NEWSLETTER

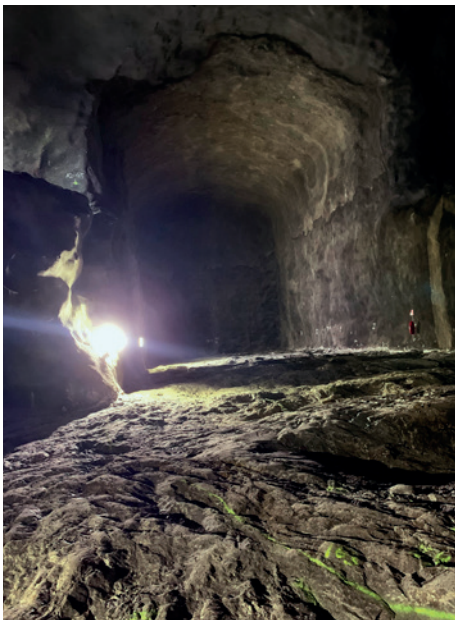
IGD-TP Newsletter
Issue #10, October 2020

safe solutions for radioactive waste

Editorial News

Irina Gaus, Chair

We have reached a milestone with the IGD-TP. Our vision, formulated in 2009 when the IGD-TP was founded, is now within reach. This is a clear sign that progress is being made in our field. It also means that new goals need to be formulated for the next decades in order to continue providing safe solutions for radioactive waste disposal. The IGD-TP WMOs agreed on these goals in the last year through formulation of our 2040 vision, reaching out to other European WMOs, both large and small and with programmes in the initial and more advanced stages, to support us in this endeavour. A common vision is already one achievement, but agreeing on how to get there is another. I would therefore particularly like to thank the Strategic Research Agenda Working Group within the IGD-TP that has worked intensively to develop our new Strategic Research Agenda (SRA) that supports our new vision. This required many interactions, initially in smaller groups but gradually widening to include all interested European WMOs, bringing us to the document that is now available and announced in this newsletter.



Onkalo, visit October 2019

This SRA document is now our reference as to where we, as the implementing organisations, see our joint RD&D priorities. The SRA has multiple objectives: developing IGD-TP projects, helping to formulate EURAD initiatives, and informing waste management communities inside and outside Europe. In the course of developing the SRA, we also experienced the progress and increasing optimism in our community, despite the inherent sensitivities associated with radioactive waste disposal. With several decades of development now behind us, geological disposal projects are moving more towards multi-decade construction and operation projects – where safety is of course the first driver – but also where optimisation of all aspects takes a more prominent role. Our planning has become more realistic, the projects more detailed, and the description of the evolution of the repository over the long timescales, during which society has to be kept safe from the radioactive waste, far more robust.

The IGD-TP is not the only organisation that has identified this progress. In its recently published Deep Geological Repository report, the NEA states in its conclusions that: "... it can be expected that experience and knowledge will increase allowing development of DGRs in other countries potentially at a faster pace than experienced for these initial facilities". This "learning effect", known from many other prototype and first-of-a-kind projects, can be significant. Collaboration between European countries can enhance their global leadership in the field of geological disposal even further.

Finally, we would like to congratulate EURAD on its first anniversary this summer. Integrating the mandated actors and establishing the structures was a huge challenge. The "learn-as-you-go" approach proved successful and the IGD-TP supported EURAD wherever possible. It is important that EURAD now evolves as the platform where scientific state-of-the-art and consensus are reached, identifying new topics but also recognising where science has matured to such a degree that efforts should now be targeted elsewhere. EURAD is expected to evolve into an important pillar of confidence in providing solutions for radioactive waste disposal. Despite the pandemic we continued to collaborate remotely in an efficient manner. We wish all our readers a safe journey through this COVID19 troubled period.

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Editorial team of the Secretariat of IGD-TP (I. Blechschmidt and T. Baldwin) and project co-ordinators

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What has been achieved?

Strategic Research Agenda 2020 – now published!

