IGD-TP
Exchange Forum n°4

October 29-30th, 2013
Prague, Czech Republic

Book of Abstracts

(Preliminary version)

www.igdtp.eu

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

After the publication in 2012 of the Deployment Plan, the Implementing Geological Disposal of Radioactive Waste – Technology Platform (IGD-TP) has entered into a new phase of implementation of new working groups and technical projects directly linked with Strategic Research Agenda (SRA) priorities. In addition, IGD-TP has set up organisational working groups on cross-cutting activities. All of them are centred on the “joint activities” described in the Deployment Plan (DP).

The outcomes of two technical working groups have already led to EC projects: DOPAS (Full Scale Demonstration of Plugs and Seals) dealing with the strategic issue of the plugging and sealing of drifts and cells, and CAST (CArbon-14 Source Term) dealing with the study of the various source terms of C14, their release modes and speciation forms.
Furthermore, IGD-TP Executive Group supervises the activities of working groups on previously launched EC projects and to prepare future calls, projects, or organisational activities.

In addition, the IGD-TP Secretariat, supported by an EC project (SecIGD2: Secretariat IGD-TP 2) has set up working groups to reinforce IGD-TP organisation and deploy its activities towards less advanced programme needs and to support the work of the Competence Maintenance, Education and Training group.

The first Exchange Forums (EFs) were mainly dedicated to explain Waste Management Organisations (WMOs) priorities and information on on-going projects or projects under development.
For this 4th Exchange Forum we would like to focus on new ideas that could complement our SRA priorities through a bottom-up approach and we would like to involve in a more efficient way new actors of the RD&D.

Thus, the aims of this 4th Exchange Forum are:

1. Bring forward new projects in a bottom-up approach in the framework of the deployment of activities described in the SRA/DP
2. Identify new subject of collaboration related with SNETP (Sustainable Nuclear Energy Technology Platform) future needs
3. Identify subject of common interest with Technical Support Organisations (TSOs) through SITEX (Sustainable network of Independent Technical EXpertise for radioactive waste Disposal)
4. Inform on working groups activities and EC projects
5. Develop new R&D programmes on stakeholder involvement

This Exchange Forum may help in preparing for future projects, calls etc and also in initiating or further deepening contacts between research organizations, waste producers and Waste Management Organizations.

To fulfil these objectives, the Exchange Forum will last two days and will give time for five technical working groups to discuss priorities and new areas of interest.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG1 - Cement

The aim of this Working Group is to determine the potential scope for future joint studies and/or experiments on cement materials interactions with other repository components, based on input from WMOs in relation to their needs. The emphasis is on long-term performance rather than engineering aspects.

Presentations and speakers:

1- Introduction and discussion of commonalities & differences among WMO concepts (L. Johnson)
2- Results and future plan of RWMC's R&D regarding cement-bentonite interaction (H. Owada)
3- How do we treat cement in performance assessment? (F. Neall)
4- Thermodynamics and modelling (L. Duro)
5- RN retention and redox conditions (M. Altmaier)
6- Cementitious materials: state of the art (X. Bourbon)
7- Status of the proposed CEBAMA project (B. Kienzler)
8- Immobilisation of radionuclides by a cementitious backfill (D. Read)

Rapporteurs: Lawrence Johnson, Nagra & Bernhard Kienzler, KIT

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG1 - Cement

Results and future plan of RWMC's R&D regarding cement-bentonite interaction

Hitoshi Owada, RWMC, Japan

RWMC has been researching in the field of cement alteration and its influence onto bentonite buffer.
In the field of cement alteration, (1) alteration model for fly ash mixed cement and blast furnace slag mixed cement had developed and (2) change of diffusion coefficient due to the deterioration of cementitious materials have been developing. As the research regarding cement-bentonite interaction, in-situ measurement of bentonite dissolution rate under alkaline and pressurized condition had beed done. Hydrogical-Mechanical-Chemical coupling simulation has been tried. Long term immersion test of cement-bentonite coupled samples have been carrying out for 9 years.

In this presentation, outline of RWMC's R&D in this field and some results of those experiments will be presented. And the future plan regarding cement-bentonite interaction will be explained.

How do we treat cement in performance assessment?

Fiona Neall, Galson Sciences Ltd, UK

The use of cement-based materials in the EBS tends to be viewed in a black and white manner as regards assessment of repository post-closure performance: favourable if you want high pH conditioning in the near field but unfavourable if that high pH extends its influence where you don't want it, particularly where bentonite is used or in the geosphere. In both cases, the problem is that using cement introduces uncertainty - 'how long will the high pH last?' in one case, and 'what properties or parameters will be altered?' in the other. This paper will try to identify how we might go about tackling these sorts of uncertainty in a robust and defensible way, using existing knowledge and without merely resorting to unacceptably conservative approaches.

Radionuclide Retention and Redox Conditions

M. Altmaier, KIT-INE, Germany

Cementitious materials play an important role for several aspects related to the safe disposal of radioactive waste. Specific interactions of radionuclides with cementitious materials and the corresponding aqueous solutions generated can lead to either retention or mobilization of long-lived radionuclides. As the projected risk related to radionuclide mobilization from a repository is dominated by (frequently anionic) fission products in many scenarios, alpha emitting actinides are investigated because of their extremely high radiotoxicity and the need to ensure their quantitative retention.

Chemical mechanism controlling radionuclide (geo)chemistry and retention in cementitious environments include solubility and dissolution phenomena, sorption and incorporation processes and redox reactions involving radionuclides. Several important radionuclides can exist in more than one oxidation state, each exhibiting distinct chemical properties and often strongly differing features. Detailed understanding of radionuclide redox chemistry is therefore essential. Considering radionuclide chemistry in cementitious systems, the presence of strongly alkaline solutions and complexation with organic ligands, potentially affecting both solubility and radionuclide speciation, are of particular importance. Sorption processes on cement phases likewise need to be addressed with high priority as they constitute main retention mechanisms for both anionic fission products and actinides. Investigations should include reliable quantitative thermodynamic model descriptions, allowing for a comprehensive systematization of radionuclide behavior and the use of geochemical modeling tools to assess other related scenarios.

The aim of this contribution is to summarize main topics of interest regarding radionuclide retention processes in cementitious environment in order to develop a respective workpackage focusing on radionuclide retention processes in CEBAMA.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Scientific and technical knowledge requirements on cementitious materials/ components for next steps of HLW and ILLW repository (Cigéo) development in France

Xavier Bourbon, Andra, France

As well in other countries, cementitious materials have been selected to constitute components of HLW and IL-LLW disposal in Callovo-Oxfordian clay layer in France (i.e. underground facilities structures, IL-LLW disposal packages, walls for swelling clay based seals…). The primary functions of these cementitious components are mechanical (in operating and/or post closure period). Moreover, some of these components could participate to limit radionuclide migration in post closure period, due to the chemical properties of hydrated cements. Physico-chemical boundary conditions -clay host rock (pore water chemistry, in situ stress...) and solicitations from waste packages (thermal loading, degradation products in solution…)- that impose physical and chemical environment which can promote concrete degradation, are taken into account. In that context, specific formulations have been chosen to fulfill the requirements for each component in repository conditions. Thus CEM I and CEM V cement are considered, except for walls of seals for which Low Hydration Heat-Low pH Cement (LHH-Low pH Cement) are chosen to favor the mechanical and chemical durability of the seals.

In that context, since many years, studies were conducted to assess long term physical and chemical evolution of cementitious materials (including radionuclide behaviour) in repository conditions, mainly for CEM I and CEM V cements, and more recently for LHH-Low pH Cement. Chemical and physical behaviour have been assessed from the material scale up to the component one. Huge amount of data have been used by Andra for “Dossier 2005” that establish feasibility of a radioactive waste disposal. According to French 2006 act on sustainable management of radioactive materials and waste, Andra has to give a report for licensing authorization in 2015 prior to industrial opening around 2025.

Licensing and industrial applications are leading to precise and to validate specific questioning on cementitious components, in particular for optimization (for example possibility to design co-disposal of some IL-LLW) and operating safety. Nethertheless, post closure safety is also under consideration, taking into account industrial reality of disposal, for example to consolidate demonstration and quantify marges. According to scientific and technical current knowledge, Andra has defined priorities then R&D objectives to achieve answers for next step of repository industrial development:

- Influence of chemical evolution on hydro-mechanical properties of blended cements in massive components and interfaces with clays (microstructure evolution, cracks, swelling, …);
- Impact of organic complexing agents on physical and chemical behaviour of concrete;
- Radionuclide chemical behaviour vs complexing agents in alkaline media.

Status of the Proposed Cebama Project

B. Kienzler and M. Altmaier, KIT-INE, Germany

The Cebama Proposal was presented during the 3rd IGD-TP Exchange Forum aiming on a TSWG on Cement based materials, properties, evolution, barrier function (Cebama) within IGD-TP. Up to now, discussions took place on different levels. In May 2013 in connection with the Cement Workshop in Ghent, the ideas of Cebama and the views of the WMOs were presented to a broader interested community. The outcome of these discussions and the potential outline of a Euratom project will be reported.

Immobilisation of Radionuclides by a Cementitious Backfill

David Read, Loughborough University, UK

The present concept for the disposal of ILW and LLW in the UK, as in other countries, is based on a multi-barrier geological disposal facility. After closure, the vault will be backfilled with a specially formulated cement; one example of which is NRVB (Nirex Reference Vault Backfill), developed by United Kingdom Nirex Limited. The backfill cement is designed to play an important role within the multi-barrier system. It is intended to serve both as a physical barrier to radionuclide migration and contribute to the chemical containment of the radioactive waste by buffering the pH of the pore water to high alkalinity while providing a surface for the retention of radionuclides. Consequently, it is crucial to understand the interaction mechanisms of key radionuclides with the cementititous backfill and to build confidence in the models used to predict the retardation of key radionuclides over extended timescales. This paper summarises progress in demonstrating the feasibility of chemical containment in a series of long-term diffusion and shorter-term advection experiments. Results highlight the efficacy of the approach and also its limitations, particularly where radionuclides are co-disposed together with organic ligands

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

derived from cellulose degradation or engineered additives (e.g. superplasticisers).

