



***Our Vision: “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.”***

## Editorial

Dear Readers,

Radioactive waste management and geological disposal is a challenging and complex societal task from whichever angle one looks at it: technical, political or ethical. However, it is widely felt that it needs to be tackled by the current generation and should not be put far in the future. Even more because the last stage in the project cycle of nuclear energy bears a significant cost.

Within Europe, we can be proud that this is exactly what is happening at several places and that as a waste management community we are taking a leading role. As a geological repository for high level waste is being constructed in Finland and construction licence applications are either being submitted or being assessed in France and Sweden, the vision of the IGD-TP, namely to have operating geological repositories by 2025 is materialising slowly but surely. In addition, progress has also been made right across the spectrum of waste management programmes. While early stage programmes have published policies in support of the geological disposal facility as a preferred solution, other ‘mid stage’ programmes have developed and documented credible underpinning research programmes. This in line with the EURATOM spent fuel and radioactive waste directive which has been in force since 2011.

Another milestone in this endeavour has been reached. In June 2019 the European Joint Programme EURAD was launched. The almost Herculean work to bring the 52 mandated actors from the member states and associated countries together around a common vision, strategic research agenda and roadmap could only be realised by the sustained energy and focus of all parties involved and the much needed leadership of both the European Commission and the Core Group managed by Andra. The IGD-TP has acted to coordinate the waste management organisation (WMO) view in the proposal, along with those bodies representing the technical support organisations (TSOs) and the research entities (REs), and will continue to do so in the future. With a solid RD&D programme lined up for the next 5 years as part of the 1<sup>st</sup> wave of work packages, many relevant topics for WMO programmes in various stages of implementation will be addressed.

The IGD-TP also recognises that thanks to these positive developments, there is room to focus intensively on the needs of the WMO programmes that cannot immediately be addressed by EURAD. In the next years the IGD-TP will develop strongly application-driven joint activities that are linked more closely to decision making in the individual WMO programmes and that have shorter timelines than EURAD. The IGD-TP objective here is to combine forces around joint interests between WMOs and increase efficiency. Where possible, effort will be undertaken to integrate these activities in EURAD.



Irina Gaus,  
IGD-TP Chair

These developments will be aligned with the updated vision, which will be announced at the 10-year anniversary of the IGD-TP on 12 November 2019, and the announcement of the updated WMO strategic research agenda is expected a few months later. The new vision will consider the next step towards industrialisation of radioactive waste disposal in Europe and focus on the safe operation of the first geological disposal facilities, the necessary ongoing optimisation, and the development of tailored solutions to meet the requirements of smaller and early stage programmes with diverse waste inventories in Europe.

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## The View from the IGD-TP Secretariat

### Administration

Three Executive Group meetings to steer the IGD-TP have been held since our last newsletter was published:

- EG27, 1-2 October 2018, Budapest, Hungary;
- EG28, 25-26 February 2019, Vienna, Austria;
- EG29, 24-25 June 2019, Manchester, UK.

Nagra took over the IGD-TP Chair and Secretariat at the beginning of 2019 with SURAO fulfilling the Deputy Secretariat role.

Important administrative steps taken during the last few months include:

- Establishing a working group to develop the new IGD-TP Strategic Research Agenda;
- New financial agreements and terms of reference for the IGD-TP Executive Group (EG) covering 2019-2020 have been developed and are being reviewed by EG members;
- A new IGD-TP Vision is being developed and will be communicated at the IGD-TP 10 year anniversary this autumn.

### New IGD-TP Members



Since our last newsletter we have welcomed two new organisations to the IGD-TP:

- Golder Associates (UK) Ltd - Golder's is a global organisation ([www.golder.com](http://www.golder.com)) providing consulting, design, and construction services in the specialist areas of earth, environment, and energy. It has been operating 55+ years, has 6,500 employees, 165+ offices and operates in 30+ countries. Golder's are currently supporting several organisations across Europe and globally with implementation of radioactive waste programmes. The company has undertaken projects including:
  - New nuclear station, Paks, Hungary
  - Performance assessment of the LILW Repository at the Bataapati Site, Hungary
  - Safety assessment at a radioactive waste site in Korea
  - Site investigation for HLW disposal in the Boda Claystone Formation, Hungary
- Helmholtz Centre for Environmental Research (UFZ) – UFZ is one of the world's leading research centres in the field of environmental research ([www.ufz.de](http://www.ufz.de)). As an international competence centre for environmental sciences, the UFZ investigates interrelationships between humans and nature under the influence of global change. In the energy sector (resources and waste management), the covered topics range from process modelling and simulation to development of innovative monitoring strategies and investigation of socio-economic aspects. In particular the specific strength of one of the departments (the department of Environmental Informatics (ENVINF): [www.ufz.de/index.php?en=34216](http://www.ufz.de/index.php?en=34216)) is the modelling and numerical simulation of individual and multiple coupled physical (Thermo-Hydro-Mechanical) and geochemical (C) processes in the geological subsurface. Due to the interdisciplinary approach applied in the simulations, there is a strong collaboration with other national and international research institutes (i.e. PSI, KIT, Jülich and HZDR) and universities (i.e. TU Bergakademie Freiberg).

All our member organisations and their contact points are available at : <https://iqdtp.eu/members/>



Jon Martin,  
IGD-TP Chair  
2017-2018

### Thank you

Last but not least, this is the place to thank the previous Chair and the Secretary General, Jon Martin and Rob Winsley, who have done an excellent job in ensuring the IGD-TP role during the JOPRAD project and the EURAD preparation, which was, given the novelty of the instruments, a challenging task.