In the decade since the IGD-TP was launched, geological disposal in Europe has progressed such that the aims of its original vision are expected to be achieved: Posiva and SKB are on course to establish operational geological disposal facilities (GDFs) in Finland and Sweden, respectively, with Andra (France) not far behind. To reflect this progress, an updated vision, Vision 2040, was announced in 2019. The new vision is intended to reflect the different stages of the various IGD-TP member organisations with respect to implementation of geological disposal, and to include the Small Inventory Member States (SIMS) and those who may wish to pursue the possibility of shared repositories. Vision 2040 sets out details of the vision for the industrialisation of radioactive waste disposal in Europe by 2040, via three pillars: (1) safe operation of the first geological disposal facilities in Europe; (2) optimisation and industrialisation of planning, construction and disposal operations; and (3) development of tailored solutions for disposal of the diverse radioactive waste inventories in Europe.

2040 – Towards industrialisation of radioactive waste disposal in Europe		
Safely operate	Optimise & industrialise	Tailor solutions
the first geological disposal facilities in Europe	planning, construction and disposal operations	for disposal of the diverse waste inventories in Europe

IGD-TP Vision 2040 – announced 2019

Consequently, the IGD-TP Strategic Research Agenda (SRA) has been updated to reflect progress made since its 2011 publication, and to identify the collaborative RD&D activities needed to achieve Vision 2040. The 2020 SRA has been produced by an IGD-TP SRA Working Group with representatives from the IGD-TP's member waste management organisations (WMOs). IGD-TP Executive Group members and non-member European WMOs were consulted and encouraged to contribute to the content of this revision of the SRA, by being given the opportunity to suggest research topics of high priority to their particular national context or organisation and to prioritise the research topics. In this way the 2020 SRA has been produced to identify the RD&D needs and opportunities that are of common interest to European WMOs.

The priorities of RD&D depend upon the national radioactive waste inventory, host rock geology, national context and/or legislation, and the stage of the programme's lifecycle – and these priorities change as the programme progresses. RD&D effort is therefore necessary throughout the entire lifecycle of radioactive waste management and disposal programmes in order to ensure optimisation of management routes in general and of disposal solutions in particular, as well as to comply with EC Waste Directive obligations. RD&D must also continue in order to address evolving societal and regulatory concerns.

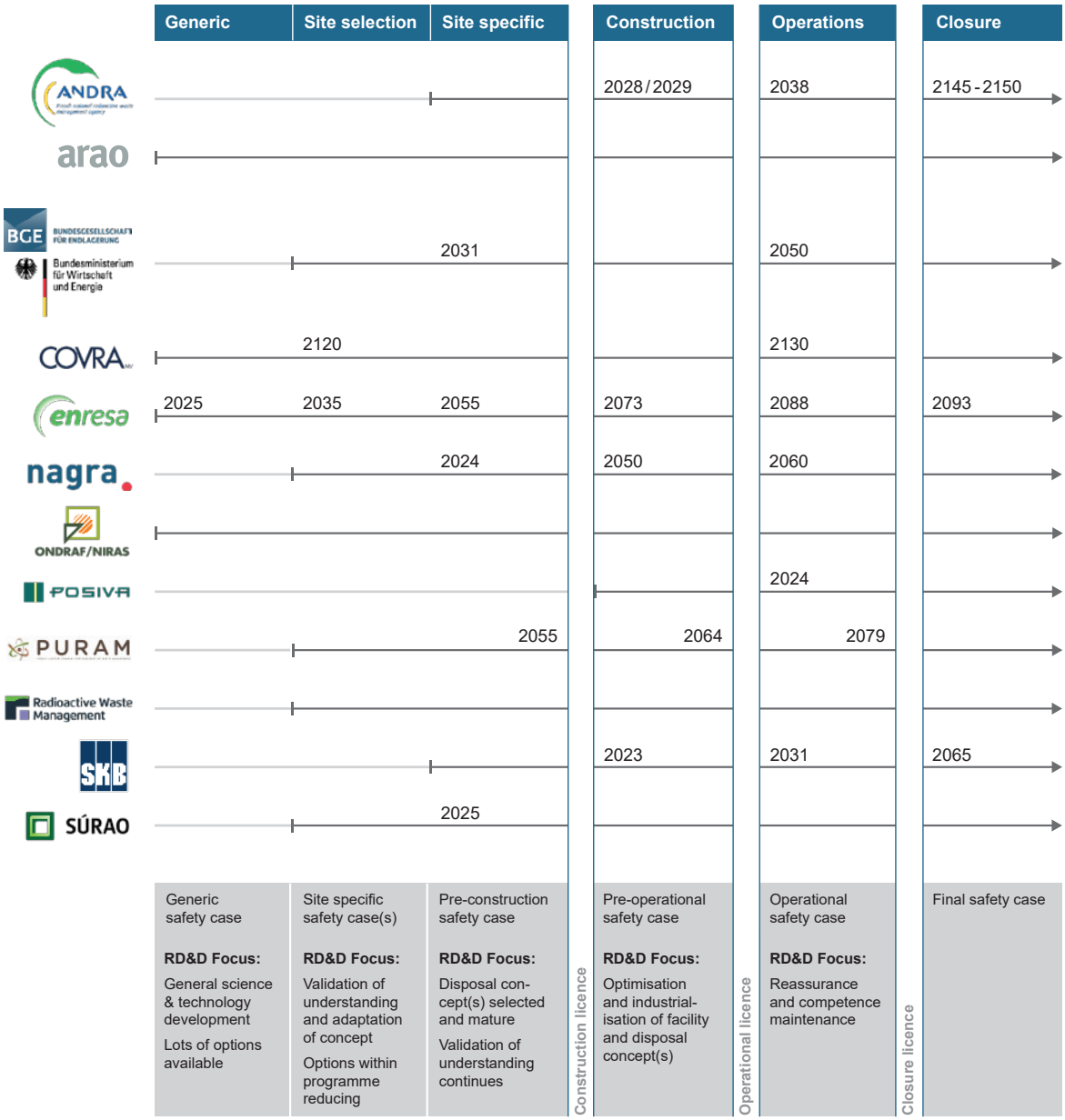
Maarten Van Geet, RD&D Manager at ONDRAF/NIRAS