WG2 – Monitoring

After the MoDeRn (Monitoring Developments for Safe Repository Operation and Staged Closure) project, further developments of a monitoring collaborative project could be achieved by sharing partner developments of in situ technologies to match specific repository requirements (durability, metrology, hardening, etc.). R&D on technologies needs a qualification process that entails testing and qualifying the complete measurement chain based on several stages. These stages will take into account environmental conditions such as radiation rates etc. Discussions and presentations will be around 4 themes based on the following work areas:

1. Strategy aspects
2. Technology development
3. Practical implementation
4. Communication & stakeholder involvement

Presentations and speakers:

1- Implementing monitoring into Geological Disposal: The Belgian case
(Jan Verstricht SCK-CEN)

2- Monitoring in Waste Disposal - Dutch perspective and possible contributions to 'MoDeRn 2'
(Thomas Schroeder, NRG)

3- Return experience with the use of innovative monitoring techniques to measure deformation, cracking and corrosion in the Belgian Supercontainer
(Lou Areias, EURIDICE)

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

4- State-of-the-art and typology for the wireless transmission system in real use. The estimation and judgement for the triggered value in EBS against the reference design value
(Kei Suzuki, RWMC)
5- Short range data transmission for repository monitoring:Technology status and required R&D
(José-Luis Garcia-Siñeriz, AITEMIN)
6- Determination of trigger values for monitoring results related to disposal and closure concepts
(Michael Jobmann, DBE Tech)
7- MoDeRn Project. Lessons learned and further work requirement
(Matt White, GALSON SCIENCES)
8- Results of the call for ideas exercise on repository monitoring
(José-Luis Fuentes-Cantillana, AITEMIN)

Rapporteurs: José Luis Fuentes-Cantilana, Aitemin and Stéphane Buschaert, Andra

This event is co-funded by the European Union under the 7th Euratom Framework Programme,
Grant agreement number 323260 - SecIGD2 project

WG2 – Monitoring

Implementing monitoring into geological disposal: the Belgian case

Jan Verstricht, EIG EURIDICE, Belgium

The development of a monitoring plan for geological disposal requires both a solid approach based on the safety and feasibility case, as well as a proficiency in the application of the relevant monitoring techniques. The first aspect is currently being developed by NIRAS/ONDRAF and the current status will briefly be presented.

Regarding the technological aspect, the long-term (> 25 y) monitoring experience with the underground HADES lab is invaluable, which will be illustrated with some relevant examples.

Monitoring in Waste Disposal - Dutch perspective and possible contributions to 'MoDeRn 2'

Thomas Schröder, NRG, Netherlands

The presentation elucidates the Dutch perspective on monitoring, its relation to the retrievability requirement, and the possible views and expectations of stakeholders. In addition, the contribution of NRG in the MoDeRn project is summarized, with the focus on the wireless, long-distance transmission of data from the HADES URL to the earth's surface. Finally, potential contributions, or themes, to a possible 'MoDeRn-2' proposal are inventoried.

Return experience with the use of innovative monitoring techniques to measure deformation, cracking and corrosion in the Belgian Supercontainer

Lou Areias, EURIDICE, Belgium

A test is being performed to obtain insight into the feasibility to construct the Belgian Supercontainer (SC). This test incorporates a number of state-of-the-art and new monitoring techniques, including the use of Digital Image Correlation (DIC) and Acoustic Emission (AE) to monitor concrete cracking, four types of corrosion sensors to measure active corrosion of the carbon steel overpack and different fibre optic sensors to monitor deformation in the three orthogonal directions. This presentation gives an overview of the monitoring techniques used, their main results and outlines areas of future research needed to transfer these technologies to an underground geological repository setting.

State of art and typology for the wireless transmission system in real use

Kei Suzuki, RWMC, Japan

In application of wireless transmission system to buffer blocks in depsotion hole, the required specification for the system and the sensor is not cleary specified considering the geometric restriction, lifetime of the battery, corrosive ground water and geological mechanics and hydraulics. Then the specification for the effective use of wireless transmission system and typology for it should be discussed.

The estimation and judgment for the triggered value in EBS against the reference design value

Kei Suzuki, RWMC, Japan

Among the significant process in EBS to the long term safety, the following process are hardly to understand by the measured value, such as:

- Water uptake of bentonite buffer,
- Homogenisation and self-sealing of buffer,
- Piping and chemical erosion,
- Mass redistribution of bentonite

How to judge whether the above process is in the safety condition? Or should we need to estimate the result with comparing the lobolatry test result?

Short range data transmission for repository monitoring: technology status and required R&D

José Luis García-Siñeriz, AITEMIN, Spain

A new wireless system based on high frequency radio transmission (short range type) and capable of monitoring the physical parameters inside a repository cell independently of the host rock type was designed, developed and tested under realistic conditions thanks to FP7 Euratom´s MoDeRn project. This system represents a step forward for the design of a complete measurement chain for repositories.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG2 – Monitoring

The proposed presentation will inform about further improvements that will be required (R&D activities) to provide a reliable wireless system capable of transmitting the evolution of the physical parameters inside a repository.

Determination of Trigger Values for monitoring results related to disposal and closure concepts

Michael Jobmann, DBE TECHNOLOGY GmbH, Germany

An outcome of the MoDeRn project was that Trigger Values play an important role in the Reference Framework. In parallel to the development of a monitoring programme and prior to the selection of monitoring systems an analysis of potential future monitoring results should be performed. This analysis could be based on the development of a reference scenario (normal repository evolution) and on one or several alternative scenarios (deviating repository evolution). The aim is to identify how "bad" monitoring results must be to indicate a risk for the safety of a repository. This would allow (i) getting a feeling of how monitoring results should be evaluated with respect to deviation from predicted results, (ii) the development of trigger values, the identification of necessary technological systems able to identify and characterize all different evolutions, and to propose actions to respond to those results exceeding trigger values.

MoDeRn Project: lessons Learned and Further Work Requirements

Matt White, Galson Sciences Ltd, UK

MoDeRn developed and documented the collective understanding of repository monitoring approaches, technologies and stakeholder views to provide a reference point to support the development of specific national repository monitoring programmes. MoDeRn advanced the ability to monitor repositories, for example by elaborating the process for developing a monitoring programme and linking this development to the safety case, by developing specific monitoring technologies, by undertaking case studies associated with specific programmes, and by improving the understanding

.

of stakeholder involvement in monitoring. The MoDeRn Synthesis will be published in October 2013, and this presentation will provide a summary of the key lessons presented in the synthesis document and propose ideas for on-going collaborative research to support the implementation of repository monitoring programmes.

Results on the "Call for Ideas" exercise on repository monitoring

José-Luis Fuentes-Cantillana, AITEMIN, Spain

A "Call for Ideas" was launched in June 2013 from the IGD-TP in order to identify the areas related to repository monitoring in which further research and development is required in the short term. This exercise was coincident in time with the termination of the MoDeRn project, in which a general framework that addresses all relevant aspects of repository monitoring, including the objectives, strategy, available technologies, practical implementation, and the relationship with stakeholders, has been developed.

A document that collects and integrates the different inputs received in this exercise has been prepared, that identifies topics in which the participants consider that further research and demonstration activities are required, in the different areas mentioned above. This is considered to be a basis for the definition of the scope of a potential future collaborative project on repository monitoring, which should be proposed by the IGD-TP to the European Commission.

The presentation will comment the process of the Call for Ideas and will describe the results obtained.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG3 - New Waste Type
in collaboration with SNETP

Expected changes in waste forms may have implications for geological disposal and needed R&D. The changes expected in waste forms that will need to be disposed of in geological repositories are of primary concern for WMOs. Indeed, the confirmation that this waste will be compatible with the current engineered barrier systems and host rocks may require intensive and decade long R&D. In line with its vision, the issue for IGD-TP concerns primarily changes expected in the coming two decades (e.g. higher burnups, change of cladding materials, use of fuel form other than UO2, increased separation and recycling, change in the reprocessing end-product, GenIII reactors…). This includes also the primary and secondary waste that will be generated from the R&D facilities dealing with GenIV and other facilities…

Presentations and speakers:

1- Importance of the waste form from a safety assessment perspective: The SR-Site experience (L. Zetterström Evins)
2- Results of R&D on future fuel cycle and associated HL waste disposal: the French case (D. Warin)
3- CarboSOLUTIONS: Implementing irradiated-graphite management (G. Laurent W. von Lensa)
4- EDF pilot plant and a project for the graphite treatment (G. Laurent)
5- Advanced wasteforms for future nuclear fuel cycles (N. Hyatt)
6- RED IMPACT (W. von Lensa)
7- Management of current and future radwaste for deep geological repository : French approach and articulation with R&D (F. Plas)
8- Long term behavior of waste forms from Gen IV Reactors towards Geological Disposal (G. De Angelis, A. Dodaro , M. Sepielli)

Rapporteurs: Dominique Warin SNETP/CEA
Lena Zetterström Evins IGD-TP/SKB

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG3 - New Waste Type in collaboration with SNETP

Importance of the waste form from a safety assessment perspective: The SR-Site experience