Robert Winsley,  
IGD-TP Secretary  
2017-2018

## News

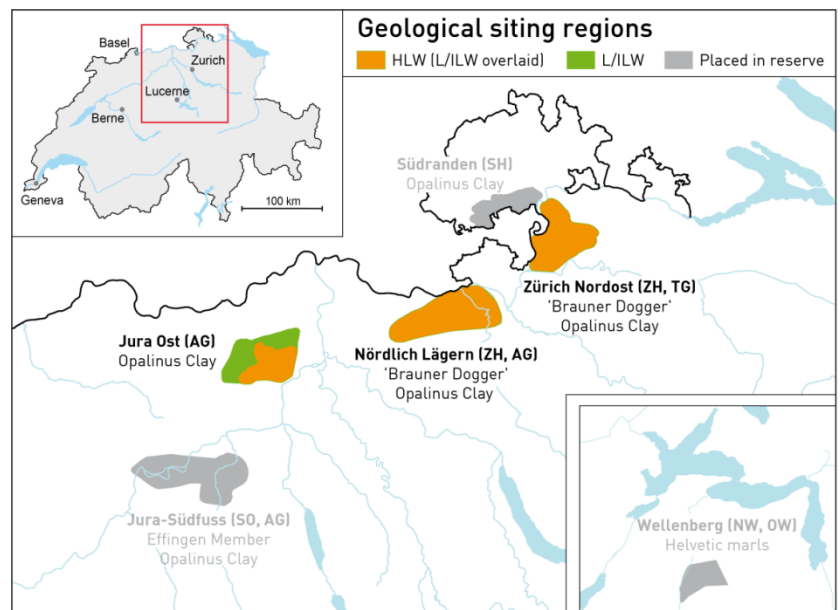
### National Update - Switzerland



The Swiss nuclear energy legislation requests that all types of radioactive waste and spent fuel, when declared as waste, should be disposed of in deep geological repositories. The concept prescribed is that of “monitored long-term geological disposal”, which combines passive safety with a monitoring period and retrievability “without undue effort” before repository closure. The site selection process (so-called “Sectoral Plan”) is led by the Federal Government. This three-stage, step-wise decision-making approach has a strong participatory component from the affected communities, regions and cantons. Two repositories (for L/ILW and HLW/spent fuel respectively) are foreseen, although the option of a combined repository at the same site is also being investigated.

In Stage 1 of the site selection process Nagra, on behalf of the waste producers, proposed six potential siting regions, which were approved by the Federal Government in November 2011. The narrowing-down process resumed in Stage

2, with the goal of selecting at least two potential sites for each type of repository within the siting regions identified in Stage 1. In addition to the emplacement of the underground facilities, areas for surface facilities were identified as a result of interaction with the regional interest groups. In January 2015, following a safety-based comparison of the potential sites, Nagra submitted a proposal for two siting regions for Stage 3 (“Jura Ost” and “Zürich Nordost”), where more detailed investigations should be performed and, ultimately, licence applications submitted. The investigation of a third site (“Nördlich Lägern”), which Nagra had proposed to place in reserve, was requested by the safety authority ENSI. Following review by the authorities and a nationwide public consultation, the three proposed siting regions were accepted by the Federal Government in November 2018.



Swiss geological siting regions accepted by the Federal Government in 2018.



Site investigation drill rig.

In Stage 3, now on-going, the findings relating to the site-specific geological conditions will be supplemented by geological studies. The design and location of the various elements of the surface infrastructure (including the encapsulation plant) will be finalised in cooperation with the regions and the socio-economic impacts of the repositories will be examined in greater detail. Based on the results of the geological investigations and the safety-related comparison of the three remaining siting regions, Nagra will submit license applications for the selected site(s) in 2024.

The deep geology of the three siting regions has been investigated with 3D-seismic campaigns from 2015 to 2017. Interpretation of the data showed that sufficient space is available in the clay rich host rock formation in all regions. However, the investigations revealed differences from the point of view of lithology and tectonic setting. The investigation of the rock properties in the siting regions requires deep boreholes up to 1200 m below surface and a total of 23 applications have been submitted by Nagra. Drilling has started in April 2019 at the first site in Bülach, slightly north of Zürich. Furthermore, a drilling campaign with shallow boreholes to characterise the quaternary deposits and reconstruct the quaternary glacial history of the sites was initiated in 2018. In parallel, a comprehensive RD&D programme with a strong international component is on-going, in particular with tests performed at the underground research laboratories Mont-Terri and Grimsel Test Site.

For further information <https://www.nagra.ch/>



## News

### National Update – United Kingdom



Following the recent publication of the UK and Welsh Governments' new 'Working with Communities' policies on geological disposal facility (GDF) siting, RWM as the Governments' delivery body has now begun the search for a suitable site with a willing host community in England and Wales.

The new policies incorporate lessons learned from the previous siting process, which ended in 2013 following a vote by three local authorities in Cumbria, one of which voted to withdraw from the process, effectively ending siting discussions in the region at the time.

One of the significant differences compared to the previous process is that RWM has published a series of reports called the National Geological Screening (NGS) which summarise and outline what is already known about the geology of England and Wales relevant to the safety of a GDF. These reports are divided into regions and sub regions demonstrated through maps and accompanying explanatory information. The NGS reports are published online (<https://www.gov.uk/guidance/about-national-geological-screening-ngs>) and are supported by short videos designed to make the information accessible in order to promote dialogue with RWM about the potential for developing a GDF.