The update of the SRA demonstrates the needs of R&D for all implementers of geological disposal facilities, independent of the maturity of the programme, and the wish of all of us to collaborate.

… and where to go from here?

As representatives of the implementers of geological disposal in their respective nations, the IGD-TP Executive Group asserts that a sustained, coordinated and collaborative RD&D programme in the area of radioactive waste management and disposal is vital to ensure that all European countries, at various levels of advancement, continue to progress towards implementation of geological disposal. RD&D will not stop following successful implementation but will continue during the construction and operational phases. The same level of RD&D effort will not be applied continuously; it will need to be adapted and re-prioritised as national programmes progress and needs evolve.

Therefore, the SRA has been produced to present the common research needs of the WMOs in order to support identification of future collaboration opportunities and priorities. The research topics presented are those where there are commonalities between several WMOs (but not necessarily all WMOs given their different research needs and stages of implementation) and where collaboration is desirable, uncertainties are highest, and/or important progress can be made. The SRA is a document for communicating the WMO research needs and opportunities to stakeholders in the waste management community, and it is also an instrument for creating synergies, co-operation and co-ordination with activities taking place in other international co-operation fora.



Some organisations do not assign dates as their process is responsive to the local communities involved.
The dates that are presented are current as of July 2020 and are subject to change.

Overview of European DGR Maturity and Associated RD&D

Update from the Members – Posiva

Posiva is living very exciting times in its DGR programme for spent nuclear fuel. Posiva is constructing the above- and underground facilities, is preparing to submit an application for an operating licence and is also preparing for operation of the final disposal facility for spent nuclear fuel. To construct the facilities, to prepare for their operation and to compile and apply for the operating licence, Posiva launched "EKA" project, with a cost estimate of 500 M€ and equivalent employment of approximately 2,500 person-years.

The Finnish Government granted to Posiva the construction licence of the encapsulation plant and the final disposal facility in November 2015. The construction of the final disposal facility started in 2016. The underground works have progressed by:

- constructing vehicle access and central tunnels leading to the first deposition tunnels;
- installing heating, ventilation and air-conditioning equipment into the tunnels;
- raise-boring and reinforcing the canister shaft;
- equipping the canister and personnels shafts; and
- constructing the canister receiving station and storage to the deposition level in the final disposal facility.