Lena Zetterström Evins, SKB, Sweden

The waste form analysed in the SR-Site safety assessment is spent nuclear fuel. In Sweden, the fuel is UO2 used in BWR and PWR reactors, and in the analysis also some MOX fuel is considered. The fuel is to be directly disposed in the canisters which will be emplaced in the repository at ca 500 depth. Each canister will be surrounded by bentonite and crystalline bedrock. For the safety assessment, the vast amount of existing information concerning the repository system needs to be taken into account. Many calculations and models require input data from site investigations as well as from analyses of material properties. The analysis still concerns an idealized concept; further information and data will be required in the stepwise progress towards a repository in operation. The studies concerning the waste form, here the fuel, play a central role by providing data for Instant Release Fraction, Corrosion Release Fraction, Dissolution rate, and Solubilities. At the time when water gets in contact with the waste, radionuclides will be available for release. How and when the radionuclides are released determined by their distribution in the different parts of the fuel. For example, for the fuel, it is important and necessary to provide information regarding how large fraction of certain key radionuclides will be available almost immediately after water contact (IRF). Examples of these radionuclides are I-129 and Cs-137. The time it takes for the full inventory to be released is essential to the assessment, and this includes applying the long-term dissolution rate. In SR-Site, it is pessimistically assumed that the dissolution rate is not changing with time. In the long-term dissolution, radionuclides that are found within the fuel matrix are released at the rate of fuel dissolution. The SR-Site approach is to first evaluate the possibilities for barrier failure, and then calculate the consequences, in terms of dose and risk, for the barrier failure scenarios. In the case of SR-Site, the primary safety function is containment, and if containment if fulfilled, there is no need for consequence analysis. However, in the scenarios where barriers are breached, the consequence is radionuclide release and transport. In the SR-Site analysis the canister failure occurs in scenarios with relatively low retention in the bentonite and the bedrock. This leads to the observation that the fuel dissolution rate has a large impact on the result of the safety assessment. The experience gained from the SR-Site assessment is therefore that, in spite of low probability of failed containment (0.12 canisters in 1 Ma) the dissolution rate of the waste form has a large impact on the final result. This can be used in further reflections on the importance of the stability, in a repository environment, of any other and future waste forms. As a last comment, there is a difference between providing input data for the calculations, and the larger view of what is required for a safety assessment. The data are carefully chosen by using sound scientific method, which has been built up by decades of research. The methodology requires process understanding, as well as a systematic documentation of this process understanding, which emphasizes that any safety assessment concerning geological disposal of nuclear waste requires a research programme devoted to the stability of the waste form.

Results of R&D on future fuel cycle and associated HL waste disposal: the French case

Dominique Warin, CEA, France

Reactors and fuel cycle offering the best safety features while staying economically competitive have to be promoted in the next decades in order to recycle valuable materials, such as plutonium, and to better manage highly radioactive nuclear waste. Long term sustainable nuclear systems would be fast reactors which allow full use of uranium with no enrichment needs, efficient burning of plutonium and potentialities for improving waste management by minor actinide transmutation.

Within the framework of the 2006 waste management French Act, CEA did produce R&D results on applicable solutions for still minimizing the quantity and the hazardousness of final nuclear waste using industrial perspectives of partitioning and transmutation of actinides. These studies have been carried out in tight connection with GENIV fast systems development, and with the support of recent European projects devoted to innovative partitioning process development.

In this perspective, CEA and waste management Agency (Andra) did assess the impact of high and intermediate level waste as produced by various transmutation options, on the sizing of a geological repository. Andra used repository architectures similar to those employed in the Cigéo project which is under development for current NPPs. Results allow to compare the underground footprint and the excavated volume for each option; the impact of the interim storage duration is also assessed. Solutions are proposed to optimize the footprint of the repository. An analysis of the

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

advantages and drawbacks of transmutation options is proposed, taking into account the evolution of waste types in the repository, still as a long term (several decades from now) possibility.

CarboSOLUTIONS: Implementing irradiated-graphite management

Gérard Laurent, Electricité de France and Werner von Lensa, Forschungszentrum Juelich GmbH

Carbon-based materials have been / are used in nuclear reactors as neutron moderators and reflectors, due to their low neutron capture cross sections. More than 250,000 t of irradiated-graphite have been accumulated world-wide awaiting safe and economic solutions for the management of this specific radioactive waste, which contains varying amounts of radiocarbon, tritium, chlorine-36 etc. The European CARBOWASTE project addressed the `Treatment and Disposal of Irradiated-Graphite and Other Carbonaceous Wastes' as an integrated approach to decommissioning and i-graphite waste management on a broad R&D basis within a consortium of 30 partners representing waste management organizations, utilities, nuclear industries, graphite manufacturers, research centers and universities from 10 European countries plus RSA. Main results are:

- I-graphite waste features significantly depend on the specific manufacture process, ingredients (filler & binder) and residual impurities
- The nuclear reactor operational conditions (neutron dose, atmosphere, temperature etc.) strongly determine the i-graphite waste characteristics
- Radiolytical oxidation of graphite core internals leads to partial releases of activation products during reactor operation
- Neutron activation processes generate significant recoil energies breaking pre-existing chemical bonds resulting in dislocations of the activation products and new chemical speciation
- Most activation products exist in different chemical forms and at different locations
- I-graphite can be partly purified by thermal and chemical treatment processes

Leach tests and preliminary performance analyses show that i-graphite can be safely disposed in a wide range of disposal systems, after appropriate treatment / conditioning.

A `Toolbox' that is underpinned by Multi-Criteria-Decision Analysis (MCDA) methodology allows the assessment of different choices for retrieval, treatment, storage, conditioning and disposal of i-graphite with regards to ecologic, economic and social issues is ready for specific applications.

I-graphite management has become an urgent issue in many countries and a subject of national and industrial programmes. The next step from laboratory scale tests to semi-industrial pilot scale demonstration of innovative treatment and conditioning processes has been announced by industry. Due to the strong interaction of the different steps the whole process must be investigated from the removal of i-graphite from the core via treatment till secondary waste conditioning. This still needs to be supported by R&D to optimize the related processes with regards to decontamination factors, operational safety, environmental issues, adaptation to the specific features of the different i-graphite grades, economics etc.

A provisional survey of the R&D needs in those countries being confronted with i-graphite waste management has shown such a spectrum of common targets and communalities that a broader trans-national collaboration will be of mutual benefit, for all. Some countries operated similar reactor types like UNGG, Magnox, RBMK, MTR, whilst others are facing similar waste forms (e.g. sleeves) and others need to find co-disposal solutions, when likely i-graphite volumes cannot justify specific i-graphite repositories.

Under this background, the CarboSOLUTIONS project has been proposed to confederate the national and industrial activities on i-graphite management around a `Programme-related R&D approach' targeting to near-term national and industrial solutions at the pilot scale. It is addressing the open R&D issues, providing scientific support for the adaptation of the treatment processes to industrial needs, treating different i-graphite grades in the pilot scale, designing a full process line including secondary waste management, testing alternate treatment options, leaching of pre-treated i-graphite as proof-of-concept test, optimizing waste package concepts, improving alternate waste matrices manufacture in relevant scale (e.g. Impermeable Graphite Matrix), establishing reuse options, alternate disposal routes etc.

The CarboSOLUTIONS project is relevant for the management of existing legacy waste and for closing the 'I-Graphite Cycle' of Generation IV reactors such as Very/High Temperatures Reactors (V/HTR) and Molten-Salt Reactors.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG3 - New Waste Type in collaboration with SNETP

Advanced waste forms for future nuclear fuel cycles

Neil Hyatt, University of Sheffield, UK

Sustainability of fissile resource will require both fuel recycle, using advanced separations methods, and enhanced fuel burn up, to support future expansion of civil nuclear energy. The current international strategy for management of the high level waste stream from reprocessing, comprising fission products and minor actinides, is vitrification in as HLW glass. A substantial expansion of the civil nuclear energy programme is therefore expected to require a concomitant expansion of the repository footprint to accommodate the resulting HLW products (which must be well separated due to radiogenic decay heat). It is not clear that such an expansion is sustainable or feasible in resource, social, or political terms. This presentation propose and examine the feasibility of conceptual glass and ceramic wasteform options, integrated with advanced separations flow sheets, with the aim of reducing the radiogenic heat burden on the repository. The fundamental strategy is managed decay storage of short lived heat generating radionuclides, conditioned in a single wasteform or suite of wasteform materials, with subsequent final disposal of waste packages in more efficient disposal configuration (due to the reduced thermal budget). Conceptual wasteform options will be evaluated against the outputs of advanced separations flowsheets and the scientific and technological barriers to realisation identified.