The new Working with Communities policies also provide a greater degree of flexibility for communities to enter discussions to work in partnership without commitment. Communities can engage to find out more about geological disposal and proceed at their own pace without being forced to make decisions at pre-determined steps through the siting process.

Shortly after the publication of the NGS reports, RWM opened national consultations across England and Wales on the factors and considerations it will use to evaluate potential GDF sites in future. In support of this, RWM carried out a series of consultation events with ten public meetings in England and four interactive webinars for audiences in Wales. The site evaluation consultations are now closed, and following a good response RWM have begun analysing the feedback with a view to publishing the consultation findings later this year.



*Thirteen UK geological screening regions.*

Government has continued to work on aspects of the programme and is due to lay a National Policy Statement (NPS) for geological disposal infrastructure in the UK Parliament later this year. The NPS will explain the policy against which applications for development consent will be considered and how the impact of any proposed infrastructure, including deep borehole investigations, will be assessed and mitigated. Ultimately the NPS will be used to guide the Secretary of State and the Planning Inspectorate in their consideration of applications for GDF development.

And it's not only government policy that has changed since the last siting process - RWM has grown over the past few years and has been busy supplementing its science, engineering and research expertise by increasing its corporate capability in communications, community engagement and programme management as it enters a new phase of delivery. RWM's attention will now turn to a dedicated stakeholder and public engagement campaign. This will see various public, political and business groups (including academics, civil society, land owners, local authorities and community organisations) engaged in an effort to raise awareness, build understanding and encourage interested parties to find out more about the realities of geological disposal and what a GDF could mean for their area and their communities.

Even in the six months since the launch of the new Working with Communities policies, RWM finds itself constantly challenged within the public arena via the press, social media and community forums about plans to tackle radioactive waste in the context of energy policy, industrial strategy and climate change. As the public body tasked with implementing government policy on geological disposal RWM is just at the start of a 150 year journey which will ultimately see a GDF established where it is safe to construct and operate and where a community has given their explicit consent to host it.

For further information see <https://www.gov.uk/government/organisations/radioactive-waste-management>

## News

### Posiva starts construction of encapsulation plant in Olkiluoto



Posiva has decided to implement the production facility which is designed for spent fuel handling and consists of the encapsulation plant and the final disposal facility. In addition to construction of the encapsulation plant, the rooms that have already been excavated in ONKALO® shall be equipped with the systems needed for starting the final disposal.

According to Posiva's President Janne Mokka, the Finnish nuclear power industry can take pride in this decision which also means that safe final disposal will start first in the world in Olkiluoto. "In Finland, full lifecycle management is a precondition for the production of climate-friendly nuclear electricity. Posiva will execute the final disposal of the spent fuel of its owners' Olkiluoto and Loviisa nuclear power plants responsibly", Mr. Mokka says.

The cost estimate of this large-scale construction project implemented in the municipality of Eurajoki in the province of Satakunta totals ca. 500 million EUR and it has an employment impact of ca. 2500 person years.

"The very significant project we are about to launch covers the encapsulation plant as a whole, the systems which are needed to begin final disposal, the operating licence process, and preparations for the supply chains required for the production stage of the facility.

The multi-disciplinary project must be founded on world-class expertise.

Carrying out this project successfully requires the expertise developed during the last four decades as well professionals in project management and various partners. We expect to award contracts for the most significant works in the near future", Mr. Mokka explains.

For further information see: <http://www.posiva.fi/en>



*Illustration of the final disposal facility (Posiva Oy).*

## IGD-TP Exchange Forum 8 - Summary

The IGD-TP's eighth Exchange Forum was a great success with over 140 attendees from 21 different countries. Our host, BMWi, provided a superb venue and welcoming environment that facilitated an excellent array of presentations and a great deal of discussion and networking. A brief summary of the scope, objectives and outcomes of EF8 is provided here - but please visit our website for further information, and copies of the presentations and posters.



EF8 was a two-day event with a dual focus. The first day was dedicated to the European Joint Programme on Radioactive Waste Management (EURAD). Representatives of the future EURAD Project Management Office (PMO) led sessions dedicated to:

- Presenting the R&D topics, strategic studies and knowledge management activities that comprise the initial scope of EURAD.
- Presenting the shared EURAD Strategic Research Agenda (SRA) and its future development.
- Updating the community on the expected EURATOM Call WP2019-2020.

The change to a Joint Programme approach for EC-funded research means that the IGD-TP Executive Group will now focus more intently on direct implementation-related opportunities for collaboration between members and their common research needs that sit outside of the scope of the EURAD programme and its governing SRA. Therefore, the IGD-TP Executive Group led sessions on the second day of EF8 that aimed to:

- Communicate the changing needs and drivers for radioactive waste management research (in light of the complimentary and parallel EURAD project).
- Update IGD-TP members on the platform's activities during 2017 and 2018.
- Collectively explore collaborative opportunities for implementation-related research projects that are complementary, but separate to, the common areas of interest being addressed via EURAD. Initially, for EF8, this was undertaken by discussing the current status, challenges and potential solutions in three specific technical topic areas in dedicated parallel breakout sessions.

We structured the event to act as a transition between the previous IGD-TP Exchange Forums and our traditional way of operating (i.e. working groups to develop scope for future EC calls) to our future revised remit, following the expected initiation of an inclusive and enduring European Joint Programme in the area of radioactive waste management.