The construction of the first deposition tunnels has been started by boring their pilot holes.

Tiina Jalonen, Director at Posiva

Tiina, sitting in a real size copper canister, is happy about the progress of Posiva's deep geological disposal program for spent nuclear fuel.

Construction in Posiva's final disposal facility is ongoing, photo Posiva Oy

Construction of the encapsulation plant at ONKALO® site, photo Posiva Oy

Update from the Members – Posiva

Before final disposal of spent nuclear fuel starts in the mid 2020's, a pilot operation to investigate and prove the functioning of the whole system will be carried out. This pilot consists of:

- encapsulation of "dummy" fuel elements into four canisters;
- transferring each canister underground via the canister shaft to the final disposal facility;
- installing each canister with a canister transfer and installation vehicle into a deposition hole lined with bentonite buffer;
- installing the rest of the buffer on top of the canister;
- backfilling the tunnel with a granular backfill installation system; and
- casting a deposition tunnel end-plug to close the tunnel. This massive test, lasting for about one year, will be open through Posiva Solutions Oy for international participants who wish to learn from the process by following it and taking part. Such participation was successfully implemented also in the previous stage test, Full scale In-Situ System Test (FISST).

Casting of the end plug of the Full-scale In-situ System Test, photo Posiva Oy

Construction of the encapsulation plant has progressed from foundation excavations to construction of the plant. Now the building has reached a few metres above ground, to the level where the encapsulation process will be located. The photo (at the previous page) of the ongoing construction at the ONKALO® site shows the floor of the fuel handling cell and the top of the canister shaft, through which the canisters will be lowered to the final disposal facility.

Posiva personnel and our main consultants are also working hard compiling the safety case and supporting documentation to be included in the operating licence application to be submitted by the end of 2021. The documents are reviewed by international experts and communicated with the Finnish Radiation and Nuclear Safety Authority (STUK). The safety case comprises eight main reports and tens of supporting reports, including Olkiluoto Site Description, Canister Evolution, Buffer, Backfill and Closure Evolution and Sulphide Fluxes.

In parallel, Posiva is undertaking the detailed design, manufacturing and testing of the vehicles and machinery for the operation phase, making alternative production plans and negotiating with potential suppliers on the future material and component supply, to be ready for operation in the mid 2020's.

Update from the Members – SURAO

SURAO has completed the site assessment process and has submitted a technical proposal for four sites to the government for the next phase of research.

Radioactive waste disposal in the Czech Republic is managed by SURAO. In line with the requirements of the Spent Nuclear Fuel and Radioactive Waste Management Concept, SURAO is currently working on development of a deep geological repository for the permanent disposal of high-level radioactive waste. With respect to the Czech Republic, the DGR will be constructed in a suitable crystalline rock mass around 500 metres below the earth's surface and the commencement of operation is planned for 2065. The current DGR development phase is devoted principally to determination of the optimum disposal concept and selection of the most suitable site. In 2020, a total of nine potential sites were assessed with the aim of reducing their number to four (Fig. 1 & 2).

Lukas Vondrovic, Head of RAW Repository Development Department, SURAO

After surface-based characterisation and assessments of safety, feasibility and environmental impact, as well as communication with communities, SURAO has recommended to the government of the Czech Republic four sites at which to continue the site characterisation process.

For the purposes of reducing the number of potential sites and to determine the relatively most suitable sites, both criteria that exclude the location of the DGR at a specific site (exclusion legislation criteria) and criteria that can be used to distinguish relatively more suitable sites (comparative, so-called key criteria) were identified (Fig. 3). The key criteria were further divided into "indicators" (partial characteristics for each criterion). In total, the assessment team considered the nine potential sites in terms of 26 exclusion criteria and 13 key (comparison) criteria, which were further divided into 38 indicators.

