with thermal-hydraulics or fuel behaviour. Tools are also being developed and used to validate and calibrate models, and to quantify sensitivity and uncertainty.

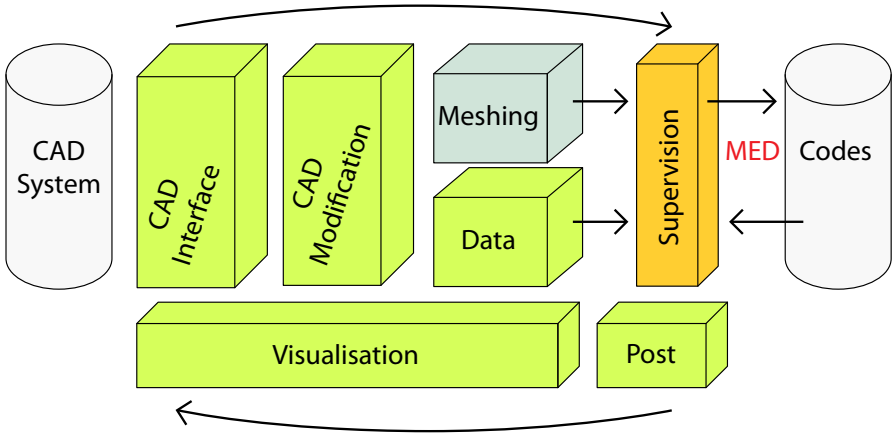
Societal impact

NURISP is working to create a simulation platform that will serve to enhance reactor safety, improve operational support and optimise reactor designs. It will be used as a reference platform to host a new generation of experimentally validated 'best-estimate' simulation tools, offering models and methods that surpass the state of the art. The simulation platform will integrate products and knowledge generated by several European countries, easing cross-border collaboration by setting common standards. Its development draws on situations that are typical to current and future nuclear reactor designs, and benefits from ongoing dialogue with the European nuclear industry. Accordingly, it serves the interests of both the public and the nuclear industry.

The reference tool will be shared via a Users' Group, which comprises representatives of nuclear utilities, vendors, technical safety organisations, regulators, universities and research institutions. The users will contribute to the ongoing improvement of the simulation platform, thus enabling significant progress in the numerical simulation of nuclear reactors.

Important public events

The activities and results of the NURISP project will be presented both in open NURISP seminars and at several European and international events, including FISA, the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (MC), the International Conference on Nuclear Engineering (ICONE) and the European Nuclear Conference (ENC). NURISP will also organise training sessions and courses for young researchers.



Salomé sofware, used for code coupling and data processing

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PERFORM 60

The materials used to construct nuclear power plants (NPPs) are exposed to extremely high levels of radiation. Over time, this causes the materials to undergo degradation and may limit their operational lifetime. PERFORM 60 is developing virtual tools to predict the effects of radiation and corrosion on power station components. The tools will help Europe's nuclear industry ensure that its power plants remain safe as they age.

PREDICTION OF THE EFFECTS OF RADIATION FOR REACTOR PRESSURE VESSEL AND IN-CORE MATERIALS USING MULTI-SCALE MODELLING — 60-YEAR FORESEEN PLANT LIFETIME

EUROPE'S NUCLEAR POWER PLANTS – GROWING OLD GRACEFULLY

The materials used to construct nuclear power plants (NPPs) are exposed to extremely high levels of radiation. Over time, this causes the materials to undergo degradation and may limit their operational lifetime. PERFORM 60 is developing virtual tools to predict the effects of radiation and corrosion on power station components. The tools will help Europe's nuclear industry ensure that its power plants remain safe as they age..

RPVs: critical components of the NPP

At the heart of the nuclear power plant is the reactor pressure vessel (RPV), whose thick steel walls house the reactor core. The fuel in the reactor core irradiates the walls and internal components of the RPV, rendering them rather brittle. Understanding how these structures are affected by long-term exposure to radiation is key to predicting their lifetime and ensuring the safe operation of nuclear power plants.

Currently, much of our knowledge of how radiation affects RPVs draws on data from long-term irradiation programmes in test reactors. Testing specimens from surveillance capsules inserted into the reactor also sheds light on the RPV's health. Yet predicting how a material will behave under irradiation remains difficult, especially if the lifetime of reactors is to be extended to 60 years.

Advances in our understanding of the underlying mechanisms of the effects of irradiation on materials, along with progress in computing science, now make it possible to develop numerical tools that can simulate the effects of irradiation on materials' microstructure.

Building on work begun in the PERFECT project under the previous Euratom framework programme, PERFORM 60 aims to develop virtual tools to simulate how the RPV and its internal components behave when irradiated in contact with the coolant.

Virtual tools for reactor safety

PERFORM 60 is developing modelling tools to simulate the combined effects of irradiation and corrosion on RPVs and their internal components at all scales, from the pico scale (which investigates how atoms interact with one another) upwards. The 20 project partners will integrate their tools into a user-friendly platform to produce experimentally validated physical models that can predict the lifetime of RPVs and their internal components.

A Users' Group allows constructors, vendors, utilities and research organisations from Europe and elsewhere to test the limits and potential of the tools developed and validate them against experimental data. This will help the team to improve the tools further.

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Project details

Project type // Collaborative Project (Large-scale integrating project)

Project start date // 01/03/2009

Duration // 48 months

Total budget // EUR 13 595 825

EC contribution // EUR 5 985 465

www.perform60.net

In addition, the project's training scheme educates young researchers on the degradation of materials in the nuclear field.

Expected results

PERFORM 60 addresses major challenges related to predicting how the RPV and its core components will behave as they age. The advanced numerical codes developed by the project will make it easier for researchers to model the irradiation-related degradation of RPVs over periods of up to 60 years.

The project outcomes will aid in the selection, development and qualification of numerical simulation tools that can help to enhance the integrity of the materials used in RPVs. In addition, the partners expect to add to our understanding of the complex processes taking place in RPVs.

Societal impact

The project will strengthen links between research centres, universities and the industry, optimising the use of relevant installations (e.g. high-performance computers and hot cells) and facilitating the exchange of expertise. Meanwhile, training related to PERFORM 60 will ensure that knowledge and skills are passed on to the next generation of nuclear engineers.

Through the Users' Group, the project will have an impact on the performance of current nuclear power plants. In the longer term, the tools developed by the project will save the industry money, as running virtual tests is considerably less expensive than carrying out physical experiments. Finally, the PERFORM 60 outcomes will ensure that the current fleet of nuclear power plants ages safely.

Important public events

The PERFORM 60 partners are committed to communicating the knowledge they generate by publishing papers in major journals and presenting at international events such as FISA 2009, the International Group on Radiation Damage Mechanisms (IGRDM) and the International Cooperative Group on Environmentally Assisted Cracking (ICG-EAC). The partners are also organising workshops and summer schools. The first international summer school on materials for nuclear reactors (MATRE I), organised together with the GETMAT project (see Volume I), took place in October 2009 in Belgium.

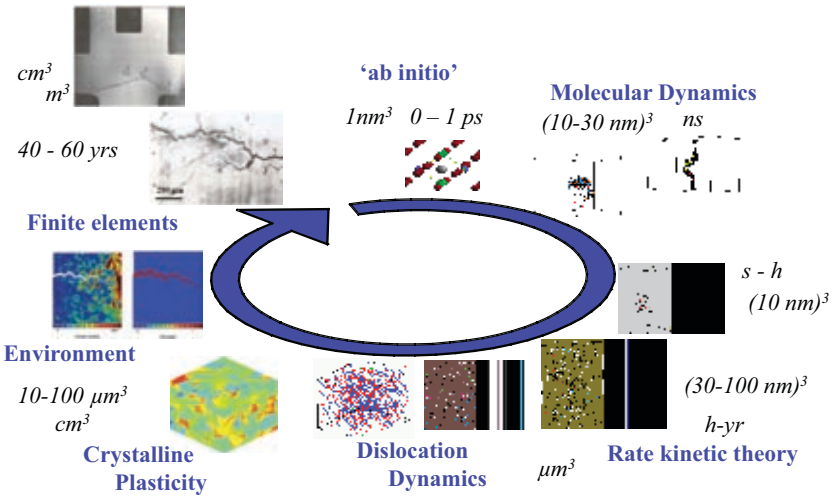

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Illustration of multi-scale approach used to simulate and predict the lifetime of the reactor pressure vessel of a light water reactor

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- BG H2 Society, BG
- Centre National de la Recherche Scientifique (CNRS), FR
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- Rolls-Royce Power Engineering Plc, UK
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CP-ESFR

Among the next generation of nuclear reactors (i.e. Generation IV systems), those with fast spectra promise to operate sustainably, generating energy in a 'closed fuel cycle' that allows them to use natural resources more efficiently and to produce less waste. One such reactor is the sodium-cooled fast reactor (SFR). This concept has the most comprehensive technological basis, and under the previous Framework Programme a research roadmap was set out identifying and organising research and development (R&D) efforts. The collaborative project for a European Sodium Fast Reactor carries on this work and implements significant R&D activities in this important area.

COLLABORATIVE PROJECT FOR A EUROPEAN SODIUM FAST REACTOR

The sodium-cooled fast reactor: a solid foundation

Fast reactors have a unique capability that allows them to be considered as a sustainable energy source: the closed fuel cycle uses natural resources more efficiently and reduces the volume and heat load of high-level waste substantially. The sodium-cooled fast reactor benefits from years of international research and experience gained using experimental, prototype and commercial-sized reactors.

Following the strategic research agenda of the Sustainable Nuclear Energy Technology Platform (SNETP), the target date for industrial deployment of the ESFR technology is around 2040, with the preliminary deployment of a demonstrator by 2020. One of the project's objectives is to have a preliminary assessment of the most innovative and promising options by 2012. CP ESFR brings together international partners with substantial experience in sodium technology to meet this deadline.

Some participating countries have never interrupted their work designing or operating plants based on this technology. Others want to renew their competencies by engaging young engineers for training on the whole nuclear system design. The collaboration addresses important areas of expertise in SFR technology, including for example scenarios for industrial deployment, core design, fuel manufacturing, reactor and balance-of-plant design, safety and non-proliferation analysis, and economic assessments.

Viability and performance

The key research goals for Generation IV ESFRs are improved safety, economic competitiveness and waste reduction. These goals were initially translated into technical requirements in the EISOFAR ('Roadmap for a European Innovative Sodium Cooled Fast Reactor') project under the Sixth Euratom Framework Programme (FP6) and have been integrated into the CP ESFR.

Over the course of the project, CP ESFR will address key viability and performance issues to support the development of a Generation IV ESFR. Two of the project partners, CEA and AREVA, both based in France, have supplied 'work-horse' images of cores and systems as starting materials. These are currently being improved and optimised within CP ESFR.

CP ESFR has a specific subproject for education and training. Of the total project budget, 5% is dedicated to the development and delivery of training courses and some doctoral dissertations.

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Project type // Collaborative project
Project start date // 01/01/2009
Duration // 48 months
Total budget // EUR 11 550 000
EC contribution // EUR 5 800 000

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http://www-cadarache.cea.fr/fr/accueil/pdf/CP_ESFR_Project_presentation.pdf

Expected results

In the first two years of CP ESFR, the partners will assess and select innovative options for introduction into the system. Any viability issues will be resolved and studies will confirm that these innovations can perform as expected. At the end of this period, one reference ESFR pre-conceptual design (and variants, if justified) will be selected.

In the following two years, performance of the retained options will be further confirmed, and a deep assessment of whether they benefit the system and how well they fit the requirements will be carried out. This will result in a set of consistent, optimised innovations which could be implemented in the future ESFR.