The main IGD-TP aim of EF8 was to help to prepare for future collaborative implementation-related RD&D that is complimentary to EURAD activities and which can be progressed in parallel.

### Summary and Outcomes

#### Day 1

Following the welcome from the IGD-TP Chair, Jon Martin (RWM), Ursula Borak of BMWi gave an excellent summary of the national radioactive waste management policy and its implementation in Germany.

Christophe Davies (EC) then presented initial EC views of the EURAD proposal, summarised the current status of the EURATOM programme, and highlighted the Euratom Call on "Developing pre-disposal activities identified in the scope of the European Joint Programme in RWM". It was also announced that EURADWASTE'19 would be held on 4-7 June 2019 in Pitesti, Romania, the 9<sup>th</sup> EC conference on EURATOM research and training in radioactive waste management.

The remainder of the Day 1 presentations then informed EF8 attendees on the scope and objectives of the EURAD project. This commenced with an overview of EURAD and and its organisation by Marie Garcia (Andra), and was then followed by presentations on each of the seven RD&D work packages, the two strategic study work packages, the knowledge management activities and the anticipated interactions with civil society. The EURAD session then concluded with a summary of the current status of the EURAD SRA and its future development by Tara Beattie (MCM), and presentations by representatives of each of the three proposed EURAD Colleges, one each for the research entities (REs), technical service organisations (TSOs) and the WMOs.



#### Poster Session

Following the end of the EURAD day, an informative and lively poster session was held. 28 posters were presented covering the range of the IGD-TP SRA, with 15 posters directly connected with the three IGD-TP technical topics. All poster abstracts and, where available, copies of the posters, can be downloaded from our website. >>

## IGD-TP Exchange Forum 8 – Summary (continued)



### Day 2

The second day was chaired by the IGD-TP Executive Group. The incoming IGD-TP Chair, Irina Gaus (Nagra), reflected on the current research needs of the IGD-TP, achievement of our vision, how the IGD-TP and its relationship with the EURATOM programme has changed and the needs and drivers of WMO research programmes. She then focussed on the changing role and remit of the IGD-TP and our next steps.

Jon Martin (RWM) discussed the preliminary list of RD&D topics identified by the Executive Group that are of interest to WMOs but are outside the scope of the EURAD project – such topics may be outside the current and future scope of EURAD for many reasons, for example:

- The scope is such that it would be inappropriate to collaborate with regulatory bodies due to a perceived conflict of interest.

- The topic area/scope of interest did not gain consensus with other EURAD actor groups (i.e. the topic is not of sufficient common interest).
- The required work is too time critical to be addressed by the ongoing joint programme.
- The required work is of WMO interest/significance, but is not deemed to be sufficiently cutting edge for inclusion in a EURATOM-funded project.

For EF8 the Executive Group selected three topics from the list to focus on in dedicated break-out sessions. The scope of each topic session and the session outcomes, as presented to the full EF8 audience, are summarised below.

### **Technical topic 1: “Technical issues in support of retrievability”**

This session addressed scientific and technical knowledge and potential issues associated with the implementation of retrievability as well as related RD&D drivers. This included the ability to model and monitor the evolution of waste packages and disposal rooms over time during the operating period, the technical provisions that can be included in the design to enhance retrievability, and the retrieval techniques.

Jean-Michel Hoorelbeke (Andra) summarised the presentations and discussions held. Four presentations were given by representatives from Andra, BGE TEC, RWM and SKB, which demonstrated international experience in:

- removal of concrete buffer (UK);
- removal of bentonite backfill and buffer (Sweden);
- removal of salt or other material (Germany); and
- retrieval of waste packages (France; Germany; Sweden).

Three next steps were identified in the technical session:

- To collate and formalise the current state of the art to form a technological toolbox to support international knowledge sharing;
- To progress and share information on retrievability scenarios and risk analysis; and
- To assess the possibility of a common demonstrator programme within EURAD2 or the IGD-TP.



### **Technical topic 2: “Heat generating waste containers”**

This technical topic focussed on reviewing the technology readiness and development of alternative ‘next generation’ disposal container materials/designs. The session aim was to highlight the state-of-the-art in container materials and design, covering ceramic containers, supercontainer concepts and alternative candidate container materials, and to develop areas of commonality in terms of future WMO RD&D needs.

Michelle Cowley (RWM) reported that this session included extensive representation from WMOs, very helpful contributions from TSOs and active contributions from REs, and had representatives from 12 countries. Three presentations were provided by WMO representatives, covering ceramic containers (Andra), coated containers (Nagra) and supercontainers (ONDRAF/NIRAS), with active discussion following each presentation. The session concluded that:

- ceramics are promising but represent a significant challenge due to their low technology readiness level;
- the opportunity to drive ceramics development forward at pace is through industry collaboration;
- there is an opportunity to create adaptable designs;
- understanding other factors (e.g. heat, legal requirements) also needs to be considered in container development;
- coated containers were considered to be the most transferrable across different host rocks;
- the majority of the session attendees were supportive of further discussion on container coatings;
- it was agreed to hold a follow-up meeting to discuss concepts that include ceramics and coated containers. >>



## IGD-TP Exchange Forum 8 – Summary (continued)

### **Technical topic 3: “Progress in site investigation and characterisation techniques”**

This technical session sought to address aspects of advanced site characterisation techniques and identify topics for potential knowledge transfer towards emerging programmes. It covered investigation and modelling of the biosphere and geosphere according to typical higher-strength rock and lower-strength sedimentary rock repository requirements. It also addressed the process for site selection before and after advanced site characterisation, and site characterisation during construction and operational phases.