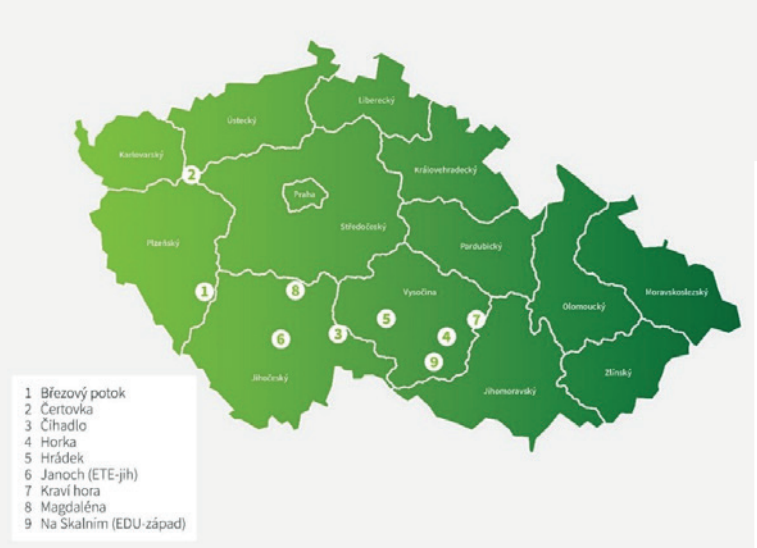


Fig. 1: Potential sites for the deep repository in the period 2014-2020

Fig. 2: The site assessment process

The key criteria reflected the three main areas of concern with respect to the DGR, i.e. long-term and operational safety, technical feasibility and the environmental impacts of the facility (Fig. 4). The assessment of the sites was performed in two stages. The first stage – risk exclusion – involved assessment of the probability of fulfilling the exclusion criteria according to Czech legislation, while the second stage – the application of priority – involved mutual comparison of the sites in terms of the defined key criteria. In the second step the weightings of the various criteria and indicators were determined via the application of a SAATY method of expert comparison of the significance of the criteria. This method distinguished between relatively strongly and weakly weighted criteria (Fig. 4). The sites were graded with respect to the estimated value of the criteria; moreover, the grading of the sites considered various types of data (e.g. a value was attributed to particular physical qualities and the frequency of the occurrence of a particular phenomenon or logical value). The value of each indicator was graded for a given site as in the school classroom, i.e. all the sites were mutually compared with respect to each indicator.

Update from the Members – SURAO

C1: Size of the usable rock mass
C2: Infrastructure availability
C3: Describability and predictability of the rock blocks
C4: Variability of the geological properties
C5: Water flow characteristics in the vicinity of the DGR and the transport characteristics
C6: Identification and location of drainage bases
C7: Seismic and geodynamic stability
C8: Characteristics that might lead to intrusion into the DGR due to future human activities
C9: Phenomena that influence the spread of radioactivity and the operation of nuclear facilities
C10: Impact on surface waters and water resources
C11: Impacts on nature and landscape protection
C12: Impacts on the agricultural land stock and land intended for forestry
C13: Impacts on the population and property and the protection of cultural monuments