Long term behavior of Waste Forms from Gen IV Reactors towards Geological Disposal

G. De Angelis, A. Dodaro , M. Sepielli , ENEA, Italy

SNETP Gen IV fast reactors prototypes (sodium, lead, gas - cooled) produce downstream reprocessing a spent fuel “new” waste type which will require in the long-term proper geological disposal repositories for fission products and minor actinides storage.
Geological disposal requirements can be relaxed by adopting particular processes for spent fuel treatment, in terms of stability, durability, environmental impact, loading and volume reduction of the final waste inventory.
This proposal concerns a very promising research activity concerned with the treatment and conditioning of chloride wastes coming from spent fuel treatment by pyro-processes, including the characterization of the final waste forms.
Pyrochemistry is a term referred to process reactions at high temperatures. At present it appears as a promising alternative for the separation of uranium from fission products, which is ordinarily carried out in eutectic molten chloride salts, such as LiCl-KCl.This method is expected to be very suitable for advanced nuclear engineering due to its many advantages compared with the hydrometallurgy process currently used for the extraction of lanthanides. They include: radiation stability of molten salts (allowing processing of spent fuels of high radioactivity); absence of neutron moderator such as water; low waste production; non-proliferation requirements. Furthermore, it represents an excellent alternative for treatment of UO2 and MOX fuel, and the only possibility for fuels like nitride and carbide fuel, to which hydrometallurgy cannot be applied.
Since many years ENEA is involved in research programmes concerning separation of actinides from other fission products and treatment of related wastes. The latter are chloride salts, for which different materials have been proposed as conditioning matrices. They include sodalite, a mineral phase which contains chlorine, SAP, a formulation recently proposed by Korean Atomic Energy Research Institute (KAERI), and murataite, an isometric-hextetrahedral black mineral containing several metal cations.
Sodalite, a naturally occurring mineral containing chlorine, has been investigated as an immobilization matrix for chloride waste. To this end, various synthesis methods have been tried: on one hand, direct synthesis from kaolinite, metakaolinite, nepheline, or from silica and sodium aluminate have been carried out; on the other hand, a synthesis from Zeolite 4A used for preliminary decontamination of the salt by ion-exchange has been performed. The former allows the conditioning of the waste salt as a whole whenever discarding an entire process salt batch becomes necessary. This is the case when an electrorefiner plant has to be decommissioned, or in the event of a severe process upset. The latter is more suitable for routine operations, which require clean-up of the salt and its recycle to the electrorefiner, thus avoiding the production of large quantities of solidified wastes to be disposed of. The present proposal refers to the synthesis from kaolinite, through nepheline, for the treatment of the spent salt as a whole.
The matrix termed SAP (SiO2-Al2O3-P2O5), synthesized by a conventional sol-gel process, is able to stabilize the volatile salt wastes owing to the formation of metalaluminosilicates, metalaluminophosphates and metalphosphates.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG3 - New Waste Type in collaboration with SNETP

The addition of a borosilicate glass as a chemical binder and a treatment at around 1100°C gives the final waste form. With this method a higher disposal efficiency and a lower waste volume can be obtained.The eutectic LiCl-KCl, containing chlorides of alkaline, alkaline-earth, and lanthanide metals will be used to simulate the waste salt. The SAP matrix offers different domains suitable to "catch" the chloride metals present in the wastes coming from pyroprocesses.
Murataite, on its own, is an isometric-hextetrahedral black mineral containing calcium, fluorine, hydrogen, iron, la, ce, pr, nd, sm, manganese, niobium, oxygen, silicon, sodium, titanium, yttrium, and zinc. It was identified in a titanate ceramic with HLW simulants produced at the Savannah River nuclear plant in USA in 1974. It was also identified (1997-1998) in the Synroc matrix with simulants of HLRW wastes from PO Mayak, a radiochemical facility for production and reprocessing of nuclear fuel in Russian Federation. Five volume percent of this phase accumulated about 40% of the total uranium present in the sample, which led to detailed investigations of chemistry and properties of murataite, in particular, of its chemical durability and radiation resistance. However, structural mechanisms of incorporation of actinides into murataite remained unknown up to date.
Several tests and analyses are envisaged in order to characterize the final products: density measurements; thermogravimetric analysis; SEM-EDS; optical microscopy; FTIR; XRD. Leach tests under static conditions will be carried out in demineralized water at both 23° and 90°C, up to 150 days. For the tests, in addition, the most suitable radiological characterization techniques will be investigated in order to verify their applicability to New Waste Types arising from Gen IV reactors fuel cycles.

The main scope of this proposal is a comparison among these promising matrices for conditioning of chloride salt wastes, with a particular attention to the incorporation mechanisms and to their durability in the long-term to comply with geological disposal requirements.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG4 - RD&D TSO's needs: the view of SITEX

The aim of this Working Group (WG) is to present the TSO's RD&D needs and discuss some of these priorities which may meet WMOs needs as expressed in the SRA and DP. This WG offers a forum that could foster, where possible, and considering the deontological issues linked with the respective role and missions of assessors and implementers, the identification of possible joint activities linked with the joint programming strategy to be developed in the EC frame work of H2020.

Presentations and speakers:

1- SITEX view on development of TSO´s RD&D programme for providing independent expertise (Václava Havlová)
2- Overview of the IGD-TP Strategic Research Agenda (SRA) (Jon Martin, NDA)
3- Development of an R&D programme by Bel V in the field of safety of radioactive waste disposal (Valéry Detilleux)
4- The experimental research programme at Tournemire – examples of safety challenges from IRSN point of view (Jean Dominique Barnichon)
5- Impact of permafrost on repository safety (Ton Wildenborg)

Rapporteurs: Václava Havlová SITEX/UJV
Jon Martin, NDA

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG4 - RD&D TSO's needs: the view of SITEX

SITEX view on development of TSO´s RD&D programme for providing independent expertise

Václava Havlová, UJV Rez, a.s., Czech Republic

The objective of Sustainable network of Independent Technical Expertise for radioactive waste disposal (SITEX) FP7 program is to build up a network capable of harmonizing European approaches to technical expertise in geological repositories for radioactive waste. SITEX brings together 15 organisations representing technical safety organisations (TSOs), research organisations and safety authorities, as well as civil society outreach specialists. SITEX aim is to help establishing the conditions that are required for developing a sustainable network of technical safety experts providing their skills, analytical tools and expertise for independent analyses to built the namely confidence in safety cases, developed by waste management organisations.
Presentation will summarise the upcoming results of SITEX project, describing the vision of RD&D actions which should be undertaken by potential TSO network in order to support independent technical and scientific review of safety cases and key technical issues arising during implementation of deep geological repository.

Overview of the IGD-TP Strategic Research Agenda (SRA)

Jon Martin, NDA, UK

The IGD-TP's work is driven by European waste management organisations that share a common vision that "by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste will be operating safely in Europe" (Vision 2025).

This presentation gives an overview of the IGD-TP's Strategic Research Agenda (SRA), which is dedicated to identifying the main RD&D issues that need a coordinated effort over the next years in order to reach the Vision 2025. Key Topics and their priorities have been identified through discussions among many European waste management organisations. Of particular interest are the issues for which enhanced co-operation within the IGD-TP are considered desirable and practically achievable. In developing the SRA, attention has been focused on increasing cooperation in areas of repository safety and technological development through combined use of resources, which represent the major objectives of the EC framework programme.

The SRA will also be the instrument for creating synergies, co-operation and co-ordination, both internally between the IGD-TP participants and with external activities that take place in other technological platforms such as the SNE-TP, SITEX etc and within other international forums.

The SRA is complemented by the Deployment Plan introducing various adapted cooperation tools to implement its actions. They will rely in particular on the Euratom Framework Programmes, which will echo the SRA's priorities.

Development of an R&D programme by Bel V in the field of safety of radioactive waste disposal

Valéry Detilleux, Bel V, Belgium

Bel V, constituting with FANC the Belgian Regulatory Body, has an important effort in R&D devoted to radioactive waste management. The R&D activities of Bel V are primarily related to the development and the maintenance of expertise in nuclear safety and to a lesser extent in radiation protection. The overall R&D effort foreseen by Bel V has been recently significantly increased to about 10% of the total available time for the technical staff. Within the framework of radioactive waste disposal safety, Bel V previously participated in international projects like 6th FP EC MICADO and 6th FP PAMINA, participates in international working groups (like IAEA PRISM and more recently IAEA GEOSAF II), and develops scientific collaborations with universities and other TSOs (e.g. IRSN).

This presentation will give an overview of the methodology followed by Bel V to develop its R&D programme in the field of disposal of radioactive waste and will give examples of R&D projects and collaborations in which Bel V participates.

This event is co-funded by the European Union under the 7th Euratom Framework Programme,
Grant agreement number 323260 - SecIGD2 project

WG4 - RD&D TSO's needs: the view of SITEX

The experimental research program at Tournemire – Link with safety challenges

Jean-Dominique Barnichon, IRSN, France

The presentation will give an overview of past, present and foreseen studies carried out by IRSN at the Tournemire Underground Research Laboratory. Each presented item will be put in context of its related safety challenges from the TSO point of view.

Impact of Permafrost on Repository Safety

Ton Wildenborg, TNO, Netherlands

The idea focuses on studying the effects of permafrost on the long term safety for radioactive waste disposal, and its significance for the safety case. The scope of the initiative includes the effects of deep permafrost, salination, melt-water intrusion and cyclic freeze-thaw effects. Relevant boundary conditions, like glacial meltwater influx, and erosion depth will be accounted for.

It is the view of the initiators of this idea that the treatment of permafrost within the safety case is a significant remaining issue, which was confirmed in discussions of the Euradwaste '08 Conference. In particular, by realizing this initiative it is thought that demonstrable improvements to the robustness of the repository safety case and related safety analyses will be achieved, through the application of newly-acquired scientific knowledge into how the performance of natural and man-made barriers of a repository respond to permafrost conditions.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG5 - Microbiological Studies

Microbial processes have been investigated by most, if not all, WMOs for up to two decades or more. Although the disposal concepts and the geological formations vary significantly from country to country, baseline microbial processes are the same. Nevertheless, the wealth of knowledge on microbial processes in radioactive waste disposal mostly remains with individual WMOs. The aim of this WG is to bring together the competence and knowledge on microbiological processes and form a long-lasting international community within which new results, projects and proposals can be shared and discussed. The WG will identify general cross-WMO interests, gaps in knowledge and discuss opportunities for a cooperative program and its financial and practical implementation. Subjects suggested for technical session and areas proposed for discussion and ground for a new proposal are:

- What energy sources and fluxes of energy will be available for microorganisms at repository conditions?
- To what extent, if any, can microbial dissolution of immobilized radionuclides and production of complexing agents increase radionuclide migration rates?
- Can microbial activity contribute to keeping the repository anoxic and at a low redox potential?
- To what extent can microbial production and consumption of gases from organic and inorganic sources influence the performance of repositories?
- Under what conditions can sulphide producing microorganisms increase corrosion rates of metal canisters for wastes?
- Microbial degradation of concrete is a well-known problem for many present day engineered constructions – can similar microbial processes occur in repositories?
- How do we model microbial processes in repositories over a very long time period. Present day models and requirements for the future.