As summarised by Bernd Frieg (Nagra), this session included five presentations on site characterisation in national programmes across the spectrum of GDF implementation stages:

- Site characterisation in the Hungarian early-stage programme (Puram);
- Preparation for site characterisation in the UK: a needs-driven exercise (RWM);
- Site characterisation in the final stage of selecting the site in sedimentary clay rock in Switzerland (Nagra);
- Site characterisation in the Swedish crystalline rock before and after submitting the construction licence (SKB);
- Site characterisation in the French sedimentary/clay rock programme, close to construction licence submission (Andra).



It was concluded that knowledge transfer is the key area to develop in the future, but this first needs the requirements to be refined by those planning to use the knowledge. Possible options suggested to enable knowledge transfer included secondments in more advanced programmes, holding workshops, creating an expert network, and web-based activities (e.g. webinars, platform discussions, WhatsApp groups). It was recommended that knowledge transfer in the area of site characterisation and investigation is a topic addressed in the EURAD knowledge management activities.

### **Panel Session**

Irina Gaus led a panel discussion on linking WMO RD&D programmes at different stages with the IGD-TP. Presentations were given on five national WMO programmes at various stages, summarising their current programme stage, highest RD&D priorities and their RD&D drivers:

- Denmark, representing an early stage programme that is not currently an IGD-TP member (DEKOM);
- The Netherlands, representing an early stage programme (COVRA);
- Switzerland, a mid-stage programme (Nagra);
- Sweden, an advanced-stage programme (SKB); and
- Finland, an advanced-stage programme (Posiva/SKB).

The discussion focussed on how knowledge can be maintained and transferred over the long lead times and operational periods expected for the various national programmes, and how much and what RD&D is needed at each programme stage. The point was also made that knowledge transfer is necessary between advanced national programmes, as well as between advanced and small/early-stage programmes. It was suggested that the IGD-TP could help to record and collaboratively share information between WMOs to ensure it is not lost, particularly as issues may be considered closed and then reopened in the future.

Following active and informative discussion over the two days, EF8 was closed by Jon Martin, with thanks to all the presenters, organisers and our host, BMWi.





## Technical Projects

### Modern2020 International Conference



Modern2020 organised the 2<sup>nd</sup> international conference on Monitoring in Geological Disposal of Radioactive Waste, 9-11 April 2019, Paris, France. This conference was a great opportunity to find out main results and achievements of the Modern2020 project and to invite experts - through a Call for Abstracts - to contribute to and participate in discussions on monitoring strategies, monitoring technologies, on how monitoring is used to support decision-making during the operational phase of a disposal facility and on how monitoring can contribute to confidence building in relation to the geological disposal of radioactive waste.

Modern2020 in figures... There were 150 participants, 90 organisations, 15 countries, 43 oral speakers and 30 Posters!



All the conference presentations are available at: <http://www.modern2020.eu/final-conference/presentations.html>

### CHANCE Second General Assembly



On May 20<sup>th</sup> and 21<sup>st</sup>, the second CHANCE General Assembly took place and was kindly hosted by KEP Nuclear in Lyon, France.

During this meeting the general progress of the CHANCE project was discussed with the meeting participants.

At the meeting, it was also announced that one project partner, Forschungszentrum Jülich GmbH, will be withdrawing from the project as of 31<sup>st</sup> May 2019. The other project partners discussed and aligned the redistribution of work caused by this withdrawal.

The meeting ended with a visit to the laboratories of KEP Nuclear, where the new-built large-scale calorimeter could be admired which will soon be dispatched to CEA (France) and SCK•CEN (Belgium) as part of the WP3 work plan.



For further information see: [www.chance-h2020.eu/](http://www.chance-h2020.eu/)

## Technical Projects - CEBAMA

### JA6 - Confidence Increase in Safety Codes: Material Interaction

CEBAMA



CEBAMA was a research and innovation action granted by the EC within the HORIZON2020 programme in support of the implementation of the first-of-the-kind geological repositories. The 4-year project started on the 1<sup>st</sup> of June 2015 and lasted until 31<sup>st</sup> May 2019. It was carried out by a consortium of 27 partners consisting of large Research Institutions, Universities, one Technical and Scientific Support organisation (TSO), and one small-medium enterprise (SME) from 9 EURATOM Signatory States, Switzerland and Japan. The IGD-TP and the national Waste Management Organisations supported CEBAMA, for instance by co-developing the work plan, participating in the End-User Group, granting co-funding to some beneficiaries, and providing for knowledge and information transfer.