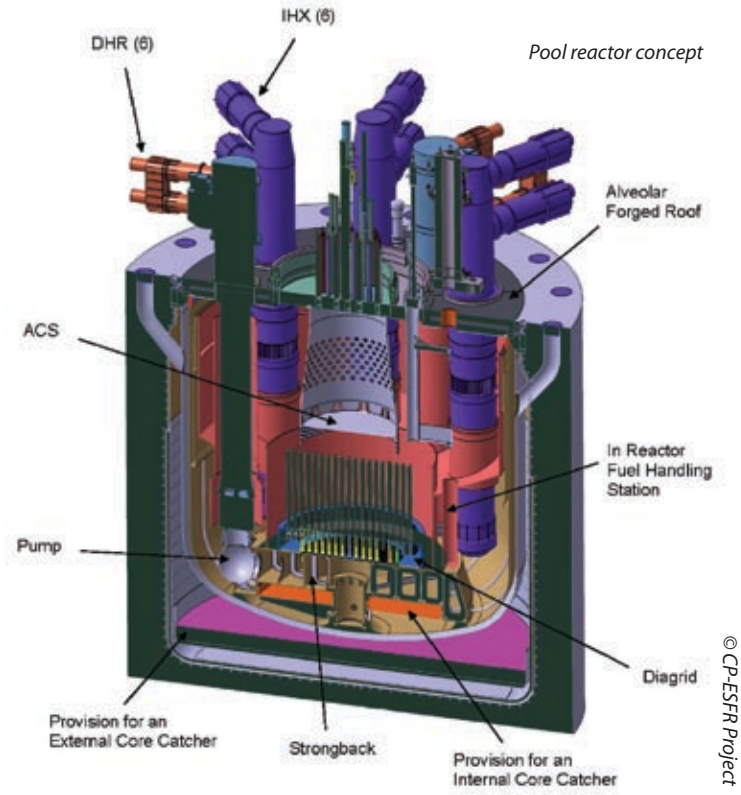
Societal impact

Considerable economic effort is needed to meet the extremely ambitious schedule of the ESFR. Developing innovative SFR technology depends, therefore, on joint national efforts. Such efforts impact contributor countries on both national and EU levels, and impact the rest of the world in terms of energy safety and sustainability.

The CP ESFR represents an opportunity for Europe to confirm its leading role in developing innovative, sustainable nuclear reactor systems. It also offers significant training opportunities for young scientists, engineers and technicians. The importance of such activities cannot be understated.

Important public events

In addition to presenting at relevant international conferences, CP-ESFR plans to hold five open workshops. A one-week 'open' workshop on sodium behaviour and safety took place in Cadarache, France, on key elements of the sodium fast reactor: choice, structural-materials behaviour, dedicated instrumentation and safety related to sodium use. Information about future workshops will be available on the project website.



Pool reactor concept

© CP-ESFR Project

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- ANSALDO, IT
- AREVA NP, FR
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- Institute for Radiological Protection and Nuclear Safety (IRSN), FR
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- Joint Research Centre - Institute for the Protection and Security of the Citizen (JRC-IPSC), EU
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STORE

STORE is establishing a platform to facilitate the storage and retrieval of data and corresponding biological material from past, current and future radiobiological studies. The platform will make it easier to share data and material across the radiobiology community.

SUSTAINING ACCESS TO TISSUES AND DATA FROM RADIOBIOLOGICAL EXPERIMENTS

FACILITATING SHARING OF DATA AND MATERIAL

Sharing data and material

The assessment of risks associated with radiation exposure is based on knowledge gained primarily from epidemiological studies of radiation-exposed populations, in conjunction with data from experimental animal studies. It also draws on the results of biophysical, molecular biological and cellular (in vitro) studies. Recent developments in molecular and genetic research provide new opportunities to further quantify radiation exposure at the individual level. Applying this new knowledge to material and data from previous studies is important for evaluating new risk parameters. Indeed, sharing data and biomaterials from publicly funded experimental radiation science adds enormous value to the original investment. Such an initiative will yield substantial scientific rewards through reanalysis and further investigation. The STORE platform will facilitate the storage and retrieval of data and the corresponding biological material from past, current and future radiobiological studies.

The project's concept...

The STORE platform will consist of a combined 'data warehouse' as well as physical and/or virtual repository to enable the sharing of experimental data sets and materials. Once the platform has become active, it will provide a single portal to radiobiological information that is presently distributed over several scientific centres worldwide. The project will outline the necessary standard operating procedures (SOPs) for the evaluation of archived tissue. STORE will also carry out an assessment of viable financial models for the long-term support of its radiobiology bioresource and data warehouse.

Developing the best possible SOPs for the isolation of RNA, DNA or proteins from samples of archived biological tissues is important, as advances in methodology have made it much easier to extract DNA or RNA from archival materials. Rapid developments in proteomic (i.e. protein-related) technology also make it possible to extract proteins from samples. These methods should be efficient, reproducible and applicable to a wide range of tissue, tumour types and target genes.

STORE members

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Project details

Project type // Support Action
Project start date // 01/04/2009
Duration // 36 months
Total budget // EUR 1 352 736
EC contribution // EUR 983 987

www.fp7store.eu

…and its strategy

STORE is providing a 'one-stop-shop' portal that will allow scientists to access several international databases, including the European Radiobiology Archives, the Chernobyl Tissue Bank (another FP7 project), the JANUS biomedical research reactor and other active repositories. In this way, researchers may find the materials and data they need for a specific study, even if the data is stored in a different country. This undertaking will require making the STORE platform interoperable with other databases.

STORE will archive raw data from radiobiological experiments or, if necessary, provide 'pointers' referring to the data in public databases. It will use existing material that is currently available (i.e. held by consortium members or their affiliates), or material that will become available during the course of the project. The STORE portal will provide a single point of access to integrated biomaterial resources through standardised request procedures. It will also be open to individual investigators and to funding agencies as a potential central repository for data sharing. This will greatly help to raise awareness among the radiobiology community of the existence of these resources, many of which may be underused because their availability is unknown.

STORE will actively pursue materials arising from ongoing research, and will physically archive threatened material resources. Benchmarks will be set within the project for sample preservation and usability, and SOPs will be set for adopting new technologies in the preparation of material from tissue samples. The project will also collect existing animal tissue samples, and will gather materials that have arisen from multi-centre studies on humans and animals exposed to radiation.

Societal impact

It is important to save data and biological materials from publicly funded projects. Every year, one or more local archives are lost, as curators retire or storage space is taken away for other purposes. It is essential that local endeavours are transformed into national and international efforts to provide safe storage for endangered materials and data. STORE will provide a single portal to maximise the use of biological materials and data, and will promote collaboration across the wider radiobiological community by facilitating data exchange and sharing materials.

Important public events

STORE will be presented at major scientific conferences and through publications in peer-reviewed journals. A satellite symposium will be held during the International Congress of Radiation Research (ICRR) in Warsaw, Poland, in 2011. Standards and benchmarks for quality assessment will be openly accessible on the project's website.

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- University of Edinburgh – Edinburgh Cancer Research Centre, UK

ALLEGRO

With an increasing population of surviving cancer patients treated with radiation therapy, the harmful effects of the radiation on normal tissue are becoming more evident. ALLEGRO is investigating many of the aspects of damage to normal, healthy tissues surrounding tumour sites that are not yet well understood. This applies to both conventional treatment techniques and emerging techniques that make use of protons and heavy ions.

EARLY AND LATE RISKS TO NORMAL/HEALTHY TISSUES FROM THE USE OF EXISTING AND EMERGING TECHNIQUES FOR RADIATION THERAPY

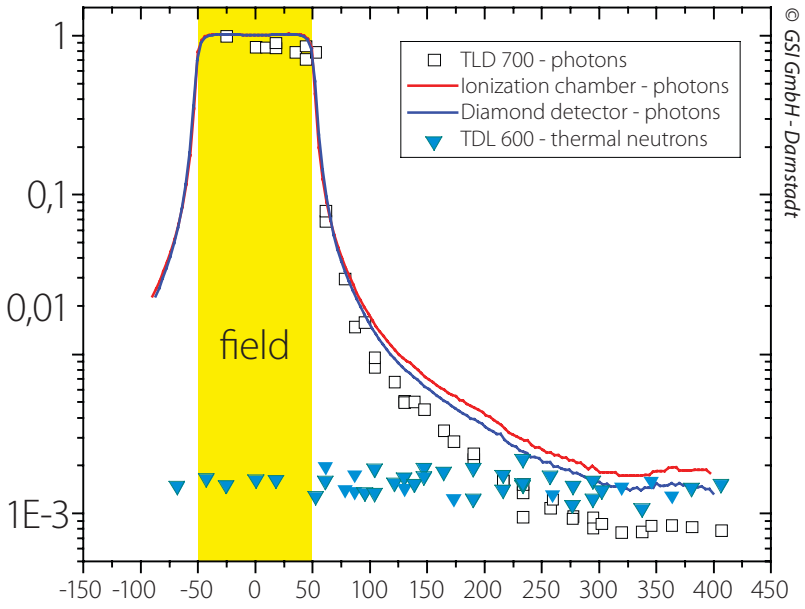
SIDE-EFFECTS OF RADIATION THERAPY

Towards safer radiotherapy

ALLEGRO is an initial two-year investigation into the risks to healthy tissue from radiotherapy. As the problems addressed will need longer-term research, the ALLEGRO project is primarily investigating the current state of knowledge, summarising and disseminating available information and providing a solid base for recommendations for further radiation-protection research. The ALLEGRO consortium comprises leading research institutes, hospitals and university medical departments that are active in developing new radiotherapy methods or optimising existing methods.

Activities

ALLEGRO project partners are covering every aspect of radiation damage to normal tissues resulting from current and emerging radiotherapy treatments. For example, measurements are being taken of the 'out-of-field radiation' (including protons and carbon ions) that is scattered from radiotherapy beams, exposing healthy tissue outside the treated volume. Numerical models will be made of these measurement configurations; these models in turn will allow researchers to assess the biological 'effectiveness' of heavy particles and neutrons.



Example of experimental configuration: measurement of the production of neutrons

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Project details

Project type // Collaborative projects
Project start date // 01/02/09
Duration // 24 months
Total budget // EUR 3 917 300
EC contribution // EUR 2 599 350

www.allegroproject.org

These experiments are expected to verify estimates of the extent to which a given dose of radiation will affect normal tissue in actual patients, as deduced from clinical databases. The dose information will be applied to extensive clinical databases to investigate current methods for predicting both normal tissue complications and radiation-induced second cancers. This part of the investigation will evaluate current risk-modelling methods and test the practicality of using conventional clinical databases to perform sophisticated dose-risk analyses.

The results of these activities will be reviewed by experts from each of the participating institutions together with a specially selected Scientific Advisory Committee. Following this review, a series of focused documents will be produced defining the current state of knowledge and identifying all of the gaps that limit the confidence with which clinicians can predict normal tissue response from a particular treatment on a patient.

The expert forum will make a series of recommendations to clinicians on minimising risks to healthy tissues in treatment and optimising treatment plans. It will also advise equipment manufacturers on safety features to minimise normal tissue risk, and provide the research community with a detailed summary of current knowledge and recommendations on future data-collection and research activities.