Presentations and speakers:

1- Restriction of microbial growth and activity in a geological repository for radioactive waste (K Wouters, SCK-CEN, Belgium)
2- Microbial oxidation of H2 at the Mt. Terri underground laboratory (R. Bernier-Latmani, EPFL, Switzerland)
3- Understanding presence, diversity and activity of microorganisms in swelling clays intended for use in geological disposal of radioactive wastes (K. Pedersen, Micans, Sweden)
4- Modelling microbiology, gas reaction and chemical evolution of geological disposal facilities (J. Small, UK National Nuclear Laboratory, United Kingdom)
5- Carbon cycling in deep groundwaters and in manmade geological sites (M. Itävaara, VTT Finland)
6- Gas generation and removal in geological disposal of nuclear waste disposal: How do microorganisms fit in? (H. Moors, SCK-CEN, Belgium)
7- The impact of microbial metabolism on the geodisposal of radwaste in multibarrier systems (JR. Lloyd, University of Manchester, United Kingdom)
8- Microbial influences on radionuclide behaviour – an example of less-understood problems and how to solve them (H. Moll, HZDR, Germany)
9- Microbe-radionuclide interaction in geological waste disposal facilities (N. Leys, SCK-CEN, Belgium)
10- Microbial influence on the immobilization of radionuclides in crystalline rock environments, Evelyn Krawczyk-Bärsch, HZDR, Institute of Resource, Germany

Rapporteurs: Birgitta Kalinowski, SKB
Karsten Pedersen, Micans

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Restriction of microbial growth and activity in a geological repository for radioactive waste

Katinka Wouter, SCK•CEN, Belgium

Katinka Wouters[1], Hugo Moors[1], Xiang Ling Li[2], Natalie Leys[1]
[1] Belgian Nuclear Research Centre SCK•CEN, Mol, Belgium
[2] EIG Euridice, c/o SCK•CEN, Mol, Belgium

The presence of microbes in geological disposal facilities seems unavoidable. Microbes will very likely be introduced by human activity, through facility infrastructure and waste packages but some may also originate from the host rock itself. Pre- and post-closure activity of these microbes cannot be ruled out: bio-foiling, microbial mediated gas production and consumption, metal biocorrosion, concrete biodeterioration, etc. have been observed and reported in numerous in-situ and ex-situ test set-ups and facilities. It is thus necessary to investigate, besides the chemical, geological and physical processes, also the microbiological processes in such disposal scenario's and how they may have an impact on the storage facility evolution and performance, on the short- and long term.
To address this aspect correctly, geomicrobiology research of waste disposal facilities is recommended, (i) to map the geochemical processes that can be catalysed by microbes in geological disposal facilities, (ii) to evaluate the rates at which these processes can occur in the given facilities, and (iii) to use this information to assess the impact of those bioprocesses on the waste, the facility and its environment.
A variety of parameters are expected to have an effect on the microbial community in the so-called excavation disturbed zone (EDZ) in the vicinity of the Engineerd Barrier System (EBS) and within the EBS itself. The combined EDZ-EBS effect is prone to lead to initially transient effects and an evolving geological environment and possibly a succession of different microbial activities and metabolisms. Apart from enhancement of microbial growth by the introduction of space, water, heat, energy sources and/or nutrient sources, a set of restrictions can be identified, depending on the host rock and the disposal concept. In the Belgian concept for disposal in clay, but also in other scenario's where bentonite is a candidate buffer material, restrictive parameters for microbial proliferation and metabolic activity are identified as (i) space limitation upon consolidation pressure, (ii) elevated temperature up to 80° C, (iii) a lack of energy and nutrient sources and (iv) elevated pH due to alkaline leaching. Understanding how these restrictions will finally contribute to shaping the microbial community and the bioprocesses in and around the facility would thus be a first, essential step to assess the potential effects of microbial activity on the disposal system evolution and performance.

At the SCK•CEN, the interaction between the restrictive parameters temperature and consolidation, microbial community activity and composition, and Boom Clay (pore water) characteristics, are investigated. The researchers make use of the Underground Research Laboratory HADES (High Activity Disposal Experimental Site) that is managed and operated by EIG EURIDICE, in combination with intensive lab scale testing. HADES, located in the Boom Clay at a depth of 225 m below the surface, offers a unique access to a microbial community in a representative environment of which all geological and geochemical characteristics are being thoroughly studied.

Temperature

With the in situ, large scale PRACLAY experiment in HADES, the behavior of the Boom Clay upon increased temperature will be observed over a period of ten years or more (X. L. Li et al., 2010). From two of the piezometers, Boom Clay pore water and gas phase samples are being collected and analysed on a regular basis, to estimate the effect of the planned gradual heating on clay characteristics, including pore water composition. It was already shown that an active microbial community resides within these water samples. Any change in this microbial community regarding activity or composition is compared with changes in the geochemical pore water composition, to identify possible causal relationships. In an effort to distinguish between genuine geochemical processes on one hand and biologically induced artefacts on the other, additional state of the art analyses for screening presence, activity and diversity of the microbial community (Wouters et al., 2013) are therefore included in the PRACLAY experiment. Although these microbial analysis will be of utmost importance to evaluate geochemistry effects upon temperature increase, the thermal restriction of a true Boom Clay microbial community that is unbiased by piezometer sampling and circulation, remains to be addressed.

Consolidation

Because of the high plasticity of Boom Clay it is expected that, after excavation and facility installation, voids and fractures around the gallery and instrumentation will fill and close rapidly and that consolidation will restore clay density close to its initial state over a long time. Hence, porosity will be a parameter that returns relatively fast to its

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

initial state. At certain consolidation thresholds, inhibition of microbial life is expected as a consequence of (i) isolation from nutrients required for growth or dependence on slow diffusion rates thereof, (ii) lack of space for cell proliferation, (iii) separation of synergistic community members and (iv) devastating consolidation pressure on the cells as such. To investigate this process more in detail, a high technology lab scale set-up was developed, in which a gradually increasing consolidation pressure will be imposed on Boom Clay slurries inoculated with a relevant Boom Clay borehole water microbial culture, using a set of continuously percolated oedometers. By combining the assessment of microbial presence and activity with physicochemical analyses, the consolidations thresholds for microbial life can be defined, which will be relevant for clay host rocks comparable to Boom Clay and could also contribute to microbial research on compacted buffer materials like bentonite (Stroes-Gascoyne et al., 2011, Rättö M. & Itavaara, 2012).

Acknowledgements
The on-going work on consolidation and temperature restriction referred to in this abstract is undertaken in close co-operation with, and also with the financial support of ONDRAF/NIRAS, the Belgian Agency for the Management of Radioactive Waste and Enriched Fissile Materials, as part of its programme on the geological disposal of high-level and intermediate-level long-lived radioactive waste.

References

Rättö M. & Itavaara M (2012) Microbial activity in bentonite buffers. Literature study. VTT Technical Research Centre of Finland, Finland.

Stroes-Gascoyne S, Hamon CJ & Maak P (2011) Limits to the use of highly compacted bentonite as a deterrent for microbiologically influenced corrosion in a nuclear fuel waste repository. Physics and Chemistry of the Earth 36: 1630-1638.

Wouters K, Moors H, Boven P & Leys N (2013) Evidence and characteristics of a diverse and metabolically active microbial community in deep subsurface clay borehole water. FEMS Microbiol Ecol. Epub ahead of print.

X. L. Li, W. Bastiaens, P. Van Marcke, J. Verstricht, G. J. Chen, E. Weetjens & Sillen X (2010) Design and development of large-scale in-situ PRACLAY heater test and horizontal high-level radioactive waste disposal gallery seal test in Belgian HADES. Journal of Rock Mechanics and Geotechnical Engineering 2: 103-110.

Microbial oxidation of H2 at the Mt. Terri underground laboratory

R. Bernier-Latmani, EPFL, Switzerland

The Mt. Terri laboratory is a good model for clay rock based nuclear waste repositories. The current radioactive waste disposal plan in Switzerland calls for steel canisters serving as radioactive waste containers to be emplaced in Opalinus Clay. Anoxic conditions that are expected to prevail in the repository will allow anoxic steel corrosion to proceed and the concomitant release of H2 gas. The hydrogen serves as an excellent electron donor for microbial processes, including sulfate reduction. Hence, it is expected that autotrophic sulfate reduction using H2 as an electron donor, SO42- as an electron acceptor and CO2 as a carbon source will take place as a result of steel corrosion. There is little known about microbial H2 consumption in this system –in particular, what fraction of H2 in consumed by microbes as opposed to lost through diffusion –as well a little direct information about autotrophic systems and the microbes and processes involved. Here we present an experiment carried out at Mt. Terri that involved introducing H2 gas into a borehole and characterizing the geochemical and microbiological impact. During repeated H2 amendments, we evaluated the microbial community changes using 16S rRNA pyrosequencing and a metagenomic approach and characterized the microbial processes using isotopic and conventional measurements. The results show rapid establishment of sulfate-reducing conditions and the predominance of a representative of the family Desulfobulbaceae, Gram-negative sulfate reducing bacteria (SRB) with known genera able to grow on Fe(III), sulfate as well as autotrophic representatives. This result is striking in light of the dominance of Gram-positive SRB in anoxic boreholes sampled at Mt. Terri. This works suggests that H2 supports an active microbial community and strongly selects for a subset of SRB. Implications for waste repository design is that H2 will be consumed rapidly if water and space are available within the repository.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG5 - Microbiological Studies

Understanding presence, diversity and activity of microorganisms in swelling clays intended for use in geological disposal of radioactive wastes

K. Pedersen, Microbial Analytics, Sweden

The presence of microorganisms in commercial bentonite has been investigated in several studies. The analyses of different clays generally show a significant diversity and numbers of microorganisms including anaerobic nitrate- iron - and sulphate-reducing bacteria (NRB, SRB, IRB), acetogens and aerobic bacteria. Swelling clays can preserve microorganisms in a desiccated, inactive but viable state. Most radioactive waste disposal (RWD) designs include commercial bentonites in barriers and buffers. Consequently, there is a great chance that RWD repositories are inoculated with a significant diversity of microorganisms that will be activated when the clays come in contact with groundwater. Published results and on-going investigations show that NRB, IRB and SRB are activated in such a scenario. Nitrate-reducing bacteria produce nitrogen gas from nitrate present in some intermediate-level wastes. The presence of IRB implies a risk for microbial destabilization of the swelling clays due to reduction of structural ferric iron. It has been readily demonstrated that this process can occur with ferruginous nontronile-type clays but montmorillonite clays are not well investigated. Sulphate-reducing bacteria produce sulphide which is corrosive to metal canisters.