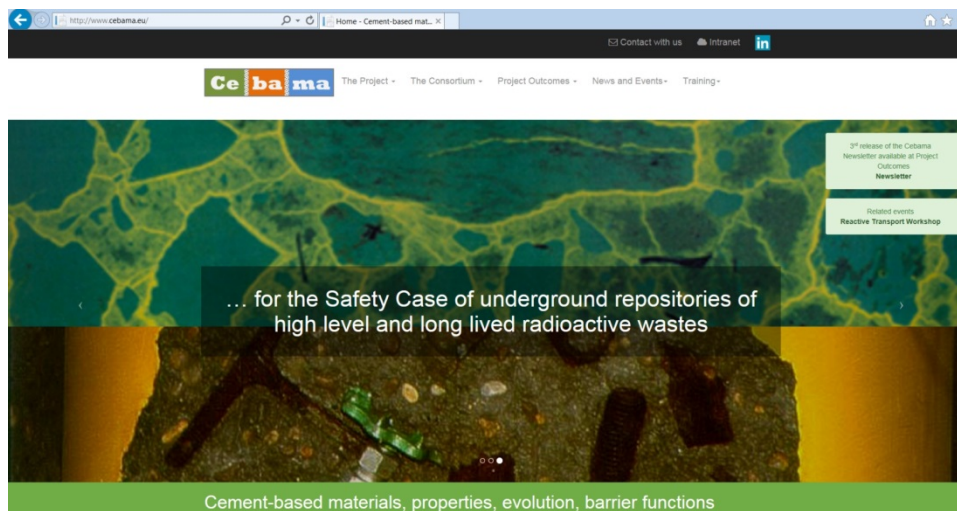


Fig.1: CEBAMA project website at [www.cebama.eu](http://www.cebama.eu).

The aim of CEBAMA was to clarify remaining issues pertaining to the use of cement-based material in nuclear waste disposal applications. R&D in CEBAMA was largely independent of specific disposal concepts and addressed different types of host rocks, as well as bentonite. CEBAMA did not focus on one specific cementitious material, but aimed to study a variety of representative cement-based materials for nuclear waste disposal in order to provide insight on general processes and phenomena which can then be transferred to different applications and national and international projects.

Specific objectives and research activities of CEBAMA are summarised as follows:

- Experimental studies analysing interface processes between cement-based materials and potential host rocks (crystalline rock, Boom Clay, Opalinus Clay (OPA), Callovo-Oxfordian (COX), Toarcian mudstone, Borrowdale Volcanic Group) or bentonite backfill, and assessing the impact on physical and chemical properties.
- Investigation of radionuclide retention and migration processes in high pH cementitious environments, focusing on radionuclides which have high priority from the scientific and applied perspective (Be, C, Ca, Cl, I, Mo, Ra, Se, Tc).
- Improved validity of numerical methods to predict changes in transport processes as a result of chemical degradation, including advanced data interpretation and process modelling.

The studies performed in CEBAMA progressed the state of the art in this field, e.g. by including the use of new methodological approaches to study changes in microstructure and impact on transport properties. Advanced modelling approaches have been developed which allow predicting the transport characteristics such as porosity, permeability and diffusion parameters of cement-based materials in contact with the engineered and natural barriers of repositories in crystalline and argillaceous host rocks and the retention of radionuclides by cement-based materials. >>

## Technical Projects – CEBAMA (*continued*)

>> CEBAMA has produced a huge number of new scientific results and generated knowledge potentially impacting the nuclear waste disposal Safety Case. For instance, CEBAMA influences several design issues and safety assessment issues, accounting for evolution of the repository system. With the view on radionuclide retention, the results can be used in particular by WMO, TSOs or regulators for the evaluation and assessment of radionuclide migration in cementitious repository near fields. Regarding modelling, CEBAMA increases the level of confidence in reactive transport models for further use in near-field applications. The project provided improved reactive transport modelling tools to quantify how bentonite barrier or clayey host rocks could affect the integrity of normal and selected low-pH cementitious materials. CEBAMA thus enhanced the publicly available knowledge on the performance and reliability of the barrier systems for nuclear waste repositories.

Detailed information on results generated in CEBAMA is available at the project website ([www.cebama.eu](http://www.cebama.eu)), including a list of peer-reviewed publications and integrated summary reports defined as public deliverables.

The experimental and modelling work in CEBAMA was to a significant extent performed by young researchers and within PhD theses. This contributes to the continuing availability of highly trained specialists for implementers and regulators throughout Europe. CEBAMA has contributed to European integration by bringing together experts from several European member states. The involvement from experts coming from countries at very different stages of implementation likewise poses a positive achievement, for instance in view of sharing of expertise and resources and integrating new member states.



Fig.2: Attendees to the Final CEBAMA Workshop, held in Karlsruhe, Germany, March 2019.

Further information is available at: <http://www.cebama.eu/>

*The research leading to these results has received funding from the European Union's European Atomic Energy Community's (Euratom) Horizon 2020 Programme (NFRP-2014/2015) under grant agreement, 662147 – Cebama.*



## Technical Projects - MIND

### *JA6 - Confidence Increase in Safety Codes: Material Interaction*

#### MIND



Microbiology in Nuclear waste Disposal (MIND), which finished in May 2019, was an interdisciplinary project consisting of two experimental work packages and a third one that handled integration of society and policy-oriented studies.

Work package 1 focused on the influence of microbial processes on organic containing long-lived Intermediate Level Waste (L/ILW) forms (e.g. waste solidified with cement or bitumen). In work package 2 the influence of microbial processes on high level waste (HLW) and spent fuel geological disposal was studied. The emphasis was on quantifying specific measurable impacts of microbial activity on processes and the long-term performance of the system with its barriers under repository-relevant conditions to be considered in safety cases. Work package 3 was oriented towards interaction within (by e.g. sharing experience and results with other experts) and between different groups, including both experts and the civil society, through education and communication and thereby improving the general awareness of microbial issues.