Expected results

The ultimate purpose of the ALLEGRO project is to help clinicians make better-informed radiotherapy treatment decisions by taking into account medium- and long-term harm to normal tissue. There is a considerable amount of upcoming new radiotherapy technology, all of which promises to minimise normal tissue damage. It will be essential to predict medium- and long-term effects in order to evaluate these competing technologies. ALLEGRO project partners expect to produce solid recommendations that will have an immediate impact on both clinical practice and equipment design. The most valuable contribution to society as a whole will be the identification of gaps in existing knowledge and recommendations for the direction of future research.

Societal impact

Approximately one in three people in the developed world get cancer, and about half of these are treated with radiotherapy. More and more people are surviving for decades after being undergoing radiotherapy for cancer; accordingly, medium- to late-term harmful effects are becoming more significant. There are many competing radiotherapy treatment methods, each of which offers a trade-off between cost and ability to spare normal tissue. Currently, there is little solid science establishing 'normal' tissue damage from each method. This makes it difficult to make informed treatment choices for each patient. ALLEGRO specifically addresses this problem, and as such has the potential to positively impact the health of a large part of the population.

Important public events

The European Society for Therapeutic Radiation and Oncology (ESTRO) is a partner in the ALLEGRO consortium. Project progress will be published in the ESTRO Newsletter, which is released quarterly. An ALLEGRO symposium is also planned at the society conference, ESTRO 29, to be held in Barcelona in September 2010. The proceedings of this conference are published in Radiotherapy and Oncology ('The Green Journal'). The final reports and recommendations will also be published in a peer-reviewed journal.

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DESIGN OF OPTIMISED SYSTEMS FOR MONITORING OF RADIATION AND RADIOACTIVITY IN CASE OF A NUCLEAR OR RADIOLOGICAL EMERGENCY IN EUROPE

EUROPEAN MONITORING SYSTEMS FOR EFFICIENT EMERGENCY RESPONSE

DETECT

After the Chernobyl accident in 1986, many European countries installed systems to monitor radioactive contamination of the environment. These systems are linked together through a network and serve to provide early warnings of nuclear accidents. Many of the older monitoring systems require updating, and some regions would benefit from new networks built with state-of-the-art technology. DETECT is developing a tool that will optimise the deployment of environmental radiological monitoring devices to be used during nuclear emergencies, in some cases in conjunction with portable devices. This will help to ensure that nuclear regulators and emergency response organisations can quickly detect any accidental releases of radioactivity into the environment.

A new tool for emergency response and decision making

To make the most efficient use of European monitoring resources and to optimise the way decisions are made during emergencies, DETECT is developing a planning tool for nuclear regulators, nuclear emergency response organisations and people operating nuclear facilities. The software tool will also allow these operational specialists to improve their monitoring activities.

DETECT project partners offer extensive experience in monitoring, data assimilation, uncertainty handling, optimisation procedures, atmospheric dispersion calculations, decision support, stakeholder involvement and software development. This combination of competencies, together with previous collaboration experience on large national and international projects, ensures that DETECT members will work according to the highest standards of scientific excellence to guarantee the operational aspects of the end product.

Optimising national monitoring strategies

The DETECT consortium will provide direct and practical guidance on the optimal design of monitoring networks and strategies. Complete planning and design of monitoring networks will address technological needs from the most local to the international scale, for example from individual monitoring installations in a fence surrounding a nuclear facility to the whole plant-monitoring system, to regional and national networks. DETECT will concentrate on developing strategies to optimise national networks, which consist mainly of fixed stations.

The project will investigate the national networks of Belgium, Finland, Germany, the Netherlands and Norway, performing optimisation calculations for each country. Mobile devices may improve the functionality of fixed networks, and will be considered for each case. 'Country scenarios' will be detailed based on information provided by both the end users and DETECT project partners.

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Project details

Project type // Collaborative project
Project start date // 01/07/2009
Duration // 30 months
Total budget // EUR 713 000
EC contribution // EUR 400 000

http://detect.sckcen.be

Expected results

DETECT is developing a software tool that allows end users to test and develop monitoring strategies for their specific needs. It will combine the knowledge gained during country-specific scenario calculations with the Member States' monitoring guidelines. The end-product will be a standalone, easy-to-use, JAVA-based application with a graphical user interface.

Societal impact

The DETECT software tool will optimise the deployment of environmental radiological monitoring devices to be used during nuclear emergencies. It will be mainly used by nuclear regulators and nuclear emergency response organisations, which are interested either in renewing existing monitoring capabilities installed post-Chernobyl or in designing new networks using state-of-the-art technological advances. The adoption of this new tool will ensure the early detection of any accidental or incidental release of radioactivity into the environment, which in turn will result in early deployment of countermeasures to protect the public.

Important public events

The DETECT website will offer updates on project progress to the public and will also be used to disseminate the ultimate product to end-users in a restricted area. The project coordinator will organise stakeholder workshops in which DETECT achievements can be shared with all European emergency-response organisations.

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- Karlsruhe Institute of Technology, DE
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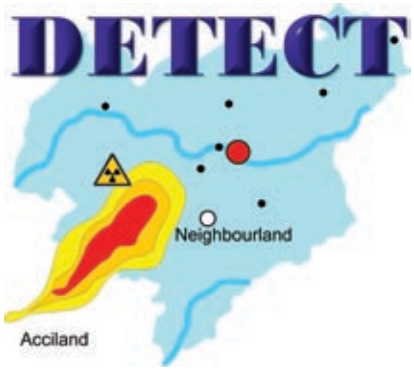

ACTINET-I3

Actinides are heavy elements, some of which are created during the production of energy from nuclear fuel and remain as a component of radioactive waste. Research in actinide sciences is essential for managing nuclear waste and for developing future nuclear fuel, and several European infrastructures currently support this important research. The ACTINET-I3 consortium aims to reinforce the networking of these infrastructures, and to facilitate their efficient use by the European scientific community. This will help maintain Europe's leading position in the field of nuclear energy research.

ACTINET INTEGRATED INFRASTRUCTURE INITIATIVE

NETWORKING ACTINIDE RESEARCH FACILITIES

Strengthening the European actinide science community

To maintain its leading position in the field of nuclear energy, in terms of both safety and efficient use of natural resources, Europe must reinforce its expertise and prepare a new generation of scientists and engineers. Indeed, it is crucial to provide the next generation of experts with ample research opportunities so that they may make meaningful contributions, based on sound scientific bases, to new actinide management strategies. However, actinide science requires specific tools and facilities that are only available in a limited number of laboratories in Europe. As part of a strategy to strengthen this highly specialised community, the ACTINET-I3 consortium gathers all the key players to coordinate existing European actinide infrastructures.

A network of facilities

The ACTINET-I3 partners are working to establish a network of actinide facilities across the EU in order to better integrate and structure the facilities' operations, and to foster their development in terms of both capacity and performance. To make the best use of the facilities, the consortium also supports and jointly manages a programme that helps scientists access appropriate infrastructures for training and associated research projects.

Together with consortium member organisations, ACTINET-I3 is conducting a set of joint research activities that will improve the performance of infrastructures by developing new instrumentations and/or data of common interest. These activities will be complemented by a virtual infrastructure which will provide support in the fields of theory and modelling.

ACTINET-I3 will also help transnational research teams with well-defined research topics gain access to selected infrastructures that match the team's scientific and training needs.

Expected results

Although the nuclear power industry was built on national policies, its objectives are now shared at the international level. Attaining the knowledge, know-how, tools and skills necessary to sustain a thriving industry, share costs and find consensus on scientific matters

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relies on a similar evolution in nuclear research infrastructures. Beyond collaboration among researchers, the challenge is now to ensure the sustainable development of the European Research Area (ERA) through a solid European research infrastructure policy.

The European scientific community must be able to benefit from the complementarities of existing tools (e.g. facilities and virtual infrastructures). To that end, appropriate rules for the use of these tools must be implemented, their management at the European level should be assured, and access should be granted to a wider set of users, from academic researchers to industrial partners. It is equally important to stimulate complementarities of national tools. This can be done by implementing coherent European policies, both for their evolution and future development.

Access to these pooled facilities will encourage the development of joint research activities; this in turn should have a strong structuring effect. The infrastructures can also be used in close cooperation with related EU-funded research projects, including among others, ACSEPT and F-BRIDGE. Information exchange and potential cooperation will be considered with similar networks of infrastructures (e.g. J-ACTINET, recently established in Japan).

Students and young researchers will also benefit from access to ACTINET-I3 facilities; this has important implications for the training of future actinide scientists and engineers.

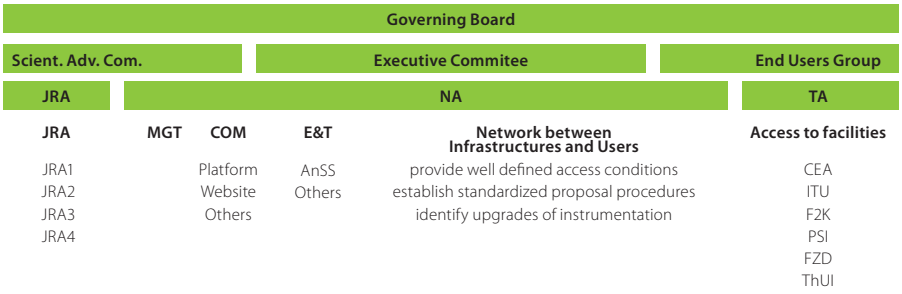
Societal impact

The major challenges of the nuclear industry, from safety to waste management and environmental impact, can be addressed only with the development of expertise in actinide sciences. ACTINET-I3 activities will make it easier to conduct actinide science programmes in Europe by increasing the set of possible experiments available to researchers. It will also promote the circulation of researchers between these facilities, thus contributing to the spreading of excellence at the European scale. Finally, ACTINET-I3 will foster training and education activities, both through a specific training programme and by providing students and young researchers the opportunity to take advantage of a larger, connected scientific community. In this respect, the very existence of the network, and its support by the European Commission, will make actinide science much more visible and attractive to students and young researchers.

An end-user group may also give rise to clients such as industrial partners, which will add further value to the network.

Important public events

Information on the activities and opportunities offered by ACTINET-I3 will be available on the website; in addition, a newsletter will be published twice a year and two plenary workshop meetings will be organised (one at midterm and at another at the end of the project).



Structure and activities of ACTINET-I3

Project details

Project type // Collaborative Project and Coordination and Support Action

Project start date // 01/10/2009

Duration // 36 months

Total budget // EUR 7 681 874

EC contribution // EUR 3 000 000

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- LGI Consulting, FR
- Institute for Transuranium Elements (JRC-ITU), EU
- Karlsruher Institut für Technologie (KIT), DE
- Paul Scherrer Institut (PSI), CH
- Royal Institute of Technology (KTH), SE
- Victoria University of Manchester, UK

ENEN-III

The nuclear industry relies on highly trained people to safely run and maintain existing installations and build new ones. The ENEN-III project will help to preserve nuclear knowledge and skills in Europe by creating a range of training schemes designed to suit the needs of different professions in the nuclear sector. Special attention is devoted to the training of professionals in the areas of Generation III and IV nuclear reactors. The ECVET system will be applied (European Credit systems for Vocational Education and Training).

