

WM2017 Conference Panel Report

PANEL SESSION 81: Deep Borehole Disposal of Radionuclides (focused on SNF and HLW)

Co-Chairs: **Carl Reinhold Brakenhielm**, *Swedish National Council for Nuclear Waste/Uppsala University (Sweden)*
Eric Knox, *AECOM*

Panel Reporter: **Mark Arenaz**, *US DOE*

Panelists:

1. **Karl Travis**, *Reader in Computational Physics and Nuclear Waste Disposal, University of Sheffield (United Kingdom)*
2. **Andrew Orrell**, *Section Head, Waste and Environmental Safety, IAEA (Austria)*
3. **Ernest Hardin**, *Sandia National Laboratories*
4. **Frank Charlier**, *RWTH Aachen University, NET (Germany)*
5. **Jong-Youl LEE**, *Principal Researcher, Korea Atomic Energy Research Institute (South Korea)*
6. **Mary Lou Zoback**, *Stanford University*
7. **Rod McCullum**, *Director, Used Fuel Programs, Nuclear Energy Institute*

About 30 people attended this panel session which focused on the past, ongoing, and planned research and development activities designed to increase the understanding of the related scientific and engineering challenges facing all deep geological solutions for long-lived radioisotopes with a focus on spent nuclear fuel and other high-level waste. The session opened with seven panelists presenting on their individual areas of concern. This was followed by a question and answer session which included questions on retrievability of the canisters, brine migration, thermal plume movement, fractures, canister size, objectives of the field testing and others.

Summary of Presentations

Karl Travis discussed deep borehole concepts for spent nuclear fuel and high level waste. There is consideration for co-disposal of HLW, SNF, and ILW in the same geologic disposal facility. HLW could be disposed of in six deep boreholes at 5 km deep and the deep boreholes could also be used for SNF and Pu. The deep borehole concept has variants for the different waste types. He suggested that consolidated disposal is the most efficient form. They are developing the main seals and establishing a seal zone which would provide no escape of the waste from the disposal zone into the biosphere. They are also developing a “rock welding” concept that heats crushed rock that will seep into the disturbed rock zone and the molten rock will recrystallize. He believes they are investigating versatile solutions for a lower cost and lower environmental footprint.

Andrew Orrell discussed the safety principles of disposal regardless of waste type. He talks to the need to protect the accessible environment, contain and isolate the waste and the development of reasonable confidence of the uncertainties related to disposal. He discussed that SNF and HLW come in many forms and may need many options. No EU countries have disposal options available except Sweden and different countries have different affordability options.

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The Deep Borehole Disposal may be an attractive option for many countries. He discussed Mexico as a possible example where three or four boreholes could be enough for their entire inventory. He discussed other concerns that included retrieveability, the need for mined space, how to deal with packages that get stuck in the borehole and the competition from other programs. He stressed that Deep Borehole Disposal could be “a” solution but is not “the” solution.

Ernest Hardin discussed Deep Borehole Disposal isolation strategies. He talked to how hypersaline brines form. He also discussed groundwater survey examples from the AECL and the change in the water chemistry as the borehole is drilled deeper. You get into older water. The brine at these points is stable as it was created millions of years ago. He raised the questions as to what to do with the information being generated about the ground water and how do we use it to establish the safety case.

Frank Charlier discussed the Deep Borehole Disposal – a Solution for HLW in Germany? He provided a background of nuclear power in Germany. He talked to the new site selection process in Germany for HLW disposal including the length, consensus process, safety issues, time frame to get it done, and site selection criteria with a goal to start operation by around 2050. He discussed Deep Borehole Disposal in clay and salt layers up to 5,000m below the surface. He discussed the use of canisters and the different well thicknesses based on depth, number of canisters per borehole, number of boreholes in the area and the diameter of the boreholes. He suggested that Deep Borehole Disposal should be considered as an alternative but the concept needs to be supported and researched.

Jong-Youl LEE presented a Concept for Disposal Canister and Handling System for Deep Borehole Disposal. He discussed the key technological challenges that they are experiencing as they develop the disposal technology. They have manufactured a 1/10 scale container to test the concept.

Mary Lou Zoback talked to Addressing the Technical Challenges of Deep Borehole Disposal. She explained that she was representing the views of the Nuclear Waste Technical Review Board. She talked to three major concern areas 1) Siting, which included the public involvement and technical siting 2) System, including engineering concerns and the deep earth environment and 3) Evolution with Time, that discussed the reliance on engineering and the earth environment. She talked to the Deep Borehole Disposal as a great concept until you drill a hole through the natural media. She discussed the borehole deformation at 1-1.5Km. She discussed that even if the Deep Borehole Disposal is feasible; the need for a Deep Geologic Repository is still there. She discussed some other concerns and issues including the need to follow the same siting process for a Deep Borehole Disposal as Deep Geologic Disposal, her belief that a Deep Borehole test will not provide adequate information to make decisions, the need for in-situ testing of the seals and at depth and a need for a comprehensive risk analysis. She talked to the need for an independent technical expert review of any data generated.

Rod McCullum discussed the Deep Borehole Disposal – the Retrieveability Conundrum. He stated that he represented potential customers of a possible Deep Borehole Disposal facility. He stated that retrieveability is required by regulation. The waste disposed might have reuse value in

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the future. He talked to safety concerns after emplacement and that future generations may be smarter than us now and figure out something to do with the waste.

He discussed how deeper disposal is intuitively safer but less retrievable. There is no perfectly straight drilled hole and the borehole would need larger gaps. He did not believe that rod consolidation is a good idea from an industry viewpoint. He believes that some HLW can be placed in a Deep Borehole as well as some reprocessed commercial fuel. He stated that we need years of regulatory and community involvement and agreement on this issue and it should be a part of the larger discussion of waste disposal.

Questions and Answer

In response to a question on how do you discuss retrievability with stakeholders, **Eric Knox** replied that current technology says that it is difficult to retrieve the package intact. If the seals are successful then you would have to drill back into them. This is possible but has engineering issues and is more of a problem if the package is corroded. Retrieval options would need to be looked at. There is an ethical value of retrieval.

On the question of what are special considerations made for retrieval of the Deep Borehole Disposal, **Carl Reinhold Brakenhielm** responded that no strong analysis has been done yet but there is considerable drilling technology available.

Frank Charlier was asked where Germany would put the waste that they are removing to which he provided the answer.

To the questions of how does the heat generated drive the brine migration and an explanation of the thermal plume issue back in the borehole, **Ernest Hardin** replied that they are looking at it and how the heated fluid flows. The seals would not allow the fluid movement. **Mary Lou Zoback** responded that the fracture flow is the area and need to stay away from the fractures. She believes that there are important issues with He generation.

On the question as to should this be used for countries with a thick, large sedimentary layer, **Ernest Hardin** replied that it would not be a good idea as the waste would move.

Other questions were asked of the panel and responded to including:

Does the size of the container and compaction lead to a criticality issue in the Deep Borehole disposal? This needs to be examined. The regulators would require the development of the criticality calculations.

Is there a risk of criticality in the Deep Borehole Disposal facility? Yes, if disposing of SNF and fissile materials. There could be a potential reconfiguration of the fuel at depth over time.

What are the objectives of the field tests? Phase III of the Deep Borehole Disposal investigation would go into the details. It depends on the character of the formation itself.

Is there any international collaboration on the deep borehole concept? Yes, but are looking into it. The Working Group is in initial stages with a Workshop in England.

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Mary Lou Zoback suggested that we need an international collaboration on a deep borehole test facility.

Eric Knox suggested continued study of a deep borehole disposal facility.