MIND investigated the impact of microbial processes on organic material in cementitious waste forms and the impact of their behaviour on the technical feasibility and long-term performance of repository components, including clay and canister materials. Research focussed on key questions posed by waste management organisations. Overall, many experiments were conducted providing further insights into different microbial processes that can be expected during geological disposal of radioactive waste. Chemical conditions that may limit methanogenesis and hydrogen consumption in LLW/ILW repositories were elaborated on in more detail. The research related to  $H_2$  consumption by sulphate reduction processes is also of relevance to microbial induced corrosion of metal canisters. In addition, the knowledge base concerning the range of organic polymers and additives that may contribute to gas generation from LLW/ILW, including the combined effects of irradiation and biodegradation under alkaline conditions, was increased.

Further knowledge was also obtained regarding the biodegradation of potential radionuclide complexants, including ISA under alkaline conditions. Furthermore, several experiments showed that enhanced microbial activity could result in solid partitioning of radionuclides, which could affect their mobility in ground water. The different experiments resulted in a more detailed understanding of microbial activity in backfill material and bentonite buffers. In addition to the experimental work, the MIND project spent a lot of time on education and communication. All the expertise gathered within the project was summarised in annual synthesis report deliverables [D3.1, D3.4, D3.5], which are valuable for waste management organisations to define further knowledge gaps that could be considered in future projects.

## Technical Projects – MIND (*continued*)

*JA6 - Confidence Increase in Safety Codes: Material Interaction*

**MIND**



The evaluation report deliverable [D4.6] by the end user group concludes that MIND has been invaluable to assemble the competence on microbiological issues of relevance to repository safety and has helped to clarify what issues are of potential importance to the safety case and what is primarily of scientific interest. Thereby the outcomes from MIND form an essential platform for how further efforts should be prioritised.



### **Acknowledgement**

All MIND partners (TUL, CVREZ, UKRI, UniMan, EPFL, UGR, HZDR, VTT, GTK, Posiva, TVO, NNL, Micans, SCK•CEN, SKB) are acknowledged for their contribution in making this project successful. The partners are grateful for the input on the work from the Implementers review board (IRB). This project received funding from the Euratom research and training programme 2014 - 2018 under grant agreement No. 661880.

For further information see: <http://www.mind15.eu/>

## Technical Projects - THERAMIN

### JA1b - Thermal Treatment for Radioactive Waste Minimisation and Hazard Reduction

## THERAMIN



The HORIZON 2020 EURATOM Collaborative Project “Thermal treatment for radioactive waste minimisation and hazard reduction (THERAMIN)” has received funding from the European Union’s Horizon 2020 Euratom research and innovation programme under grant agreement No 755480. THERAMIN is a three year project, which started in June 2017. Project partners represent industrial technology providers, waste management organisations, consulting companies and research and development organisations from seven EU member countries. The members of the End User Group primarily represent companies responsible for radioactive waste management.



The primary objective of the THERAMIN project is to increase awareness, understanding and confidence in the application of thermal treatment processes to enable safe long-term storage and disposal of low and intermediate level radioactive waste streams (i.e. LLW and ILW). The project provides tools for coordinated EU-wide research and technology demonstration designed to improve understanding and optimisation of the application of thermal treatment in radioactive waste management programmes across Europe. In addition, the project improves the technology readiness level (TRL) of these technologies to accelerate industrial implementation.

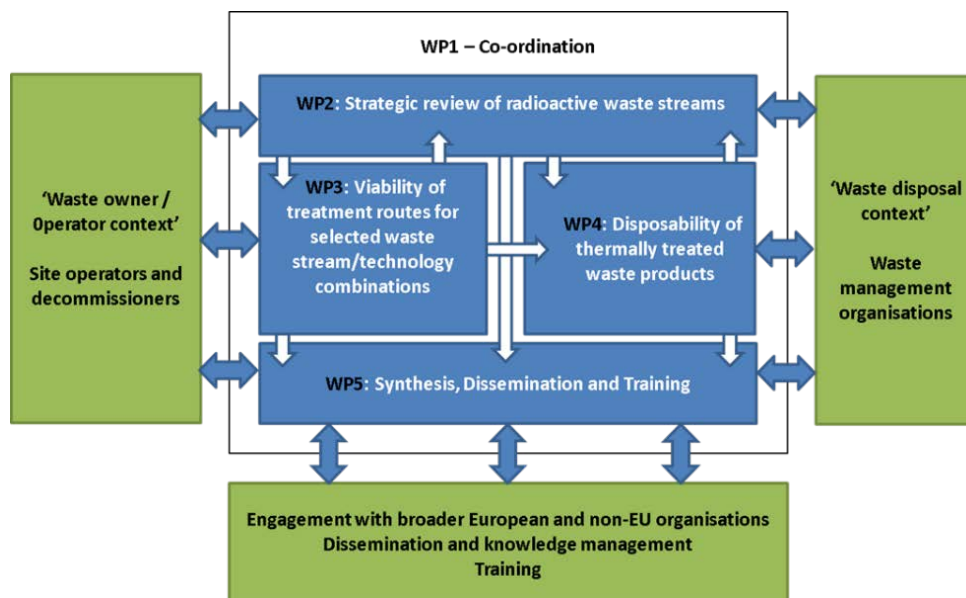


Fig 1. Relationship between THERAMIN work packages, showing engagement with various stakeholders.

In the first two years, the THERAMIN project has focused on following topics:

- Strategic review of waste streams suitable for thermal treatment, availability and planned development of thermal treatment technologies and preparation of a viability matrix of waste streams and potentially applicable treatment processes.
- Demonstration of selected treatment technologies (on real and simulated waste materials).
- Identification of criteria and requirements for the disposability of thermally treated waste products.
- Characterisation of thermally treated waste products and secondary waste.
- Dissemination of the results of the project.