EUROPEAN NUCLEAR EDUCATION NETWORK TRAINING SCHEMES

PRESERVING KNOWLEDGE AND DEVELOPING SKILLS

Education for all

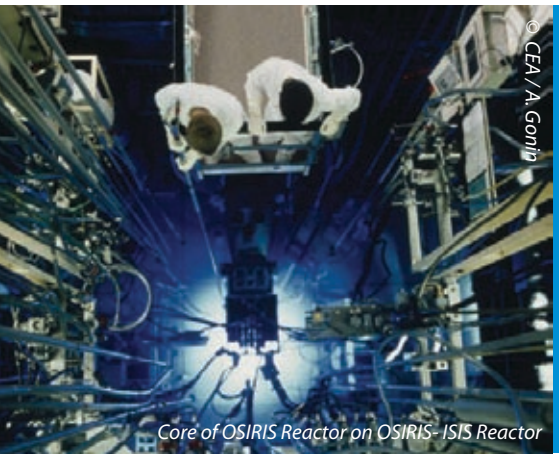
Major industrial organisations have the expertise and the money to hire engineers and train them for specific duties through in-house programmes, external courses and on-the-job training. In contrast, providing staff with adequate training is much more problematic for smaller organisations and in countries where recent nuclear energy policies have led to a decrease in nuclear education and research funding.

Well-designed training schemes are critical to maintaining the safety and efficiency of existing nuclear installations as well as to planning and building the next generation of facilities. ENEN-III targets the structuring, organisation, coordination and implementation of European Fission Training Schemes (EFTS) to provide training to professionals in nuclear companies, research centres and regulatory bodies. The schemes include courses, seminars and workshops covering all the skills needed for a healthy nuclear sector.

The training schemes

The project is developing four training schemes for specific posts in different sectors of the nuclear industry. A basic training scheme is designed for non-nuclear engineers and personnel of nuclear facilities, contractors and subcontractors. Two technical training schemes address the design and construction challenges of Generation III nuclear power plants and other nuclear facilities. Another technical training scheme will focus on research and development related to the design of Generation IV reactors.

The training schemes will be developed according to the systematic approach for training (SAT) and will be tested by 30 nuclear engineers employed by nuclear power plants, their contractors and their subcontractors. The schemes will also be tested by 40 nuclear engineers involved in the design and construction of Generation III nuclear power plants, as well as 10 engineers involved in research and development on advanced, Generation IV nuclear reactors.



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Core of OSIRIS Reactor on OSIRIS- ISIS Reactor

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Project details

Project type // Coordination Action
Project start date // 01/05/2009
Duration // 36 months
Total budget // EUR 2 121 024
EC contribution // EUR 950 000

www.enen-assoc.org

Expected results

The training schemes help safeguard nuclear knowledge in Europe by providing the qualified and skilled professionals needed by industry and research for the safe operation of existing nuclear power plants, the construction and safe operation of Generation III plants, and the design of the future Generation IV reactors. The courses will also enhance the attractiveness of careers in the nuclear field.

The involvement in the EFTS of partners from different countries, together with the application of common examination standards and the assessment of the EFTS components according to accredited quality-assurance principles, will facilitate mutual recognition of nuclear-related qualifications and skills across the EU. One of the objectives is to discuss the practical implementation of existing instruments, such as the ECVET (European Credit system for Vocational Education and Training) following the EU approach for continuous professional development. A European Passport of Competences or "Personal Transcript" recording the training history of the individual throughout his or her studies and career will represent tangible evidence of the mutual recognition principle.

Societal impact

The development of the EFTS is expected to help the nuclear community cope with the shortage of highly educated graduates who possess the qualifications and skills needed to ensure the long-term viability of the sector. Conducting courses, training sessions and internships in different organisations across the EU will expose trainees to different approaches, identities and cultures. This will benefit their interactions with colleagues in an international environment and is an important pedagogical element of the EFTS.

The internationally coordinated EFTS opens up career opportunities across the EU for trainees. Employers will benefit from having a larger pool of potential recruits whose qualifications and skills are recognised Europe-wide.

Important public events

ENEN-III has been present at many recent high-level events, including the EU Research Connection event and FISA 2009, both held in Prague, Czech Republic; the International Conference on Nuclear Power Safety and Nuclear Education in Obninsk, Russia; and the International Atomic Energy Agency (IAEA) School of Knowledge Management in Trieste, Italy. A full list of events can be found on the project website.

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EUROPEAN NETWORK FOR EDUCATION AND TRAINING IN RADIATION PROTECTION – PART II

TRAINING EUROPEAN RADIATION PROTECTION EXPERTS AND OFFICERS

ENETRAP-II

Nuclear technology is playing an increasingly visible role in society: the nuclear industry is flourishing, medical applications involving ionising radiation are growing in number and radioactive materials are being used in a wide range of research and non-nuclear industrial activities. Maintaining a high level of competency in radiation protection is therefore crucial to ensuring the safe use of ionising radiation into the future, across all applications. However, the number of experts in radiation protection is decreasing.

ENETRAP-II is developing European standards for training schemes that support students and professionals in their efforts to gain and maintain high-level radiation-protection knowledge and skills. These training schemes will comply with the recommendations of the European Basic Safety Standards, and will focus specifically on vocational training for radiation protection experts (RPEs) and radiation protection officers (RPOs).

European radiation-protection experts and officers

A wide variety of training programmes for RPEs and RPOs are offered within the 27 EU Member States, where differences in national approaches in accreditation and recognition pose significant obstacles to the mutual recognition of radiation protection expertise. The ENETRAP-II project aims to facilitate the mutual recognition – and thus mobility – of workers in this important field.

ENETRAP-II consortium members have extensive experience in radiation protection training at different levels and in different sectors. They are deeply involved with education and training (E&T) policy matters on national and international levels, and most members also have an advisory role with the national regulatory authority. The participation of the European Nuclear Education Network (ENEN) Association ensures close collaboration with the nuclear industry in Europe and beyond.


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Computer simulation training

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Project details

Project type // Coordination Action within Euratom Fission Training Schemes (EFTS) in all areas of Nuclear Fission and Radiation Protection

Project start date // 01/03/2009

Duration // 36 months

Total budget // EUR 1 473 115

EC contribution // EUR 800 000

www.sckcen.be/enetrap2

The ENETRAP-II Advisory Board, which includes amongst others representatives of the European Network on Education and Training in Radiological Protection (EUTERP) and the International Radiation Protection Association (IRPA), helps the project to balance E&T supply and demand. It also ensures that the project receives regular feedback from all stakeholders such as regulatory authorities, international organisations, professional organisations, training providers, research institutes, medicine and industry.

Activities

Together with results from the previous Euratom project (ENETRAP), ENETRAP-II will use questionnaires to establish a European standard for the training and recognition of RPEs and RPOs. A training scheme with a common basis and sector-specific specialised modules will be developed and put in place. Its effectiveness will be monitored according to newly developed approaches. To support the training sessions, text books in English and other course material will be created. ENETRAP-II will also develop and apply a mechanism for the evaluation of training courses and establish a recognised 'quality label' for training events.

One expected outcome of the project is a European Passport for Continuous Professional Development in Radiation Protection. This tool will facilitate the mutual recognition of professionals and, accordingly, their mobility in Europe.

The ENETRAP-II website will give interested students and professionals access to a database listing all relevant training events and providers. In addition, ENETRAP-II will make proposals to bring together national initiatives in an effort to attract early-stage radiation-protection researchers on a European level.

Expected results

ENETRAP-II will deliver a European standard for the training of RPEs and RPOs, introduce a European 'quality label' for radiation protection training, devise training sessions and initiate a 'training passport' that will facilitate the mutual recognition and movement of workers in Europe. It will also contribute to a database of information about all radiation protection training activities in Europe. ENETRAP-II expects to be instrumental in fortifying ongoing cooperation between regulators, training providers and customers (e.g. the nuclear industry and medical sector) in harmonising European requirements for the education and training of RPEs and RPOs. The project will also stimulate competence building and career development in radiation protection, which will have a significant impact on the EU's ability to meet future demand.

Societal impact

ENETRAP II will contribute to the implementation of European training schemes and training material. It will develop a European recognition system and encourage national authorities to get on board. The results of the project may significantly contribute to European Basic Safety Standards by formulating a radiation protection training scheme that represents an important evolution of the present syllabus. ENETRAP-II also puts forward key requirements for the recognition of RPEs.

Important public events

The first results of ENETRAP-II were presented at the International Conference on Education and Training in Radiological Protection (ETRAP2009) held in Lisbon, Portugal, in November 2009. ENETRAP-II results will be presented at international conferences and other events in the relevant fields of education and training, as well as in radiation protection, such as the IRPA conference held in June 2010 in Helsinki, Finland.

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- European Nuclear Education Network Association (ENEN), FR
- Federal Office for Radiation Protection (BfS), DE
- Health Protection Agency, UK
- Italian National Agency for New Technology, Energy and Environment (ENEA), IT
- Karlsruhe Institute of Technology, DE
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PETRUS II

Building expertise in the specific areas of engineering and science to address the geological disposal of radioactive waste requires a unified European effort over the next several decades. The PETRUS II project aims to ensure the continuation, renewal and improvement of the professional skills of European specialists in this field. Close collaboration between key training providers, universities and radioactive waste management agencies is central to the project. PETRUS II is committed to developing common frameworks for the implementation and delivery of education and training (E&T) programmes that can endure well into the future.

TOWARDS A EUROPEAN TRAINING MARKET AND PROFESSIONAL QUALIFICATION IN GEOLOGICAL DISPOSAL

LONG-TERM TRAINING NEEDS IN GEOLOGICAL DISPOSAL

E&T supply and demand: filling the gaps

PETRUS II fills the gaps between the growing demand for structured E&T in geological disposal and the limited training programmes currently on offer. The consortium comprises several major European waste management organisations as well as key members of the geological disposal and E&T communities. The partners offer scientific and technical competence in several subspecialty areas of radioactive waste disposal. PETRUS II takes a harmonised and structured approach to E&T in geological disposal. It proposes innovative strategies for sharing resources between academia and industry, agreeing on a common set of courses that meet quality standards while fostering mutual recognition and Europe-wide accreditation.

Mutual recognition and accreditation

PETRUS II takes a systematic approach to training, and is developing a dynamic system that encompasses analysis and planning, development and implementation, and evaluation and validation processes. The analysis and planning part involves assessing training needs and identifying existing resources. Development and implementation, on the other hand, establishes professional profiles, specific training areas and priorities to ensure the adequacy of academic curricula (i.e., for the European Master degree) and training programmes. PETRUS II makes intensive use of 'synchronous remote teaching', which entails broadcasting live lectures to classrooms in several locations throughout Europe.

Evaluation and validation of geological disposal E&T programmes will involve setting up appropriate methods for assessing relevance and impact as well as developing a model for accreditation and mutual recognition. The project will test the effectiveness of the developed programmes by carrying out several 'pilot' sessions.

A network for E&T in geological disposal will also be developed to sustain PETRUS II's objectives beyond the time period of the project.

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Project details

Project type // Coordination and support actions

Project start date // 15/01/2009

Duration // 36 months

Total budget // EUR 1 913 356

EC contribution // EUR 800 000

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http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7/petrus

Expected results

PETRUS II will develop adequate E&T schemes and deliver courses that synthesise relevant principles and themes from numerous disciplines in radioactive waste disposal. The project partners will also establish a framework for mutual recognition and accreditation of E&T programmes in this field. A long-term, self-supporting strategy for collaboration between E&T providers and end-users will be elaborated to ensure that these activities will continue beyond the time period of this project.

PETRUS II expects to establish at least 100 hours' worth of specialised, common, Master-level courses for students in the geosciences. These courses will represent 10 European Credit Transfer and Accumulation System (ECTS) credits. The programme meets the requirements set out by the ENEN Association for obtaining the European Master of Science in Nuclear Engineering, with 30 additional credits awarded for fundamental courses and 20 for a Master thesis in geological disposal. This PETRUS II programme should be operational in 2012, with around 30 students expected to enrol every year.

