

Summary record of the topical session of 18th Meeting of the IGSC

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Demonstration of repository technology

Chairperson: A. Hedin (SKB)

Rapporteur: C. Leigh (SNL)

Introduction

The chair for this topical session was Allan Hedin with Christi Leigh acting as rapporteur. Allan Hedin set the stage for the presentations by reminding the participants of the aim for the session which was:

To review and evaluate the current technologies of radioactive waste disposal in geological repositories

It is noted that the technologies discussed could be technologies used to provide worker safety during the operational period of the repository as well as technologies that are included in the repository design to enhance the safety case. It is also noted that Allan Hedin suggested that the topic is of interest especially regarding the aspects of it that apply to establishing the safety case.

The Programme Committee had offered the following guidance to the presenters:

- Briefly describe the design of your repository and EBS components;
- Explain testing activities and performance demonstration of the tested components (e.g. disposal containers, buffer / bentonite pellets, emplacement equipment, etc);
- If possible please provide fabrication and testing details of physical prototypes, the ability to manufacture using proven processes and practices;
- Are there any plans for a demonstration/pilot phase?
- What are the objectives?
- Does the demonstration/pilot phase include an active or inactive operation or both?
- What will be demonstrated?
- Are there plans for a full-scale demonstration of the integrated disposal sequence (and back-filling) under realistic repository conditions, remote handling and radiation shielding equipment?
- How does a pilot phase support public dialogue?
- If applicable, please explain the objectives and rationale for performance confirmation

- How can long-term testing during the (long) operational period strengthen confidence in safety/barrier functions?
- What is the role of inactive testing and tests in connection with emplaced radioactive waste, respectively?
- Are there any plans for destructive tests to verify the initial state conditions of the sealed repository?

Presentations

Given this guidance, 10 presentations from eight countries, Sweden, Finland, Canada, Germany, France, United States, Hungary and Japan, were submitted for the session. Perspectives from both the implementer and the regulator were offered for several countries. The following presentations were given and can be found at <https://www.oecd-nea.org/download/igsc/igsc-18/index.html>

The first two presentations were from Sweden. Presentation 6.1, *Developing The Detailed Design Of The Swedish KBS-3 Repository For Spent Nuclear Fuel*, was delivered by Johan Anderson of SKB. He reported that SKB is in the process of moving from the conceptual designs and scientific theory for the technology of spent fuel processing and disposal to an actual industrialized process. They have a license application that has been reviewed by the regulator. The regulator determined that the application as it currently exists for a basic design is fine but future design steps followed by testing and demonstration will be required once SKB actually start the construction of the spent fuel encapsulation plan and the construction of the final repository for spent fuel. The steps outlined for testing and demonstration are: 1. Revision of Design Requirements, 2. Facility Construction, 3. Commissioning tests (with non-active material) 4. Trial Operation, and 5. Routine operation. This is the process that would be applied as standard for any industrial facility development. The presenter noted that development of design requirements is not trivial. They can be too strict and thus unattainable or possibly too lenient and thus the facility does not perform as desired. The presenter also noted that they must leverage efficiencies that can be gained by collaboration with POSIVA (Finland).

Presentation 6.2, *A Regulatory Perspective On Demonstration Of Repository Technology*, was delivered by Björn Dverstorp, SSM. He discussed challenges associated with a step-wise licensing process, pre-licensing demonstration of repository technology, and examples of demonstration issues discussed in the ongoing licensing review.

After 30 years of siting, repository development and pre-licensing demonstration, Sweden is now in the final phase of a licensing review for a spent nuclear fuel repository. Should the Government grant SKB a license, a step-wise authorization process will follow for the actual start of construction, trial operation, routine operation and eventually closure. The on-going regulatory licensing review has identified areas where further demonstration of repository technology is needed in SKB's future programme, including manufacturing and quality control of engineered barrier components and the backfill as well as the integrated disposal sequence (under realistic repository conditions). Although there are clear merits of a step-wise authorization process it also leads to questions regarding what level of demonstration that is needed at different decision-steps. The speaker emphasized the importance of developing plans for demonstration and confirmation of repository technology early on in the programme and to

make the most of the long operational time period of a geological repository to further strengthen confidence in the repository safety.

The next presentations were from Finland. Presentation 6.3, *Large-Scale Demonstration And Commissioning Test*, was delivered by Barbara Pastina, Posiva. The presenter gave information that puts the testing activities in perspective regarding their overall programme. Specifically with regard to testing, the presenter noted that they are performing: 1) NDT inspection of copper canisters and 2) Testing of installation technology. With regard to demonstration, the presenter discussed POPLU a full-scale deposition tunnel end plug. They are also investing in full-scale dome plug test (DOMPLU). In addition, they are developing FISST, a full scale in situ system test of the KBS-3V concept that includes all engineered barriers and canister, buffer, backfill and plug.

Presentation 6.4, *Regulator's Expectations For Demonstration Of Repository Technology*, was delivered by Jaakko Leino, STUK. The presenter noted that the regulator expects to see successful demonstration of: 1) emplacement devices, 2) manufacturing of EBS components, 3) emplacement of EBS components, and 4) attainment of the initial state requirements. They expect to see demonstrations in the construction license phase, the operations phase, and post closure phase (monitoring).

The next presentation was from Canada. Presentation 6.5, *Proof Testing and Development Program*, was delivered by Neale Hunt, NWMO. First the speaker gave an overview of their repository concept. Next he noted that they have a design and proof testing programme that includes testing of 32 features of their system ranging from engineering computer tools to engineered buffer systems. He then focused on tests that were being conducted on the container copper coating, the mechanical integrity of the canister, the Highly Compacted Bentonite (HCB) consolidation and shaping, the HCB handling, gapfill placement demonstration, gapfill fabrication, and gapfill placement.