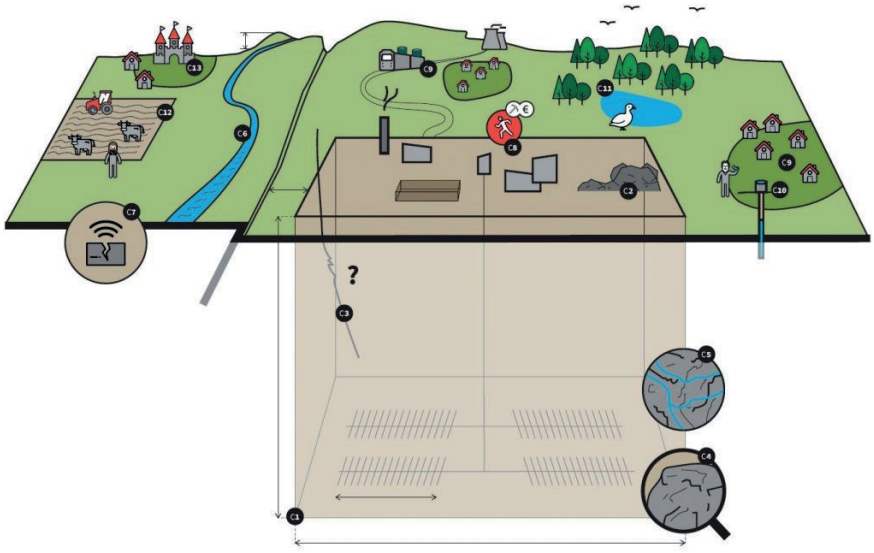


Fig. 3: Key criteria

A total of eight assessment calculations were performed for five scenarios using different procedures for the estimation of weights and for data normalisation purposes. The first assessment stage indicated that eight of the potential DGR sites were not in direct conflict with any of the exclusion criteria. The ninth assessed site was found to be in conflict with the exclusion criteria due to its proximity to a former uranium mine. However, even in this case it would be possible to remediate this conflict via the adoption of certain administrative-technical measures. Therefore, all the sites were deemed to fulfil the DGR site assessment methodology requirements. The second stage of the assessment of the comparison of the site calculations (assessment grades) of the sites was based on the levels of significance of the indicators and criteria and the resulting representative values for each site. The results of the subsequent comparison calculations indicated that the same four sites always occupied the first four positions with only minor variations in the order. A significant difference was determined in the resulting values between the four sites and the remaining five sites which, again, displayed minor variations in terms of ranking. The assessment process can, therefore, be considered robust and capable of distinguishing the most suitable four sites of the total of nine candidate sites, whether the weighted assessment is applied or not. The difference in the gradings of the five most suitable sites and the five relatively less suitable five sites ranged between 11% and 17.8% (between the fourth and fifth sites), which convincingly differentiated between the two groups of sites. In all calculations one site was in last position. In compliance with the assessment results, the following sites have been recommended to the Government of the Czech Republic for further follow-up research and analysis (in alphabetical order due to the results of the comparative calculations):

Fig. 4: Relative significance of the criteria applied

- Březový potok (mark 2,374 in reference calculation)
- Horka (mark 2,113 in reference calculation)
- Hrádek (mark 2,138 in reference calculation)
- Janoch (mark 1,960 in reference calculation)

Those sites that are not recommended for the next stage of research will continue to be considered as reserve (i.e. backup) sites (in alphabetical order):

- Čihadlo (mark 2,673 in reference calculation)
- Čertovka (mark 2,758 in reference calculation)
- Kraví Hora (mark 3,973 in reference calculation)
- Na Skalním (mark 2,469 in reference calculation)
- Magdaléna (mark 2,975 in reference calculation)

Further information is available at
https://www.surao.cz/en/site-shortlisting/

IGD-TP Projects – What is going on?

Smectite-magnetite interface, courtesy of SKB

Kiruna Natural Analogue (KiNa Project)

The Project (KiNa) is delighted to welcome NUMO as a new partner!

With NUMO from Japan the KiNa project has now grown to 7 partner organisations, bringing together even more bentonite expertise.

The annual project meeting was held on the 10th of September via MS Teams. The partners presented their first results, ongoing activities and future plans. One of the main focuses is on the age of the smectite layers, which is a fundamental parameter for the interpretation of further results. Furthermore, the first results on the safety relevant bentonite properties of swelling pressure and cation exchange capacity (CEC) were presented.

Post-closure Criticality Safety – Knowledge Share

Criticality safety over long, post-closure, timescales is unique to geological disposal and there are limited opportunities for sharing of experience within an individual company/country. Therefore, sharing of experience and knowledge between WMOs to understand any similarities, differences and areas for future collaboration has obvious benefits. To support this RWM and Nagra organised and hosted a workshop for WMOs to discuss post-closure criticality safety on Monday 10th February 2020.

Despite Storm Ciara's best efforts at stopping travel, 19 participants from Andra, BGE, Enresa, GRS, Nagra, Posiva/TVO, PSI, PURAM, RWM and SKB came together to present updates from their respective programmes and with the aim of answering the questions:

- How to ensure that the line of argumentation for the criticality safety case between the different WMOs are not contradictory?
- How to ensure that results from different WMOs do not contradict each other or, if they do, how to handle them in a transparent way?
- Which technical issues are similar for each WMO (e.g. uncertainties, assumed parameters etc.) and where can/should we benefit from each other?
- What are the different regulatory requirements in each participating nation for post-closure criticality safety?