The PETRUS II training programme will serve as a framework for a qualification-oriented, modular programme and will use the European Credit System for Vocational Education and Training (ECVET).

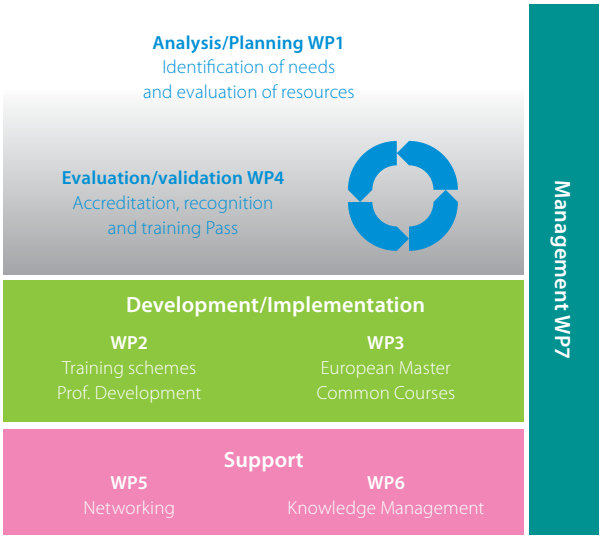
Societal impact

PETRUS II targets both professionals seeking career-long training and scientists seeking qualification. The project will help preserve knowledge and bridge the gap between the growing need for skilled professionals and the prospective shortage of qualified employees.

By sharing common resources and assembling a critical mass of specialists, PETRUS II offers support for countries with modest nuclear facilities. Building a common European framework for E&T in geological disposal also helps secure the match between labour-market supply and demand, improves flexibility and removes practical obstacles to professional mobility in Europe.

Important public events

A workshop has been organised for March 2010 to explore E&T priorities identified by regulatory authorities, nuclear industries and subcontracting companies. A database of training resources, course content, geological-disposal events and other relevant information will be developed and regularly updated, to be made available via the Internet.



Partners

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- Agencija za radioaktivne odpadke (ARAO), SI
- Cardiff University, UK
- Empresa Nacional de Residuos Radiactivos, SA, ES
- European Nuclear Education Network Association – Réseau Européen pour l'Enseignement du Nucléaire (ENEN), FR
- Gesellschaft für Anlagen- und Reaktorsicherheit mbH, DE
- Institut National Polytechnique de Lorraine, FR
- Instituto Tecnológico e Nuclear, PT
- ITC School of Underground Waste Storage and Disposal, CH
- Microbial Analytics Sweden AB, SE
- Nuclear Decommissioning Authority, UK
- Posiva Oy, FI
- Radioactive Waste Repository Authority, CZ
- Technische Universitaet Clausthal, DE

SNETP Office

The European Sustainable Nuclear Energy Technology Platform (SNETP), launched in September 2007, is a forum supporting technological developments in nuclear fission as part of a sustainable, low-carbon energy mix. SNETP members share a common vision and work together to make the most of European scientific and engineering resources. The purpose of SNETP Office is to provide professional support for the ongoing management of SNETP's many operations.

SECRETARIAT OF THE SUSTAINABLE NUCLEAR ENERGY TECHNOLOGY PLATFORM

Efficiency, reactivity, impact and visibility

An informal secretariat evolved from the organising committee of the SNETP Launch Conference, but it soon became apparent that a full-time commitment was needed from a professional organisation with expertise in project management and communication. LGI Consulting, a project management consultancy company with thorough experience in European projects related to the nuclear field, was called on to act as the main support organisation.

SNETP Office offers logistical support to ensure that the activities of the SNETP Working Groups are efficient, and acts as a centralised, permanent entry point for the platform. It also ensures maximum impact and dissemination of the activities of the SNETP and of its Working Groups, in addition to improving the visibility of SNETP through enhanced website management and participation in major international events.

Logistics and communications: in good hands

As a central point of contact for SNETP, the secretariat provides logistical and secretarial support. The dedicated office and staff facilitates interactions with platform members and external organisations, handles the professional publication and distribution of documents produced by the Working Groups, sets up meetings of the platform management and working groups, organises the General Assembly and manages day-to-day secretarial duties.

The secretariat is responsible for communication activities such as the upgrade, maintenance and continuous management of the SNETP public and private websites, the elaboration of a communication strategy and action plan, and the creation of a communication 'toolkit' (e.g. newsletters, factsheets, slide shows, stand material, posters). It also organises SNETP participation in important international events. Finally, it interacts with other related initiatives, such as the European Nuclear Energy Forum (ENEF), the SET-Plan Information System (SETIS) and the Implementing Geological Disposal Technology Platform (IGD-TP).

Secretariat at work
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Project details

Project type // Support Action
Project start date // 01/12/2008
Duration // 24 months
Total budget // EUR 991 958
EC contribution // EUR 700 000

www.snetp.eu

Expected results

SNETP Office will ensure the smooth operation of the organisational and logistical aspects of SNETP. This will make the platform's work more effective, as demonstrated by the finalisation, design and publication of the SNETP Strategic Research Agenda (SRA) in June 2009. More than 3 000 copies of the SRA were distributed in the first two months to SNETP members and other relevant stakeholders. Publication of the Deployment Strategy is expected in June 2010.

Societal impact

In addition to facilitating the platform's routine operations, SNETP Office will enhance the visibility of the platform and improve communication between SNETP and the public, EU and national decision makers, as well as the nuclear industry and the nuclear scientific and engineering research communities. The project's communications strategy comprises a complete 'toolkit', from an upgraded public website to newsletters and participation in important international events. In its communications materials, SNETP presents important facts about the overarching aims of the nuclear industry and research community, specifically targeting a non-expert audience. Areas of general concern are also addressed, such as CO2 emissions, sustainability and economic aspects. Effective communication is essential for demystifying the nuclear industry, as well as for including all stakeholders in meaningful public dialogue and decision making.

Important public events

SNETP Office is organising the Second General Assembly in September 2010. The secretariat has organised participation in past events including Research Connection 2009, Sustainable Development 2009, FISA-2009, International Conference on Structural Mechanics in Reactor Technology (SMiRT-20), GLOBAL 2009 and Strategic Energy Technology (SET)-Plan Conference. The secretariat also organised a Nuclear Workshop held in Brussels, Belgium, in October 2009, leading up to the SET-Plan Conference.

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- Forum Atomique Européen, BE
- LGI Consulting, FR
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TENEB

In the highly unlikely event of a large-scale radiological accident or a terrorist attack involving a nuclear facility, radiation exposures can vary considerably. An important initial step in the medical response is the triage of patients according to the severity of exposure using biological dosimetry. In Europe, there are several competent laboratories, but each can perform dose assessments for incidents involving only a few people. TENEB will perform a small study to determine the feasibility of creating a network of these laboratories in order to be better prepared for a radiological mass casualty event.

TOWARDS A EUROPEAN NETWORK OF EXCELLENCE IN BIOLOGICAL DOSIMETRY

PREPARING FOR MASS CASUALTY EVENTS

Integrating European excellence

Euratom is considering whether to publish a call for proposals to fund a European Network of Excellence (NoE) for biological dosimetry (i.e. cytogenetic and related assays) to assess radiation mass casualties. Such a network would serve to strengthen European scientific and technical excellence in biological dosimetry. An outcome would be preparedness for assessing radiation casualties in any of the 27 EU Member States and some Associated Countries. The TENEB advisory group was set up to establish the current status of biological dosimetry across Europe and to advise Euratom on the feasibility and operation of a NoE.

Scattered expertise

In order to assess the status of biological dosimetry in the EU, a letter was sent to the radiation protection authorities of each of the 27 Member States, plus Norway and Switzerland. The letter included a technical questionnaire to be passed on to the appropriate laboratories. The same questionnaire was independently sent to 23 additional laboratories known personally to the TENEB participants.

Of the countries surveyed, 15 have biological dosimetry laboratories of varying proficiencies. Of these 15 countries, most have only 1 laboratory; however, 5 countries have between 2 and 5 laboratories capable of undertaking biological dosimetry. The total number of operational laboratories is 24; 7 are university-based, 16 are located in governmental bodies (including research institutions and hospitals), and 1 is under military jurisdiction.

The dicentric assay, which tests the effect of radiation exposure on genetic material, is established in 21 laboratories. The overall capacity of those 21 laboratories to perform biological dosimetry in a triage mode is around 1 500 victims per week. This calculation was based on the trained staff at the time of the questionnaire, asking the laboratory head to assess the capacity based on the scoring of '50 cells per victim'. The total capacity of these laboratories to perform biological dosimetry in the full mode (500 cells per victim) is approaching 200 victims per week. The micronucleus assay, a similarly

TENEB meeting, Nice
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Project details

Project type // Support action
Project start date // 02/01/2009
Duration // 6 months
Total budget // EUR 76 869
EC contribution // EUR 47 868

www.teneb.eu

specialised test, is established in 15 laboratories. The overall capacity of those 15 laboratories to perform biological dosimetry in a triage mode is around 900 victims per week (500 binucleated cells per case).

The dicentric and micronucleus assays are the most widely applicable. However, other laboratories have expertise in other tests: 11 laboratories have the gamma-H2AX assay, 9 have PCC (premature chromosome condensation) and 17 have FISH (fluorescence in situ hybridisation). In general, most laboratories expressed their intention to extend the range of assays that they can undertake. At any given moment, the combined consumables stockpile of the 15 laboratories would enable 1 000 blood samples to be processed. In many countries, restocking can be achieved within 48 hours.

Assessment of viability

Of the 27 Member States, 18 recognise the necessity to perform biological dosimetry and 15 have established laboratories operating. Most are integrated in national emergency response planning and are regularly performing dose assessment on individual cases that arise from time to time in industry and medicine.

Over many years, often with European Commission research funding, a good level of collaboration has developed among many of these laboratories on biological dosimetry-related research. However, there has been no substantial funding for biological dosimetry per se. A few laboratories have recognised the need for networking and set up formal agreements for mutual assistance for serious radiological events. This forms an ideal basis for expansion to a European NoE. Networking at the European level has the potential to enhance and improve the existing resources to form an efficient and prepared network across Europe.

The long-term expertise and integration of the laboratories in their national governmental structures make it highly probable that a network would be sustained beyond the period when European Commission funding has ceased.

Preparing for mass casualty

The European Community has a large number of biological dosimetry laboratories but each laboratory has a limited capacity and cannot handle a mass casualty event. A surge can only be handled by European cooperation. There is a strong willingness among the European laboratories to come together as a network to prepare for a mass casualty event somewhere in Europe. The governmental funding of most laboratories is assured. This is an essential prerequisite for a sustained, interacting network across Europe.

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EU-NMR-An

Valuable information about actinide elements can be obtained using techniques based on nuclear magnetic resonance (NMR). EU-NMR-An is a small project that builds European competence in NMR while identifying future trends and promising application fields in NMR actinide research. By so doing, the project ultimately supports the establishment of a European Competence Centre for NMR on Actinides.