The next presentation was from Germany. Presentation 6.6, *Design, Manufacturing and Demonstration of Transport- and Emplacement-Techniques for a HLW Repository in an Industrial Scale*, was delivered by Wilhelm Bollingerfehr, DBE-TTECHNOLOGY GmbH. The presenter discussed the laws, regulations and safety requirements that have to be applied in Germany. He explained the HLW-repository design concept in rock salt. For testing the speaker focused on operations equipment including the shaft transport system, the borehole emplacement system the backfilling slinger truck in a disposal drift, and the drift emplacement system. He explained that they have successfully performed demonstration tests to demonstrate the safety and reliability of the transport and emplacement components, to solve operational disturbances, and to provide proof of the dimensioning of the components (e.g. transport cart) for the transport of the emplacement device. And in the future, there will have to be demonstration tests to proof the technique for waste package retrieval.

The next presentation was from France. Presentation 6.7, *Cigéo: Preparing the Industrial Pilot Phase*, was delivered by Jean-Michel Hoorelbeke, Andra. The presenter gave an overall presentation of the Cigéo project in France, a summary of current testing activities, and the formulation of their industrial pilot phase expected to be from 2025 to 2035. Much of their testing is in a URL where they are demonstrating excavation techniques, rock support

technology, and sealing technology. Outside of the URL they are performing waste package manufacturing and handling tests.

The next presentation was from the United States. Presentation 6.8, WIPP Preparations for Restart of Operations, was delivered by Christi Leigh, SNL. After a brief introduction to WIPP, where and what it is, the speaker switched to discussing the WIPP ventilations system. Ventilation at WIPP was severely compromised as a result of the two accidents occurring in February 2014. Restart of operations relies heavily on the implementation of interim ventilation and a new permanent ventilation system.

The next presentation was from Hungary. Presentation 6.9, Design and licensing of the repository technology for the Bataapati facility, was delivered by Peter Molnar, PURAM. The speaker gave an historical overview which included the movement from an original repository design to a new repository design that they are now working to license. With regard to specific testing, they are performing tests on their over packs which are key to the repository performance.

The final presentation was from Japan. Presentation 6.10, Demonstrative R&D Activities in the Japanese Geological Disposal Programme, was delivered by Hiroyoshi Ueda, NUMO. After outlining the regulatory framework and the conceptual design, the speaker discussed the Horonobe Underground Research Center where an extensive suite of demonstrations for the engineered barrier is planned, together with demonstrations of the vertical emplacement concept. These are open to the public. Finally, NUMO is planning an above ground test facility to demonstrate retrievability.

Observations and Conclusions

The questions throughout the day led to interesting discussions that were further developed in the plenary discussion at the end of the day. The following is a summary of key observations and conclusions from the discussions.

- Technology development and demonstration is relevant and important at all stages of a repository programme. The maturity of plans for technology demonstration depends strongly (and naturally) on the maturity and stage of a particular disposal programme. Examples were presented from programmes that have yet to select a host rock type, a concept and a site, e.g. Germany; from programmes with relatively well developed concepts, with possibilities to adapt either to a granitic or to a sedimentary host rock and realistic conditions at a future site (Canada, Japan); from programmes with a selected concept and site in various stages of the licensing process (France, Finland, Sweden); and from programmes with licensed repositories in operation where further technology demonstration is required for updating the design of the repository (Hungary) or where incidents at the licensed repository have led to the need for oversight of the technical and administrative procedures followed at the operation of the facility (USA WIPP).
- There was general consensus that there are considerable advantages with a stepwise approach to both licensing and technology demonstration in a repository programme.

Such an approach is seen as a suitable formal and informed interaction between implementer and regulator to handle and regulate the range of issues that need to be addressed during the several stages of a repository programme. It was also noted that during the time span of several decades over which a repository programme develops prior to reaching a mature operating phase, and during the several decades of operation, the available technical solutions are expected to develop considerably, which further enhances the need for flexibility and step-wise approaches to licensing and technology demonstration.

- From a regulatory perspective, technology demonstration is an important component in the licensing of a repository. The Swedish and Finnish cases illustrate how the regulator expects increasing levels of demonstration as an implementer reaches more advanced stages of its programme. It was also noted that the establishment of regulatory provisions on technology demonstration at a mature stage of a programme may require detailed interactions between regulator and implementer, in particular in countries where the regulator has a more prescriptive role.
- It was noted that advanced programmes have developed programme specific configuration management systems to allow a rigorous handling of design development and demonstration. In this context it was also noted that it is of importance to establish workable design requirements that are reasonably stable over time to allow the necessary technical development that leads to a design that meets the requirements.
- Regarding monitoring, it was noted that this is an issue of discussion in many member countries, with several stakeholders involved and that monitoring is being addressed internationally within the EU Modern 2020 project. It was also noted that only a limited part of repository performance can be captured through monitoring, both as regards temporal aspects and the entities that are possible to monitor, in particular if the monitoring measures themselves are not to impact negatively on post-closure safety. Monitoring is thus generally not seen as an efficient means of gaining information on fulfillment of requirements or on overall performance, and this implies, on the other hand, high requirements on quality control of the emplaced repository components.
- The issues of technology demonstration regarding retrievability (the ability in principle to recover waste or entire waste packages once they have been emplaced in a repository) and reversibility (the ability in principle to reverse or reconsider decisions taken during the progressive implementation of a disposal system) were briefly discussed. It was noted that the requirements on and approaches to both retrievability and reversibility differ considerably between countries and that this is naturally reflected in the requirements on demonstration of technology regarding these two issues.
- The issue of best available technique and state-of-the-art technology was also briefly discussed and it was noted that there is also value in using proven and well established technology.