Understanding presence, diversity and activity of microorganisms in swelling clays intended for use in RWD repositories is consequently important. The RWD designs vary significantly from country to country because the geological and technical conditions differ. Assumingly, some factors that influence microbial activity are common for all designs such as the relation between compaction, swelling pressure, temperature and microbial activity. Other conditions may be site specific such as the types of clay to be used, the geological formation and the repository design. The use of clays are unifying for most, if not all types of RWD repository designs. Research on the influence of microbial presence, diversity and activity in such clays is an excellent choice for a large, pan-European research program and the outcome will certainly contribute to competent RWD safety cases. Variables of importance for such research, in addition the above mentioned ones, can be pore space, transport conditions to and from the buffer boundaries and usability of the naturally occurring organic matter present in the clay and hydrogen from corroding metals.

Modelling microbiology, gas reaction and chemical evolution of geological disposal facilities

Joe Small, UK National Nuclear Laboratory

This presentation will provide an overview of biogeochemical modeling approaches that were originally developed and used to underpin the environmental safety case for near surface disposal of LLW in the UK. The approach represented in the Generalised Repository Model (GRM) addresses issues of gas generation (including the fate of H2), pH/Eh evolution and the speciation of redox sensitive radionuclides, including the inorganic and organic forms of C-14. This coupled microbial-growth-chemical-speciation approach has been validated and published through modelling of a large scale gas generation experiment (TVO, Finland) and has been applied to an in-situ nitrate reduction experiment at the Mont Terri URL. Currently, the NERC Bigrad project applies the model to examine the microbiological and chemical processes under cement-buffered alkaline pH conditions.

The presentation will conclude with a discussion of the data requirements, assumptions and lessons learnt in developing, validating and applying the GRM biogeochemical model. An outline of the future development of biogeochemical models of this type will be provided, including how the microbial modelling approach could be incorporated in a wider range of reactive-transport models.

Carbon cycling in deep groundwaters and in manmade geological sites

Merja Itävaara, VTT, Finland

Deep bedrock groundwaters contain very low amount of organic matter and microbes utilize mainly methane and carbon dioxide as C source. Organic substances originating from the surface or from construction materials and low radioactive wastes may also be C sources for microorganisms and accelerate their activity. Gas generation potential of organic compounds is dependent on their chemical and physical structure which can be determined by biodegradability tests. In 1997 a large scale gas generation experiment was started in Olkiluoto LLW/ILW repository (Teollisuuden Voima Oyj) to study biodegradation of low radioactive wastes and gases generated in real conditions. In addition an overview of present research activities concerning molecular microbial characterization of the Olkiluoto and other bedrock aquifers of Finland will be discussed.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Gas generation and removal in geological disposal of nuclear waste disposal: How do microorganisms fit in?

Hugo Moors, Katinka Wouters, Elie Valcke, Norbert Maes, Natalie Leys, SCK•CEN, Belgium

One of the major concerns of the safe disposal of nuclear waste in any deep geological formation is the possible impact of gasses. Gases can have different effects on the safety of nuclear waste disposal in deep geological formations. If the gas generation rate is larger than the capacity for diffusive transport of dissolved gas, a free gas phase will be formed. Such a free gas phase will alter the hydraulic and mechanical properties of the host rock. As a consequence, dissolved radionuclides (RN) and contaminants could be driven out of the engineered disturbed zone (EDZ) and/or out of the (clay) host rock, much faster than the expected diffusive transport. If the gas generation is lower than the capacity for diffusive transport, the effect will be dominated by the capacity of the gas to alter the geochemical characteristics of the EDZ and/or the clay host rock formation. Altered geochemical properties can also lead to changes in the dissolution chemistry of RN's, thus resulting in altered diffusive parameters for radionuclide migration.

Which gas production and removal reactions, can and will occur, depends mainly on the host rock properties, type and matrix of the nuclear waste, type of used backfill material and tunnel lining material. Gasses can be generated or removed, due to a complex network of interrelated physical, geological, chemical and biological reactions. Gas production can be established by four different mechanisms: anaerobic metal corrosion, radiolysis, radioactive decay and microbial metabolism. Removal of gasses can (theoretically) take place by the following mechanisms: dissolution and diffusion, two phase flow, gas induced fractures, chemical reactions, and – again – microbial gas assimilation or conversion.

In any case, the role of microbes in these processes cannot be neglected. Metabolic and respiratory pathways of microorganisms, very often involve the consumption or production of gaseous components. For instance, hydrogen gas, which will be formed in substantial amounts through anoxic corrosion of the metal nuclear waste canisters, is the preferred energy source for many microorganisms inhabiting the subsurface; which can also produce methane. Carbon dioxide gas, on the other hand, is a common metabolic end product of the degradation/oxidation of organic matter. Nitrogen gas, is the natural end product of microbial nitrate reduction. Sulphate reducing bacteria will produce dihydrogen sulphide gas. Hence, the inevitable contribution of micro-organisms on gas generation and removal and its impact on the safety of nuclear waste disposal in deep confined geological formations, needs to be investigated.

SCK•CEN has gained a profound knowledge of the effect of possible gas perturbations in relation to the safe disposal of nuclear waste into clays. It started very early with the MEGAS projects of the early nineties, and is ongoing with the current FORGE (Fate of Repository Gasses) pan-European project, a project which is funded and running within the EU Seventh Framework Program. During the MEGAS project the first proof was given of the important role microorganisms can possess, when unexpectedly, after a stable period of 210 days, the hydrogen pressure inside a closed geochemical reactor suddenly dropped to roughly a fourth of its value. Later, gas analysis showed that hydrogen was completely converted into methane. Such conversion was thermodynamically impossible and could only be explained by the presence of methane producing Archaea. Following the MEGAS reactor tests, other projects have suffered and demonstrated the impact of microorganisms on altering the gas pressure and the geochemistry of clay in closed systems. Also the interaction of microbes with the waste material compounds cannot be excluded, as is demonstrated for example in the Mont Terri BN-project studying the fate of nitrate leached from bituminized intermediate-level long-lived radioactive waste, in a geological test set-up.

To further elucidate the fundamental mechanisms driving microbial gas production and consumption, new in situ field and ex situ laboratory batch testing has to be done. Series of small batches, in which different combinations of carbon sources, electron donors and –acceptors are changed, can give "proof of principle", while more elaborate batch tests are able to give a better simulation of real repository conditions. Field testing is necessary to validate laboratory batch experiments under in situ nuclear waste repository conditions. Another major advantage of in situ experiments, from geo-microbiology perspective, is the presence of a real and representative microbial community, of which the evolution and representative in situ activity can be monitored.

Acknowledgements

Most of the work referred to in this presentation is undertaken in close co-operation with, and also with the financial support of ONDRAF/NIRAS, the Belgian Agency for the Management of Radioactive Waste and Enriched Fissile Materials, as part of its programme on the geological disposal of high-level and intermediate-level long-lived radioactive waste. Part of the work has also been co-funded by the European Commission in the frame of several Framework Programmes.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

WG5 - Microbiological Studies

The Mont Terri Bitumen-Nitrate-Clay interaction test (BN project) is undertaken in close co-operation with the operator of the Mont Terri rock laboratory (Swisstopo) and the project management team at Mont Terri, in particular Christophe Nussbaum and Thierry Theurillat. Financial support was provided by the Mont Terri Consortium.

The impact of microbial metabolism on the geodisposal of radwaste in multibarrier systems

Prof. J.R. Lloyd, University of Manchester, UK

Microbial metabolism has the potential to impact significantly on wasteform evolution and radionuclide mobility in geodisposed wasteforms, and must be incorporated into repository safety cases. It has been assumed previously that microbial metabolism will be minimal in the harsh near field environment of a multibarrier geodisposal facility, but recent research using the latest advances in post-genomic, spectroscopy and imaging techniques, focusing on appropriate analogue sites and microcosm/mesocosm experimental systems is challenging this view. This presentation will give an overview of a range of collaborative studies which have focused on microbial gas metabolism, complexant biodegradation, radionuclide biogeochemistry, radiation biology and biomineral evolution in scenarios relevant to the near and far fields of geodisposal facilities. Of particular relevance will be work conducted via the UK's NERC BIGRAD programme (with links to several European WMOs), focusing on high pH concrete-based disposal systems.