More information on the work packages shown in Figure 1 and public deliverables featuring additional technical details are available via the THERAMIN website: <http://www.theramin-h2020.eu>



## Technical Projects – THERAMIN (continued)

>> The project has organised training secondments for students and professionals interested in the practical application of thermal treatment technologies; these were arranged during the WP3 demonstration trials to maximise technical learning opportunities. Training secondments were hosted by CEA, the University of Sheffield and VTT.

A summer school, hosted by the CEA at Marcoule in June 2019, was attended by 22 participants (largely early career researchers and PhD students from the Project Partners and End Users). Presentations were given on the toolbox of treatment and characterisation approaches demonstrated in the project and participants had the opportunity to visit industrial and prototype thermal treatment facilities operated by CEA and Cyclife-EDF.

In February 2020 THERAMIN will host a conference in Manchester (UK) to share the results of the project and other recent developments in the field of thermal treatment of radioactive waste.

The conference is open to the public, industry, waste managers and researchers interested in the development or application of thermal treatment of radioactive waste.

Registrations are now open and we welcome contributions on the following themes:


- Strategic impact of thermal treatment
- Demonstration of thermal treatment technologies
- Disposability of thermal products
- Characterisation techniques

Registration, further information and details for submission of abstracts are available on the THERAMIN website:

<http://www.theramin-h2020.eu/conference.htm>.



Fig 2: Poster session at the THERAMIN technical training school in Le Visiatome, Marcoule, 12-14<sup>th</sup> June 2019.



### theramin 2020 conference

### thermal treatment of radioactive waste

**MECHANICS INSTITUTE, MANCHESTER**  
**TUESDAY 4<sup>TH</sup> TO WEDNESDAY 5<sup>TH</sup> FEBRUARY 2020**  
 Plus optional visit to University of Sheffield on Thursday 6<sup>th</sup> February 2020

**First announcement and call for abstracts**  
 The EC project theramin (thermal treatment for radioactive waste minimisation and hazard reduction) will host a conference to share the results of the project and other recent developments in the field of thermal treatment of radioactive waste. Abstracts are invited for presentations (oral or poster) relating to the following themes:

- Strategic impact of thermal treatment
- Demonstration of thermal treatment technologies
- Disposability of thermal products and characterisation techniques

Contributions from organisations that have not been directly involved in the theramin project, including those from outside Europe, are warmly welcomed. A range of perspectives will lead to interesting discussions and potential future collaborations.

The conference will also include a poster session and a formal dinner at the Manchester Conference Centre.

**The deadline for submission of abstracts** is 27<sup>th</sup> September 2019. On acceptance of your abstract, a full paper will be requested for inclusion in the conference proceedings.

**Registration**  
 Registration costs £150, including refreshments and the conference dinner. Fees are waived for theramin Partner organisations.

EC funding is available to support attendance for a limited number of participants (students, early career researchers or others unable to access alternative sources of funding, on a first-come, first-served basis)

Please go to the **theramin** website for more details on the agenda and abstract requirements and to register via the University of Sheffield webshop:  
<http://www.theramin-h2020.eu/conference.htm>

**Accommodation**  
 Accommodation is not included in the registration fee but will not be difficult to find in central Manchester. The Pendulum Hotel is attached to the conference dinner venue and the Mechanics Institute is a few minutes' walk (0.3 miles).

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 Neil Hyatt (n.c.hyatt@sheffield.ac.uk)

**Anthony Banford** (anthony.w.banford@nml.co.uk)

Fig 3: The Theramin2020 conference will be held in Manchester, UK, in February 2020.

Further information is available at: <http://www.theramin-h2020.eu>

The THERAMIN project has received funding from the European Union's Horizon 2020 Euratom research and innovation programme under grant agreement No 755480.

## Meeting Announcements

	<p><b>Grimsel Training Centre: In-situ Testing and Hydraulic Characterisation in URL Course</b>  Date: 9-14 September 2019  Location: Grimsel Test Site, Switzerland</p>
	<p><b>11th International Conference on Nuclear Criticality safety (ICNC)</b>  Date: 15-20 September 2019  Location: Paris, France</p>
	<p><b>Integration Group for the Safety Case (IGSC) Symposium 2019</b>  Date: 8-10 October 2019  Location: Paris, France</p>
	<p><b>School of Geological Disposal - Basis for Developing Safe Geological Disposal</b>  Date: 14-18 October 2019  Location: Äspö Hard Rock Laboratory, Sweden</p>
	<p><b>43rd Annual Symposium on the Scientific Basis for Nuclear Waste Management</b>  Date: 21-24 October 2019  Location: Vienna, Austria</p>
	<p><b>DECOVALEX Symposium on Coupled Processes in Radioactive Waste Disposal and Subsurface Engineering Applications</b>  Date: 4-5 November 2019  Location: Brugg, Switzerland</p>
	<p><b>THERAMIN Conference 2020</b>  Date: 4-5 February 2020  Location: Manchester, UK</p>
	<p><b>Waste Management 2020</b>  Date: 8-12 March 2020  Location: Phoenix, USA</p>
	<p><b>Third BEACON Annual Project Meeting</b>  Date: 13-14 May 2020  Location: Liege, Belgium</p>
	<p><b>Clay Conference 2020</b>  Date: 8-11 June 2020  Location: Nancy, France</p>