TOWARDS A EUROPEAN COMPETENCE CENTRE FOR NUCLEAR MAGNETIC RESONANCE ON ACTINIDES

BRINGING TOGETHER EUROPE'S NMR AND NUCLEAR RESEARCH COMMUNITIES

A European Competence Centre for NMR on Actinides

Europe suffers a deficit in NMR capacity for investigations involving radionuclides (atoms with an unstable nucleus), in particular the radioactive elements known as actinides. Because of the high demands placed on infrastructures and the very high standards of nuclear licensing, only a few nuclear research installations in Europe are suited for the establishment of active NMR facilities. The Karlsruhe Institute of Technology–Institute for Nuclear Waste Disposal (KIT-INE) and the European Joint Research Centre Institute for Transuranium Elements (JRC-ITU), both located on the same site in Germany, are collaborating to establish a European Competence Centre for NMR on Actinides. This Centre would provide access to NMR techniques specific to radionuclide research. Such access is not otherwise available: there are no solid-state NMR instruments in Europe and only a few exist for studying liquid samples (e.g., ATALANTE in Marcoule, France). The EU-NMR-An project takes the first step towards the establishment of this much-needed Centre by bringing together Europe's NMR and nuclear research communities.

Building an NMR community

EU-NMR-An will focus on two basic activities: the establishment of an expert roundtable and the organisation of a workshop on NMR investigations of actinide materials. The focus of these activities will be meeting experimental needs, specifying required NMR instrumentation and infrastructure, and building competence for the European Competence Centre for NMR on Actinides. The Centre can be established only through dialogue with the actinide research community and established NMR scientists. The workshop, planned and organised by the expert roundtable, will include key members of both communities. One goal of the event is to plan the facilities that will be needed in the future by European nuclear institutes and universities.

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Project type // Coordination and Support Action

Project start date // 01/10/2010

Duration // 9 months

Total budget // EUR 172 546

EC contribution // EUR 125 300

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www.eu-nmr-an.eu

Expected results

The EU-NMR-An project will establish synergistic collaboration between European institutions and experts from around the world specialising in NMR investigations of radioactive material. The new NMR nuclear facilities, foreseen as part of the European Competence Centre for NMR on Actinides, will be unveiled to a broad base of potential European users at the workshop.

The workshop will provide a platform for the discussion of challenges in applying magnetic techniques such as NMR to studies of paramagnetic f-elements (i.e. those that belong to the actinide or lanthanide series in the table of elements), a little-explored realm at present. Some advanced NMR techniques have not yet been used in studies of paramagnetic f-element (i.e. lanthanide and actinide) systems, which are long-lived and highly toxic components of radioactive waste.

Societal impact

NMR facilities and competence, when available to the European actinide community, will provide fundamental insights into the chemistry and physics of these f-elements and, accordingly, into some of the central questions of electronic structure-bonding relationships. New insights from NMR experiments are expected to secure fundamental understanding of the factors contributing to the stability, reactivity and behaviour of f-elements. This may advance our knowledge to a level that enables precise prediction of the stability and reactivity of a given f-element complex. These advances, in turn, potentially have significant impact on a wide field of applied research, including irradiated fuels and waste management.

Important public events

Results will be disseminated on the project website, including providing copies of presentations given at the European Radioactive Nuclear Magnetic Resonance (EURACT-NMR) Workshop. EU-NMR-An contributes to education and training of young researchers by inviting students to attend scientific presentations at the workshop.

Members of the NMR expert roundtable at their kick-off meeting in October 2009. From left to right: Ian Farnan (University of Cambridge, UK), Herman Cho (Pacific Northwest Laboratories, US), Jean F. Desreux (University of Liège, BE), Daniel Meyer (CEA, FR), Andreas Geist (KIT-INE, DE), Melissa A. Denecke (KIT-INE, DE), Zoltán Szabó (KTH, SE) and Joe Somers (JRC-ITU, EU)

Partners

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- Karlsruhe Institute of Technology, DE
- Royal Institute of Technology, SE
- Université de Liège, BE
- University of Cambridge, UK
- Joint Research Centre Institute for Transuranium Elements, EU

EU NMR

EUROPAIRS

To reduce the greenhouse gas (GHG) contribution of industrial heat applications such as hydrogen and transport-fuel production, an innovative technology, the (Very) High Temperature Nuclear Reactor ((V)HTR), could provide an alternative to fossil-fuel boilers. The (V)HTR is able to cogenerate electricity and large amounts of low-carbon process heat, and promises both high efficiency and advanced safety features. Its modular design provides the flexibility needed for efficiently powering energy-intensive processes. Nuclear cogeneration has the potential to significantly contribute to a low-carbon economy and reduce the demand for fossil fuels. EUROPAIRS unites the nuclear community and conventional industries to address the challenges of coupling the nuclear heat source with the end user, and to assess the viability of this new technology in a crucial step towards demonstration.

END-USER REQUIREMENTS FOR INDUSTRIAL-PROCESS HEAT APPLICATIONS WITH INNOVATIVE NUCLEAR REACTORS FOR A SUSTAINABLE ENERGY SUPPLY

ELECTRICITY AND PROCESS HEAT FOR INDUSTRY

Nuclear cogeneration for industry: a decisive step towards a CO^2-lean Europe

EUROPAIRS is paving the way for the development of an industrial demonstrator that will cogenerate power and heat for industrial processes (e.g. fuel production, steel manufacture). The goal is to establish strategic links between all involved communities and to collaborate on the development of (V)HTRs for such applications. The EUROPAIRS consortium gathers world leaders in nuclear engineering and research, as well as nuclear safety and conventional process engineering. Importantly, it includes representatives from relevant industries (end-users) and collaborates with international initiatives based in the US and South Africa.

Forging strategic partnerships

The coupling between the nuclear heat source and the industrial application (i.e. the end-user) poses myriad technical challenges and requires innovation on many levels. EUROPAIRS provides an opportunity for end-users to interact directly with the nuclear community in addressing these challenges.

EUROPAIRS project partners are forging strategic partnerships between the key players in nuclear technology and industrial end-users. The project also aims to establish the boundary conditions (i.e. the technical, industrial, economical, licensing and safety requirements) of future nuclear cogeneration systems connected to industrial processes, and to investigate and integrate all licensing questions early in the development process. An important aspect of EUROPAIRS is the elaboration of a roadmap for the development of a demonstration plant that will couple a (V)HTR with an industrial process.

Expected results

EUROPAIRS will define the boundary conditions for nuclear cogeneration systems, investigating the temperatures, pressures, flow rates, power and the various coupling options with industrial processes. This is an important step in the development of a demonstrator that meets the needs of industrial heat consumers.

The safety analysis of the nuclear heat source and its interface with an industrial facility will be a key upfront input for the development of a prototype. Considering safety aspects early on will enhance the design and smooth the licensing process of the demonstration plant.

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Project details

Project type // Coordination and Support Action

Project start date // 01/09/2009

Duration // 21 months

Total budget // EUR 1 370 350

EC contribution // EUR 800 000

www.europairs.eu

All information will be summarised in a roadmap towards demonstration. Based on the above inputs, the project will assess fuel-cycle scenarios (i.e., resource availability and waste) for future (V)HTR deployments and will produce a clear, realistic, consistent and comprehensive work programme. The strategic partnership between nuclear technology and process-heat industrial end-users is the strength of the project, ensuring that the EUROPAIRS work programme can become a reality.

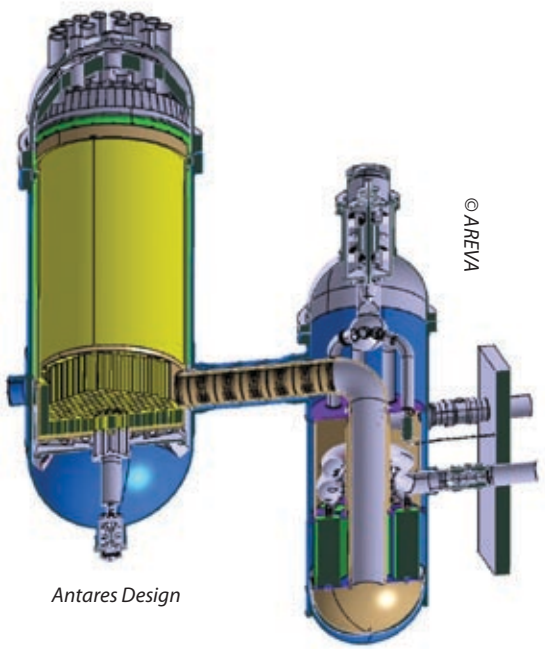
Societal impact

The power sector contributes to one fifth of European greenhouse gases emissions; the remaining emissions originate from fossil-fuel combustion, notably in many industrial heating processes. Nuclear cogeneration systems have the potential to significantly change the situation: they may replace many of the fossil-fuel boilers that produce heat for industry. Industrial heat production represents a significant market, and using nuclear energy instead of burning fossil fuels would avoid large amounts of direct GHG emissions.

In the longer term, nuclear cogeneration could produce hydrogen and recycle CO2 to synthetic hydrocarbon fuel, making a cogeneration plant an effective CO2 sink. Nuclear cogeneration offers a realistic potential to enhance the EU's security of supply by consuming less fossil fuel and by building a bridge to a hydrogen-based economy. Nuclear cogeneration can significantly contribute to a CO2-lean economy, in compliance with the EU's Strategic Energy Technology (SET) Plan targets. Development, construction and deployment of such systems could create jobs and establish the EU as a world leader in this area.

Important public events

An open workshop will be organised at the end of the project to present EUROPAIRS results. EUROPAIRS will also participate in international conferences on nuclear and other technologies.



Antares Design

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- AMEC-NNC, UK
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- Areva NP SAS, FR
- Baaten Energy Consulting, NL
- Forschungszentrum Jülich GmbH, DE
- Fortum Power and Heat Oy, FI
- Gesellschaft für Anlagen- und Reaktorsicherheit, DE
- Institute for Radiological Protection and Nuclear Safety (IRSN), FR
- Joint Research Centre – Institute for Energy, EU
- Koninklijke DSM N.V., NL
- LGI Consulting, FR
- North West University, ZA
- Nuclear Research and Consultancy Group, NL
- Pebble Bed Modular Reactor Company (Pty) Ltd, ZA
- Prochem, PL
- Rolls-Royce Power Engineering plc, UK
- SAIPEM, FR
- Solvay S.A., BE
- Technip KTI, IT
- Tractebel Engineering (GdF Suez), BE
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NUCL-EU

Research and technology development in the area of nuclear fission and radiation protection under the Euratom programme is booming. However, there is a clear need for greater coordination of research activities at both European and global levels in order to further stimulate innovation and improve the EU's competitiveness worldwide. NUCL-EU aims to create an efficient, proactive and sustainable National Contact Point (NCP) network with a view to stimulating closer cooperation among all the NCPs in the Euratom Programme.

REINFORCING THE NETWORKING OF FP7 NATIONAL CONTACT POINTS (NCP) AND THIRD COUNTRY CONTACTS IN THE EURATOM FISSION PROGRAMME

NETWORKING NCPS FOR A STRONGER GLOBAL RESEARCH COMMUNITY

NCPs: gateways to the Euratom research programmes

Across Europe, Euratom NCPs play a key role in providing information and guidance on the Euratom research framework programme to local researchers. As well as raising awareness about the funding opportunities available, NCPs help potential applicants find partners and prepare and submit project proposals. NCPs also offer support to researchers during the project itself by providing advice on management and administrative issues, for example. Euratom NCPs are present in all EU Member States as well as in several other countries worldwide.

NUCL-EU brings together Euratom NCPs from Europe and beyond who have significant experience in the promotion of European research, particularly in the fields of nuclear fission and radiation protection. The aim of the initiative is to create an efficient, proactive and sustainable network of well-informed, skilled NCPs with a view to improving the quality of services they provide. The initiative also makes it easier for researchers, particularly those based outside the EU, to participate in the Euratom research programme.