Throughout the workshop, participants from advanced programmes shared their experiences in an open and transparent manner, which had clear benefits for those participants who might not be so far down the path (in terms of criticality safety considerations). There was significant discussion around areas of potential future collaboration but also identification of areas that are unique to a particular programme/country.

As an output of the workshop, and to ensure that all the useful discussions and knowledge were captured, a 'state-of-knowledge' document was produced that concisely captured a wide range of information on the criticality safety programme for each country including: the inventory for disposal, the regulatory requirements, the approach taken and criticality safety criterion used and any key assumptions. In addition, the areas of potential future collaboration were captured and included work on how relevant criticality safety scenarios are developed, how consequence assessments are performed and used, and how important knowledge and information can be captured and retained.

The next steps of this work are to ensure a continued open and transparent sharing of knowledge in this area and to kick-off some of the collaborative working proposals. For example, RWM and Andra are in early discussions to share knowledge and progress on the criticality safety of Intermediate Level Waste (ILW) packages.

International Projects – What is going on?

International Nuclear Waste Consortium at CanmetMATERIALS

Established in 2017, the Nuclear Waste Consortium is a collaborative research programme being conducted at CanmetMATERIALS in Hamilton, Ontario, Canada. The consortium brings together experts from several national nuclear waste management organisations including: NWMO (Canada), Nagra (Switzerland) and ONDRAF/NIRAS (Belgium), with CanmetMATERIALS scientists to conduct mutually beneficial research on metals proposed for both high level waste and low/intermediate level waste repository environments. The intention is to better understand corrosion rates, corrosion mechanisms and gas generation rates in cementitious and bentonite environments.

Much of the work being produced by the consortium is based around a novel anoxic corrosion cell designed by Dr Nick Senior of Canmet for the measurement of ultra-low corrosion rates. The glass cells contain either copper or carbon steel in a sealed, oxygen-free environment in the presence of repository relevant chemistries. The design of the cell allows for changes in electrolyte chemistry either by the dosing of gaseous species, such as hydrogen sulphide, or through electrolyte replacements, while maintaining an oxygen-free environment. In the anoxic environment, any metallic corrosion that occurs as a result of such an exposure will produce hydrogen gas, which is collected and quantified using an extremely sensitive hydrogen probe. Using simple, conservative assumptions, uniform corrosion rates can be calculated for the metals being analysed. Utilising this technique, incredibly small corrosion rates as low as 0.1 nanometres per year have been measured. A detailed description of this methodology has recently been co-authored by the consortium members and published in the Journal Corrosion Science (doi:10.1016/j.corsci.2020.108913). The method has been applied to waste management organisation specific conditions for both copper and carbon steel. Results from these studies were recently presented at the 7th International Workshop on Long-term Prediction of Corrosion Damage in Nuclear Waste Systems held in Nancy, France and published in a special issue of the Journal Materials and Corrosion (https://doi.org/10.1002/maco.202011783 and https://doi.org/10.1002/maco.202011780).

The Nuclear Waste Consortium is currently refining cell designs and developing new hydrogen monitoring techniques to further enhance the accuracy of collecting corrosion rate data. The monitoring of the current long-term experiments will continue and be incorporated into the participant waste management organisations safety cases and engineering designs.

Taylor Martino (Canmet) presenting results from the Consortium at the 2019 LTC conference, courtesy of NWMO