Microbial influences on radionuclide behaviour - an example of less-understood problems and how to solve them

Henry Moll, Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology, Germany

The potential ambivalent effects of microorganisms on radionuclide transport in the near and far -field of nuclear waste repositories up to the biosphere is discussed. Issues such as microbially induced redox processes of radionuclides, the role of secreted microbial bioligands, of biosorption and biocolloids, the in-situ kinetics of microbial reactions and the quantification of their products are addressed.
Besides the prominent processes influencing the migration of actinides in the environment, e.g. sorption onto mineral surfaces, there is growing attention to the influence of indigenous microorganisms on actinide speciation. The concept of geological disposal comprises a detailed knowledge concerning potential host rock formations also in terms of such microorganisms. It is well known that respective bacteria can affect the speciation and hence the mobility of actinides. Thus, dominant bacterial strains from sites destined for future nuclear waste deposition have to be investigated regarding their interaction mechanisms with soluble actinide ions. The understanding of the speciation and the structure of the radionuclide complexes formed in presence of indigenous bacteria over a range of geochemical parameters (e.g., pH, metal concentration) becomes indispensable for eventually predicting the safety of a planned nuclear waste repository. The impact of bacteria on radionuclide speciation will be discussed by taking three examples:
a) the influence of the Mont Terri Opalinus Clay isolate Sporomusa sp. on the plutonium speciation [1]; b) curium(III) interaction with cells of the Äspö -groundwater bacterium Pseudomonas fluorescens [2]; and c) curium(III) complexation/mobilization with pyoverdins secreted by the Äspö -strain P. fluorescens [3].

Acknowledgements
The presented studies/examples were funded by BMWi under contract numbers 02E9985 and 02E10618. The authors thank the BGR for providing the Mont Terri Opalinus Clay samples.

[1] Moll, H. et al. Bacterial diversity in Mont Terri Opalinus Clay and the influence of the bacterial Sporomusa sp. isolate on plutonium speciation. Poster at the MIGRATION 2013, 08.-13.09.2013, Brighton, United Kingdom.
[2] Moll, H. et al. Curium(III) speciation studies with cells of a groundwater strain of Pseudomonas fluorescens, Geomicrobiol. J. 30, 337-346 (2013).

[3] Moll, H. et al. Curium(III) complexation with pyoverdins secreted by a groundwater strain of Pseudomonas fluorescens. Biometals 21, 219-228 (2008).

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Microbe-radionuclide interaction in geological waste disposal facilities

Natalie Leys, Nuclear Research Centre SCK•CEN, Belgium

Natalie Leys, Hugo Moors, Katinka Wouters, Christophe Bruggeman, Norbert Maes, Belgian Nuclear Research Center SCK•CEN, Mol, Belgium

Contamination of the environment by radioactive material (such as uranium (U), selenium (Se), neptunium (Np), plutonium (Pu)) leaching from waste in geological disposal facilities in the near and far future is a subject of concern for all nuclear waste agencies. The mobility and thus the ultimate release into the biosphere of these radioactive redox-sensitive elements is however a complex process and still not very well characterised.

Radionuclide mobility is mainly determined by their chemical form and speciation, which is turn is determined by the alkalinity (pH), redox potential (Eh), and the presence of ligands, in the waste and the geological repository. Many geological, physical and chemical parameters contribute to the speciation of radioactive elements and are already subject of detailed investigations. However, it has also been shown that the behaviour of radioactive pollutants can be significantly affected by the microorganisms present. The possible impact of microbes on radionuclide transformation and (im)mobilisation thus needs to be addressed, as it will be needed for the optimisation of predictive models and for the development of new technologies for safe radioactive waste management in geological disposal facilities.

Microbial processes can directly and indirectly affect radionuclide migration in multiple ways. Microbes can directly interact with the radionuclides and enhance dissolution of immobilized metals and radionuclides, and produce complexing agents which can mobilise metal ions from solid phases and thus increase radionuclide migration rates. On the other hand, microbes can also biodegrade some of the organic complexing and mobilising agents or contribute to the biomineralisation and bioprecipitation of the radionuclides. For example, biofilm coatings formed on the interfaces between waste, repository infrastructure and host rock (in the near field) can accumulate metal ions and radionuclides, thereby retarding radionuclide migration. In addition, microbes have also a significant impact on their (local) environment through groundwater pH, Eh, and chemistry, and will as such also indirectly influence radionuclide migration.

SCK•CEN has contributed to several geochemical experiments to unravel the interplay between microbial biofilms and radionuclides and the effect of microbial induced redox transformations of iron minerals (Fe) on radionuclide mobility (FUNMIG project, EC-FP6) in a clay environment. SCK•CEN has also investigated in detail the microbial communities present in clay repositories and the bacterium Cupriavidus metallidurans CH34 as a microbial model organism for microbe-metal interactions in the laboratory. The aim of these investigations is to determine the effect of microbes, such as the bacterium C. metallidurans CH34, on the speciation of (radioactive) metal pollutants and to understand the biological molecular mechanisms and biochemistry of these effects. State-of-the-art molecular biology (e.g. mutagenesis, RNA-chips, genome sequencing, metagenomics, etc.) and bioinformatics tools are used. More than 30 years of research on C. metallidurans CH34 has revealed the complexity of the cellular and biochemical processes that take place when bacteria come into contact with toxic metals such as arsenic (As), mercury (Hg), nickel (Ni), zink (Zn), cobalt (Co), chromium (Cr), copper (Cu) and cadmium (Cd), and radionuclides such as selenium (Se) and uranium (U). For example, it has been shown that C. metallidurans CH34, and many other bacteria, can change uranyl, a very soluble form of uranium which can be easily spread in the environment, into uraninite, a very insoluble form of uranium which is much less mobile in the environment. Current investigations at SCK•CEN focus on the bioleaching and sequestration capacities of C. metallidurans CH34 (e.g. by metallophore production and biofilm formation) to release metals from solid phase minerals. Furthermore, the detailed molecular knowledge on microbe-metal interaction is also being used to develop biosensor techniques to detect and monitor the biological available (mobile) fractions of metals and radionuclides in (ground)water, soils, feed or food.

However, despite the extensive laboratory research and detailed knowledge on the interaction of some bacteria with specific radionuclides, currently still little is known about the microbe-radionuclide interactions that could occur under the in situ environmental conditions prevailing in nuclear waste disposal facilities. Many of these microbial mediated biochemical processes, and the rates at which they occur, strongly depend on the actual in situ activity of the microbial community present, the waste and package type (i.e. co-leaching products), the radionuclide concentration and its radiological and chemical toxicity, and also the in situ prevailing environmental parameters in the disposal facility and the host rock, including pH, redox conditions,

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

available iron, phosphate, carbonate concentrations, etc. Moreover, the potential impact of these microbial processes on the repository safety will vary strongly with the type of host rock (clay versus granite). Thus, the extent of microbial (im)mobilisation of radionuclides needs to be further investigated under in situ repository conditions, supported with detailed geochemical and radionuclide speciation and migration analyses. To our knowledge, such in situ microbial test set-up to investigate the impact of full microbial communities on radionuclide leaching, transformation and migration, under in situ conditions in geological disposal facilities, has yet to be developed.

This research will benefit from the growing informal network of researchers in Europe investigating the biogeochemistry of radionuclides and remediation technologies. The most obvious and direct beneficiaries from such research are the nuclear industry and regulators and the nuclear decommissioning authorities in Europe. However, national governments will also benefit from this research as it addresses a significant environmental problem of public concern and will aid in the development of hazard prevention strategies and technologies.

Microbial influence on the immobilization of radionuclides in crystalline rock environments

Evelyn Krawczyk-Bärsch,Helmholtz-Center Dresden-Rossendorf, Institute of Resource, Germany

In crystalline rock, the dominant transport medium for radionuclides is groundwater flowing through subsurface fractures. Since groundwater is containing microorganisms, fracture surfaces support biological growth of microbial communities. The formed subsurface microbial communities have a significant effect on the adsorption capacity of host rock formations by forming a barrier between the rock surface and the groundwater. But how do these microbial communities influence the mobilization or immobilization of radionuclides in the case of a nuclear incident? As known from experiments performed on biofilms from the underground rock characterization facility tunnel ONKALO in Finland and from the Äspö Hard Rock Laboratory (HRL) in Sweden, microbes can significantly affect subsurface biogeochemical interactions, leading to the immobilization and (bio-)adsorption of radionuclides. Under the ambient conditions in the Äspö HRL (neutral pH of the groundwater, high amount of ferrous iron in the groundwater, aerobic conditions) the uptake of radionuclides like U(VI) and Np(V) was determined to be 85% and 95%, respectively due to the abundant surface area of the bacteriogenically formed ferrihydrite.