Networking NCPs

The activities carried out under NUCL-EU will help to create a common basis of know-how regarding Euratom FP7 issues through innovative, hands-on and interactive training measures.

Training courses will help to enhance the professional skills of Euratom NCPs in a number of key areas, including the Euratom FP7 rules for participation, grant agreements, financial rules, consortium agreements, intellectual property rights (IPR) and project management, as well as drafting a successful proposal and negotiating the proposal. The courses also cover EU and Euratom policies and agreements, such as the European Fusion Development Agreement, the ITER (fusion reactor) Agreement and the Sustainable Nuclear Energy Technology Platform.

All Euratom NCPs are welcome to participate in the courses, and training materials will be made available on the project website. Twinning and mentoring schemes will facilitate the flow of information and skills between the NCPs.

In addition, NUCL-EU will organise transnational workshops in the new EU Member States. These events will provide local researchers with the opportunity to obtain information and advice on how to get involved in the Euratom research programme.


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Project details

Project type // Coordination Action
Project start date // 01/10/2009
Duration // 36 months
Total budget // EUR 349 000
EC contribution // EUR 349 000

www.nucleu.net

Expected results

The NUCL-EU project will significantly raise the quality of NCP support services across Europe and beyond in the field of nuclear fission and radiation protection. It will also reinforce the links between Euratom NCPs through efficient sharing of information, experiences and best practice. By working together in this way, less experienced NCPs will be able to learn from more experienced ones. As a result, the wider nuclear research community will benefit from a higher and more consistent level of services and information. This will make it easier for newcomers, especially those from outside the EU, to gain access to the Euratom research programme and raise the quality of proposals submitted. The networking aspect of NUCL-EU will also make it easier for researchers to find potential partners in other countries.

Societal impact

NCPs play a crucial role in the Euratom research Framework Programmes as providers of information and assistance to both potential participants in new projects and beneficiaries in ongoing projects. Moreover, due to their closeness to the European research community, the NCPs are perceived by the European Commission as important sources of feedback on possible challenges in the implementation of the Framework Programmes.

By enhancing the quality of services provided by Euratom NCPs, NUCL-EU will ensure that the best research groups are able to take full advantage of the opportunities available under the Euratom research programmes. Finally, by improving the coordination of research activities, NUCL-EU will strengthen the competitiveness of Europe's nuclear industry on the global level.

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- Research Promotion Foundation, CY
- Slovenian Nuclear Safety Administration (SNSA), SI
- South African Nuclear Energy Corporation Ltd (Necsa), ZA
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A JOINT EUROPEAN COMMISSION/NUCLEAR ENERGY AGENCY 'ENGINEERED BARRIER SYSTEM' PROJECT SYNTHESIS REPORT

ASSESSING ENGINEERED BARRIER SYSTEMS FOR SAFE WASTE DISPOSAL

EBSSYN

Geological disposal of long-lived radioactive waste requires several 'man-made', or engineered, barriers between the waste and the accessible environment. EBSSYN will synthesise a multi-year European Commission (EC) and Nuclear Energy Agency / Organisation for Economic Co-operation and Development (OECD/NEA) -sponsored project on the engineered barrier system (EBS) to be used in geological disposal. The EBS project has examined how to design, characterise, model and assess the performance of the EBS, and how to integrate EBS issues in the safety case for disposal.

EBS: Common views on key issues

EBSSYN is being conducted by TerraSalus Limited (UK) in collaboration with a European Commission/NEA-coordinated task group comprising representatives from the European Commission and the NEA, as well as from national radioactive waste management and disposal organisations in Canada, Finland, France, Germany, Japan, Spain, Sweden, Switzerland, the UK and the US.

This project involves the preparation of a synthesis report on EBSs and the safety of deep geological repositories for long-lived radioactive waste. The objective of the report is to bring together the main conclusions from a series of international workshops on the EBS.

The EBSSYN report presents the current understanding of the role that EBSs play in the disposal system and in the safety case. The report also relates common views on how integration is necessary to achieve successful design, construction, testing, modelling and performance assessment.

The report describes progress regarding EBS studies that occurred during the course of the OECD/NEA EBS project, identifies key messages from the EBS workshops, discusses specific examples from national disposal programmes, and identifies open issues where further challenges may exist.

Fostering understanding

The EBS has a central role in the safety case for disposal. EBS design and optimisation requires a significant work programme typically lasting from several years to several decades. During such a programme, it is essential to maintain good links all the way from the fundamental understanding of the processes and phenomena that may affect the behaviour of the wastes, the EBS materials and the host rock, to their representation in safety assessments.

The rationale for the project was to enhance understanding of how safety cases for disposal can be used to integrate results from various activities. These activities include defining the requirements of the disposal system and the EBS; understanding the materials of the EBS components and the processes that may affect them; modelling the behaviour and performance of the EBS components; demonstrating that the EBS can be manufactured, constructed and installed; and providing reasonable assurance that the disposal system will provide acceptable levels of safety.

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Project details

Project type // Coordination and support action
Project start date // 01/12/2008
Duration // 12 months
Total budget // EUR 25 000
EC contribution // EUR 25 000

Expected results

The key result from EBSSYN will be a highly visible international publication that directly addresses many issues associated with performance and safety assessment for geological repositories, as well as giving high-level guidance on approaches to repository design and implementation.

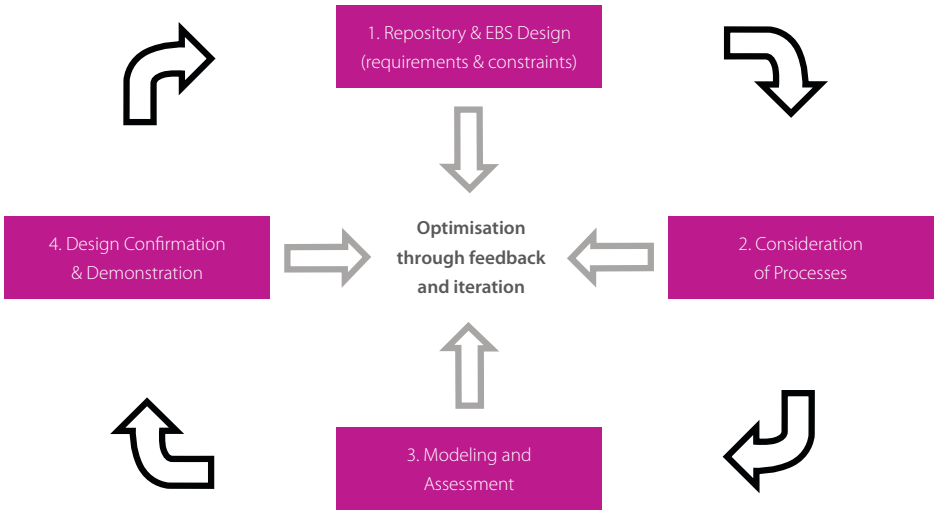
The project has led to a better understanding of the EBS design process. EBS design and optimisation is necessarily an iterative process that follows an initial step of defining the safety strategy for disposal; the optimisation process then involves a range of studies. EBSSYN has illustrated aspects of each of these steps and their combination by examining a series of examples and trends in radioactive waste disposal.

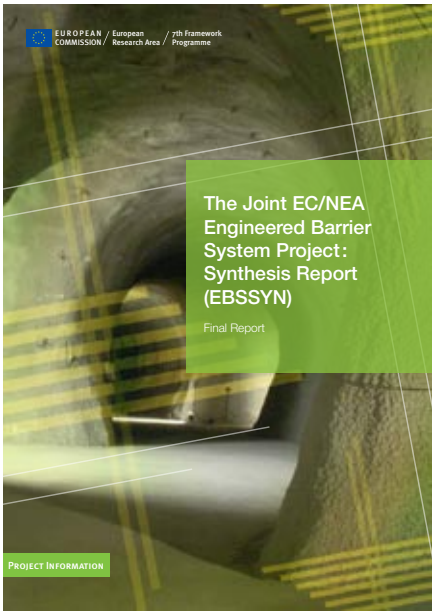
Societal impact

EBSSYN should assist radioactive waste disposal programmes to proceed in a better-informed, well-integrated and planned manner and, therefore, have an increased chance of success. Sharing of knowledge and best practices between different disposal programmes should heighten stakeholder confidence, help ensure the safety of waste disposal, and reduce the costs and emissions associated with necessary research and development works. The results from the project should be of interest to waste disposal organisations, regulatory authorities and stakeholders in radioactive waste generation and disposal.

Important public events

The results of the project will be disseminated as a public-domain 'EUR' report and will be made available for download from the European Commission and NEA websites. The final report will also be widely disseminated by the European Commission and NEA to stakeholders worldwide.





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HLEG

Although there has been a decline in scientific and regulatory expertise in radiobiology and radiotoxicology during the past decades, plans to establish new nuclear plants and the increasing application of ionising radiation in medicine now accentuate the need to revitalise the field of low dose risk research. It is necessary to address these issues at a strategic level in Europe. The European High Level and Expert Group (HLEG) produced a report that identifies key policy issues, assesses the state of science and proposes a European research strategy. The report outlines the way forward for implementing this strategy and addresses overarching policy questions.

REPORT OF THE HIGH-LEVEL AND EXPERT GROUP ON EUROPEAN LOW DOSE RISK RESEARCH

A STRATEGY FOR LOW-DOSE RESEARCH

Radiation protection standards

Both natural and man-made sources of ionising radiation contribute to human exposure and constitute a hazard for human health. Exposure of the population to natural radiation is to some extent unavoidable and medical use of radiation is now an indispensable part of modern healthcare. The exposure of workers – and to a smaller extent of the public – to low levels of radiation from nuclear energy production and other industrial uses of ionising radiation have become an integral part of industrialised society. These uses are heavily regulated. Radiation protection standards rely on current knowledge of the risks from radiation exposure. Any overestimation or underestimation of these risks could lead either to unnecessary restriction or to a lower level of health protection than intended.

HLEG: Revitalising low dose risk research

Although much is known about the quantitative effects of exposure to ionising radiation, considerable uncertainties and divergent views remain regarding the health effects at low doses. The importance of low dose risk research is now recognised globally. Many of the larger Member States of the EU undertake considerable research activities in low dose risk; however, beyond the EURATOM research programme, little has been done to integrate these programmes.

There has been a decline in scientific and regulatory expertise in radiobiology and radiotoxicology during the past decades, but plans to establish new nuclear plants and the increasing application of ionising radiation in medicine are emphasising the need to revitalise the field and related research capacity. All these aspects highlight the necessity to address these issues at a strategic level in Europe.

The European High Level and Expert Group (HLEG) was formed to consider these issues. The group comprised representatives of national funding bodies and the European Commission, assisted by experts from the research community. The objectives were to formulate and agree on policy goals to be addressed by low dose risk research; to develop a strategic research agenda and roadmap for such research in Europe; and to pave the way for a sustainable, operational framework related to low dose risk research in Europe.

The experts' report

The report of the European High Level and Expert Group was prepared with the input of a wide range of specialists within the research community. It identifies key policy issues, assesses the state of science and main research challenges, and proposes a European research strategy for its implementation. The report also addresses overarching policy questions such as the robustness of the current system of radiation protection and risk assessment, and how this system can be improved.

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The radiation protection system is underpinned by a number of value judgements and simplifying assumptions that are based on existing scientific knowledge. The validity of each of these judgements and assumptions contributes to the strength of the protection system as a whole. Therefore, it is pertinent to address them separately. The more important issues in this respect are dose response for cancer, tissue sensitivity for cancer induction, individual variability in cancer risk, effects of radiation quality and type, risks from internal radiation exposure, hereditary effects and risks of non-cancer diseases including dose-response relationships.