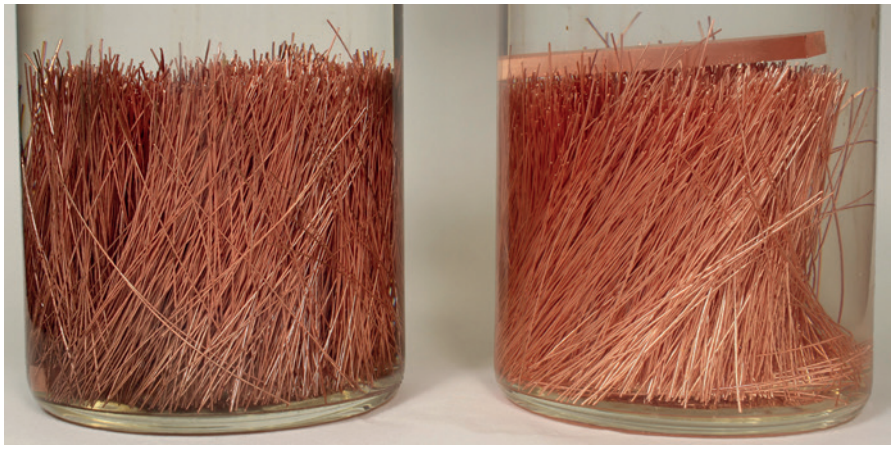
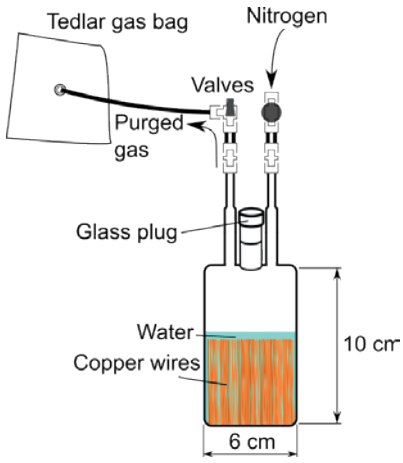


Photo of corrosion cells



Schematic of a corrosion cell

Secretariat News and Meeting Announcements

New IGD-TP Members

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

- MCM Environmental Services Ltd (mcmenvironmental.co.uk) supports all aspects of strategic, scientific and technical coordination in the field of radioactive waste management, working predominately for WMOs. They are currently supporting the EURAD Project Management Office.
- Laviosa SpA (www.laviosa.com) mines and manufactures/processes raw materials, including bentonite. They have undertaken studies of bentonite performance for geological disposal, manufacturing bentonite pellets and blocks, with their bentonite used in the BEACON project. They are interested in pilot scale tests and industrial production of bentonite-based engineered barriers.
- ROBOTSYSTEM, s. r. o. (www.robotsystem.cz/en) is a research and implementation company with a focus on autonomous robotic technology in the field of nuclear power and spent nuclear fuel disposal. The company has experience of designing manipulation systems for spent fuel containers, including handling of very heavy containers (25-30t net), in hot cells, during transport and operations, and disposal.
- Underwater Technology Center Hanover (UWTH) of the Leibniz Universität Hannover Institut für Werkstoffkunde (www.iw.uni-hannover.de). UWTH's research focus is on materials science and process technologies in special environments, especially the cutting and joining of materials as well as the influence of environmental conditions on processes and material properties. Relevant R&D includes final storage containers for heat-generating waste, behaviour of material systems over time under repository conditions, technical barrier effect of container systems, and development of coating systems and production techniques.

The IGD-TP now has 141 member organisations from 27 countries active in geological disposal. All our member organisations and their contact points are listed at: https://igdtp.eu/members/

Upcoming Meetings

Due the coronavirus pandemic many conferences, training courses and symposia are being cancelled or postponed. Please be sure to consult the relevant event websites for the latest information.

NEA Nuclear Energy Agency	**NEA International Conference on Geological Repositories: Advancing Geological Repositories from Concept to Operation** Date: 8-12 November 2020 Location: Helsinki, Finland
NEA Nuclear Energy Agency	**NEA Workshop on Developing Safety Cases for Various Radioactive Waste Disposal Facilities – Needs and Challenges of RWMC Organisations** Date: 8-10 December 2020 (back-up date 22-24 March 2021) Location: Bucharest, Romania
WM SYMPOSIA EDUCATION & OPPORTUNITY IN RADWASTE MANAGEMENT	**Waste Management Symposia 2021** Date: 7-11 March 2021 Location: Phoenix, USA
BEACON Bentonite Mechanical Evolution	**Final BEACON Annual Project Meeting** Date: 14-15 May 2021 Location: London, UK
	**Clay Conference 2021** Date: 14-17 June 2021 Location: Nancy, France

IGD-TP Website (https://igdtp.eu)

We have continued to develop the activities pages on the IGD-TP website by adding historical and ongoing collaborative research projects. You can now find project summaries, key reports and links to further information for 46 projects.

We also announce events and news relevant to geological disposal research on our website.

Please contact the IGD-TP Secretariat (secretariat@igdtp.eu) if you would like to highlight something of interest to our community.