In order to define the influence of microbial communities and their relevance in the safety assessment of a nuclear waste repository some important points have to be considered;

- We have to characterize the possible microbial diversity during changing geochemical conditions (Eh, pH, T, p, chemical composition of the groundwater) in an opened and closed deposit. Bioaccumulation experiments performed on selected microbes using different radionuclides have to emphasize at least on aerobic conditions.
- Information about the sources for electron donors and electron acceptors for microbial activity are needed.
- To estimate the relevance of microbial process, we have to know more about the kinetic of microbial growth. Therefor we have to trace the effect of microbial metabolism and growth in a geochemical system using a generalized kinetic rate law. We need to estimate biofilm growth for process description, including different scales and different types of radionuclides. What are the parameters, which are needed for modeling the kinetic of microbial growth? The aim of the modeling will be a quantification of microbial processes and the assessment of microbially mediated retention of radionuclides.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Plenary sessions

Plenary session 1

NEWLANCER: Steps towards a broader participation of the New Member States in EURATOM research

Daniela Diaconu, Institute for Nuclear Research, Romania

Since their accession to EU, the NMS participation in Euratom research remained at 5% from total EC grants both in FP6 and FP7, despite the facilitating measures taken by EC to encourage their contribution in the fission research.
Equally concerned by their low level of the involvement in the European research program in nuclear field, NEWLANCER partners performed a quantitative and qualitative analysis of NMS participation in FP6 and FP7 Euratom programmes, identifying the main reasons for this situation at organizational and national level. Organizations from NMS seem to struggle both with the national and EURATOM research programs. It seems that strategic research management and funding of these organisations only marginally affect the success in EURATOM projects. It is possible that the current success depends mainly on the excellence and connections of individuals rather than from systematic approach of the organisations and/or nations. SWOT analyses in each participating country revealed possible strategic directions leading to a wider participation in future programmes and identified research potential that could be further exploited.
A multi-level network linking national and regional experts in the Euratom fields, connecting them to OMS research centers with large participation as well as to the European Technological platforms (SNETP, IGD-TP, MELODI) and other related associations or networks (EERA, NUGENIA, Euratom NCP) was built. This complex network favored creation of specialists teams able to plan new projects, ensured access to up-to-date information on nuclear, and facilitated a better understanding of decision making mechanisms and a pro-active dialogue with the responsible players defining research strategies in nuclear field.
Participation in IGD-TP working activities improved the better knowledge of the current NMS needs and priorities of their radioactive disposal programs and facilitated the identification of future supporting actions.

As a result of the lessons learnt in the analysis of previous participation and of the networking activities, new FP7 projects were born and are underway (MAXSIMA proposed in Euratom 2012 call, and ARCADIA, EAGLE and ASAMPSA_E concretizing three ideas which became successful proposals in the Euratom 2013 call as result of a pilot exercise.

Scenarios for improving stakeholder involvement within the IGD-TP. Insights from InSOTEC

Meritxell Martell, Merience, Spain

InSOTEC is a three-year collaborative research project (2011-2014), funded under the 7th Euratom Framework Programme, which aims to generate a better understanding of the complex interplay between the technical and the social in radioactive waste management. One of the objectives is to provide the IGD-TP with concrete suggestions on how to address the entangled socio-technical challenges of geological disposal. In order to do this, we have analysed the potential for the involvement of different types of stakeholders in the Platform. In our analysis, we consider the extent to which the IGD-TP's practice as regards to stakeholder involvement matches its discourse, and what potential for improvement exists given its structural organisation as a European Technology Platform (ETPs). Technology Platforms (TPs) can be understood as knowledge networks, deliberately set up to influence (research) policy in a specific domain. We therefore use knowledge networks as a conceptual approach and look at the IGD-TP as a complex network which includes actors, knowledge and practices across different countries, focusing on a very specific topic (i.e. implementing geological disposal).

Applying Callon's [1] framework of knowledge co-production (1999) we come to define different degrees of interaction between science, society and policy in view of defining research and development (R&D) priorities. We describe how these interactions could be conceptualised and interpreted for the IGD-TP. The current approach of the IGD-TP can be mainly understood as

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

classical model involving mainly expert stakeholders and scientists. Where there seems to be a good representation among IGD-TP members of industry, research institutes, and some members of the academic community this is not the case for other types of stakeholders, such as public authorities or civil society. At this stage, the overall approach of the IGD-TP would seem to restrict the scope of stakeholder involvement, as it narrows participation down to uniquely technology experts, hindering socio-technical manifestations. Our analysis nevertheless shows that there is room for engaging with a broader range of stakeholders in the field of radioactive waste management, if this is the intention of the IGD-TP. However, this would require a commitment to developing a common knowledge base including other stakeholders through a process of mutual adjustment and negotiation.

[1] Callon, M. (1999), 'The Role of Lay People in the Production and Dissemination of Scientific Knowledge' in: Science, Technology & Society, 4(1): 81-94.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

Plenary session 2

Output from the working group on RD&D dissemination

R. Kowe, NDA, UK

The working group on RD&D dissemination is part of SecIGD2 Work Package 2 `Support for networking, structuring and developing RD&D competences in countries with less advanced geological disposal programmes'.

The first meeting of the working group was held at the Geological Society, Burlington House London, 9th May 2013.

The initial output from the working group is a questionnaire to gain wider input on RD&D information needs from IGD-TP partners. The responses from the questionnaire were evaluated, compiled and will be presented at the 4th Exchange Forum meeting Future activities of the Working Group will be outlined.

Safety of Spent Nuclear Fuel Disposal in Crystalline Rock (SAFEROCK)

Gunnar Buckau, JRC

An initiation process has started for elaborating upon a joint research project on remaining key issues for the Crystalline Rock Safety Case. A core group led by WMO's (SKB, POSIVA and RAWRA) together with key research organizations (especially KIT-INE and JRC-ITU) and organizations focusing on modelling and application to the Safety Case (AMPHOS21 and KEMAKTA) are collecting and structuring topics and associated experimental investigations and modelling applications. The encompassed project "SAFEROCK" combines the near-field, the far-field and the transition between them.
The list of far-field topics is based on the end-user group recommendations of the recently finalized Collaborative Project "Crystalline Rock Retention Processes" (CROCK). Topics on the near-field and the transition to the far-field focus around needs identified in the on-going assessments of the Swedish and Finish licensing applications. Consequently, scenarios with compromised integrity of the EBS are included in the discussion.
Relevant processes and critical data are obtained from combining a series of lab and URL experiments. In-situ-experiments at Äspö and/or Onkalo are used to capture relevant transport properties from the spent fuel to the host-rock. Different experimental material, including real spent fuel, is used in the lab. SIMFUEL and/or designed pellets including 233U doped UO2 are under discussion for the in-situ experiments. The composition, structure and burn-up of spent fuel arising in the coming decades are also considered.
Modelling for application of knowledge and data for the Safety Case is built around new data arising from SAFEROCK, but also around assessment of existing not yet fully examined data from, for example CROCK. The experimental and modelling programme, as well as time-schedule, dissemination, training and education efforts will evolve upon prioritization and involvement of additional organizations.

Proposal for the IGD-TP Knowledge Management Portal

Juhani Palmu, Posiva, Finland and Terho Laakso, Documill

On the long term horizon one challenge in knowledge management within nuclear waste management is how to preserve the basic knowledge of the final disposal activities in next decades and at least the next century while employees and generations will change. The threat is that the final disposal activities will be interrupted if any doubt of absence for the long term safety analysis will arise or the fundamentals of the analysis will not be remembered or understood. The ultimate challenge in knowledge management is to transfer the undocumented tacit information to be utilised for the organisation while personnel will leave organisation or will retire.

Solutions for the final disposal of spent nuclear produced in Finland have been under research since late 1970's. This work has been co-ordinated by Posiva since 1996 and by its' preceding organisations until then. The extensive documentation in several formats covers this scientific and technical foundation for the concept of the geological disposal of high radioactive uranium waste to the Finnish bedrock. Due to the historical reasons of general development of documentation procedures during last decades, a major part of this documentation have been archived only in paper form and thus have not been accessible in digital ways.

The first step for the KMS in Posiva has been to organise the contents of the research work and reports to be utilised in digital form and in much more intuitively approached way by using new and more enhanced technologies compared to conventional documentation management systems. Paper reports (ca 2400 pcs) have been scanned,

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project

optically character recognised and filed in pdf/A form. All of ca 3400 reports have been stored in current conventional documentation management system. The implementation of the KMS has been launched in production in the visualised web based KMS ontology portal, which is available for personnel in Posiva and also for the trusted external parties including consultants and the local authority.

Based on the development efforts done for the Posiva Final Disposal Knowledge Management Portal, Posiva representative will give a presentation and a demo how this technique could be utilised as form of the Common Knowledge Management Portal of IGD-TP. The demonstration stand will be open during all the Wednesday afternoon with Posiva and Documill representatives.

Exploring the possibilities to establish a new European Entity for social, societal and governance issues - the PLATENSO Project

Kjell Andersson, Karita Research, Sweden

The objective of the recently launched Euratom Framework 7 Project PLATENSO is to provide a proposal towards establishing the legal base for a European Entity on Socio-Economic matters linked to nuclear technology and to develop recommendations for research strategies for social, societal and governance issues.
One of the work packages includes establishing a legal base for a European Entity on socio-economic matters in nuclear technology. This new entity will address issues related to:

- Conducting socio-economic studies of interest to both academia and decision makers (e.g. private and public organisations) involved in the implementation of nuclear fission technologies
- Establishing links with similar initiatives both in the EU and abroad, thereby improving the visibility of the socio-economic research community and its complementarity with the scientific-technological community
- Boosting ETI (education, training and information) initiatives addressing knowledgeable non specialists, thereby improving public understanding of nuclear matters (especially in the new EU Member States)
- Providing an effective link between “hard” and “soft” sciences in the nuclear domain, thereby fostering the role of the scientific-technological research community in the governmental decision making processes.

The proposed entity will provide insights into the organizational structure, how an established network in Central and Eastern countries can be expanded to all EU Member States and which could be the working areas of the entity. The organization and strategic research agendas of the three EU platforms related to nuclear energy scenarios (SNETP), geological disposal (IGD-TP) and radiation protection (MELODI) as well as the European Nuclear Education Network (ENEN), the Nuclear Generation II&III Association (NUGENIA) and other relevant networks will be explored to identify legal and financial options as well as practical solutions for the foreseen legal entity.

Establishment of the new European Entity on socio-economic matters linked to nuclear technology has potential to overcome the barriers that still exist for taking them fully into account and to make the awareness of the social and political challenges to come to action.

This event is co-funded by the European Union under the 7th Euratom Framework Programme, Grant agreement number 323260 - SecIGD2 project