Future directions

The HLEG report provides a summary of the current state of knowledge and identifies the most promising future research directions for each of these issues, which can be resolved only through the integration of research at a European or international level. HLEG proposes the establishment of a transnational organisation capable of ensuring appropriate governance of research in this field, and a scientific strategy capable of structuring future research in the most effective way.

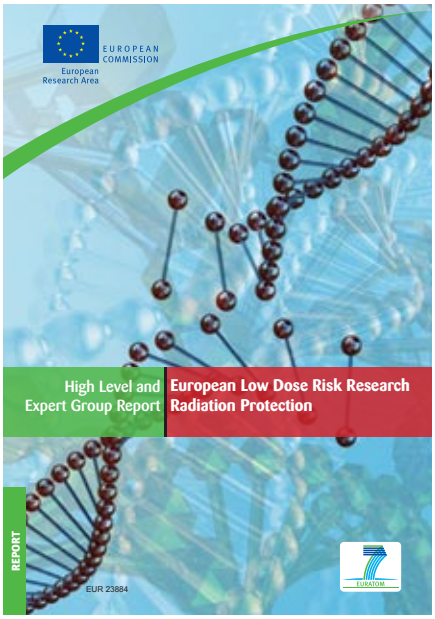
HLEG members representing funding bodies will combine their respective R&D programmes in the area of low dose health effects into an integrated, transnational programme. A new initiative, the Multidisciplinary European Low Dose Initiative (MELODI), will bring together the programmes of the various funding bodies and research organisations in Europe. MELODI will be open to other Europe-based organisations entrusted with similar missions in the field of low dose radiation research. It will establish effective interfaces between stakeholders and the broader scientific and health communities, ensure the availability of key infrastructures and establish an integrated approach for training and education.

Societal impact

Addressing policy-related questions regarding low dose risk research requires continuous dialogue between society and the authorities responsible for public protection. One of the aims of such a dialogue is to increase awareness of the current knowledge of low dose risks, with the ultimate goal of further developing institutional trust and a 'safety culture' at all levels of operation. Another goal is to address the needs and questions of researchers concerning ionising radiation in everyday applications. Importantly, ongoing dialogue will serve to raise awareness among the users and producers of ionising radiation regarding the importance and need for low dose risk research, and for these sectors to increase their contributions to its funding.

Important public events

The HLEG report was open for public consultation, and comments from the research community, regulatory bodies, industry, healthcare, NGOs and other stakeholders were considered in finalizing the report. It is available on the website of the European Commission.



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GLOSSARY

Many of the entries in this glossary are reproduced courtesy of the International Atomic Energy Agency (IAEA; see http://www.iaea.org).

Ageing

General process in which characteristics of a structure, system or component gradually change with time or use. Although the term ageing is defined in a neutral sense – the changes involved in ageing may have no effect on protection or safety, or could even have a beneficial effect – it is most commonly used with a connotation of changes that are (or could be) detrimental to protection or safety, i.e. as a synonym of ageing degradation.

Accident management

The taking of a set of actions during the evolution of a beyond design-basis accident:

- to prevent the escalation of the event into a severe accident;
- to mitigate the consequences of a severe accident;
- to achieve a long-term, safe and stable state.

Decommissioning

1) Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for a repository which is closed and not decommissioned).

2) All steps leading to the release of a nuclear facility, other than a disposal facility, from regulatory control. These steps include the processes of decontamination and dismantling.

Disposal

Emplacement of waste in an appropriate facility without the intention of retrieval (c.f. storage with intent to retrieve).

Some countries use the term disposal to include controlled discharges of effluents to the environment.

- Direct disposal: Disposal of spent fuel as waste.
- Geological disposal: Disposal in a geological repository.

Dose

1) A measure of the energy deposited by radiation in a target.

2) Absorbed dose, committed equivalent dose, committed effective dose, effective dose, equivalent dose or organ dose, as indicated by the context.

- Committed dose: Committed equivalent dose or committed effective dose.

Engineered barrier system

The designed or engineered components of a repository, including waste packages and other engineered barriers.

Exposure

The act or condition of being subject to irradiation.

- External exposure: Exposure due to a source outside the body. Contrasted with internal exposure.
- Internal exposure: Exposure due to a source within the body. Contrasted with external exposure.
- Natural exposure: Exposure due to natural sources. Natural exposure is often excluded

exposure, but in some cases may be occupational exposure or public exposure.

Fission product

A radionuclide produced by nuclear fission. Used in contexts where the radiation emitted by the radionuclide is the potential hazard.

Generations of nuclear reactors

Generation-I reactors were developed in the 1950s and 1960s as prototypes. Only a few are still running today. Most reactors operating now are generation-II reactors, developed on the basis of the most successful generation-I prototypes.

Generation III reactors are considered to be 'advanced reactors'. Examples include the European Pressurised Water Reactor (EPR) and the AP1000 of Westinghouse. These focus on improving safety, economics and severe-accident management scenarios. More than a dozen generation-III advanced reactor designs are in various stages of development. Some have evolved from existing designs, while others are more radical. The best-known radical new design is the 'pebble-bed modular reactor', or high-temperature reactor, which uses helium as coolant at very high temperatures to drive a turbine directly.

Generation-IV designs are still on the drawing board and will not be operational on a commercial basis for at least two or three decades. Presently, six different systems are being developed in the framework of the Generation IV International Forum (GIF), which brings together countries with interest in these developments. Euratom is also a member of GIF. Three of the generation-IV systems are fast reactors using sodium, lead or gas as coolant. One is an advanced HTR, one is a supercritical water-cooled reactor and one is a molten-salt reactor concept.

Geological repository

A facility for disposal of radioactive waste located underground (usually several hundred metres or more below the surface) in a geological formation, to provide long-term isolation of radionuclides from the biosphere.

High-level waste (HLW)

The radioactive liquid containing most of the fission products and actinides present in spent fuel – which forms the residue from the first solvent-extraction cycle in reprocessing – and some of the associated waste streams; this material following solidification; spent fuel (if it is declared a waste); or any other waste with similar radiological characteristics. Typical characteristics of high-level waste are thermal power above about 2 kW/m^3 and long-lived radionuclide concentrations exceeding limitations for short-lived waste.

IAEA

The International Atomic Energy Agency (IAEA) is an independent international organisation that is related to the United Nations. The IAEA reports to the UN Security Council regarding non-compliance in terms of both safety obligations and matters relating to international peace and security.

Ionising radiation including α, β, γ, etc.

For the purposes of radiation protection, radiation capable of producing ion pairs in biological material(s).

Ionising radiation can be divided into low-LET (linear energy transfer) radiation and high-LET radiation (as a guide to its relative biological effectiveness), or into strongly penetrating radiation and weakly penetrating radiation (as an indication of its ability to penetrate shielding or the human body).

ISTC

The International Science and Technology Center (ISTC) was set up in Moscow, Russia and is an intergovernmental organisation that works to prevent the proliferation of expertise related to weapons of mass destruction. To learn more, visit http://www.istc.ru.

Minimisation, waste

The process of reducing the amount and activity of radioactive waste to a level as low as reasonably achievable, at all stages from the design of a facility or activity to decommissioning. This is done by reducing waste generation and also by means such as reuse of certain fuel components and treatment of the waste, with due consideration for secondary as well as primary waste.

Model

A representation of a system and the ways in which phenomena occur within that system, used to simulate or assess the behaviour of the system for a defined purpose.

- Transport model

A mathematical representation of mechanisms controlling the movement of finely dispersed or dissolved substances in fluids.

Nuclear fuel cycle

All operations associated with the production of nuclear energy, including:

- mining and milling, processing and enrichment of uranium or thorium;

- manufacture of nuclear fuel;
- operation of nuclear reactors (including research reactors);
- reprocessing of nuclear fuel;
- any related research and development activities;
- all related waste management activities (including decommissioning).

Nuclear safety

The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards.

OECD/NEA

The Nuclear Energy Agency (NEA) is a specialised agency within the Organisation for Economic Co-operation and Development (OECD). To learn more, visit http://www.nea.fr.

Partitioning

Separation, usually by chemical methods, of minor actinides from the reprocessing stream, for the purpose of appropriate further processing, storage and/or disposal.

Performance assessment

An assessment of the performance of a system or sub-system and its implications for protection and safety at a planned or an authorised facility. This differs from safety assessment in that it can be applied to parts of a facility and does not necessarily require assessment of radiological impacts.

Radiation protection

The protection of people from the effects of exposure to ionising radiation and the means for achieving this. The International Commission on Radiological Protection (ICRP) and others use the term radiological protection, which is synonymous. The accepted understanding of the term radiation protection is restricted to protection of humans. Suggestions of extending the definition to include the protection of non-human species or the environment are controversial.

Radioactivity

The phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation. A nucleus (of an atom) that possesses properties of spontaneous disintegration (radioactivity). Nuclei are distinguished by their mass and atomic number.

Radioactive species

Either single radioactive atoms, molecules, molecular fragments or ions containing one or more radioactive atoms.

Redox

Various definitions exist for redox reactions (oxidation and reduction chemical reactions) in terms of the transfer of oxygen, hydrogen and electrons between the chemical elements involved in the reaction.

- Redox phenomena and conditions: Phenomena involving redox reactions and the physio-chemical conditions in which they take place. In the geochemical field in particular, redox reactions determine the mobility of many radioactive species.

Repository

A nuclear facility where waste is emplaced for disposal.

- Geological repository: A facility for radioactive waste disposal located underground (usually several hundred metres or more below the surface) in a stable geological formation to provide long-term isolation of radionuclides from the biosphere.
- Near-surface repository: A facility for radioactive waste disposal located at or within tens of metres of the Earth's surface.

Reprocessing

A process or operation, the purpose of which is to extract radioactive isotopes from spent fuel for further use.

Safety Case

An integrated collection of arguments and evidence to demonstrate the safety of a geological disposal facility.

Severe accident

Accident conditions more severe than a design-basis accident and involving significant core degradation.

Spent nuclear fuel

1) Nuclear fuel removed from a reactor following irradiation, which is no longer usable in its present form because of depletion of fissile material, build-up of poison or radiation damage.

2) Nuclear fuel that has been irradiated in and permanently removed from a reactor core.

STCU

The Science and Technology Center in Ukraine (STCU) is an intergovernmental organisation that works to prevent the proliferation of expertise related to weapons of mass destruction. To learn more, visit http://www.stcu.int.

Storage

The holding of spent fuel or of radioactive waste in a facility that provides for its containment, with the intention of retrieval.

Transmutation

The conversion of one element into another. Transmutation is under study as a means of converting longer-lived radionuclides into shorter-lived or stable radionuclides. The term actinide burning is used in some countries.

Underground research laboratory

Tests conducted within a geological environment that is essentially equivalent to the environment of a potential repository. A special underground laboratory, called an underground research laboratory (URL), may be built for *in situ* testing or tests may be carried out in an actual repository excavation. Only in such a facility can the full range of repository environment properties and waste repository system interactions be measured.

Very high temperature reactor (V/HTR)

A graphite-moderated nuclear reactor that uses a 'once-through' uranium fuel cycle. This generation-IV reactor concept is designed to produce an outlet temperature of 1 000°C (see Generations of nuclear reactors, above).

Vitrified waste

The vitreous product that results from incorporating waste into a glass matrix.

Waste, radioactive

For legal and regulatory purposes, waste that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body.

INDEX OF PROJECTS

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