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Deep borehole disposal of intermediate-level waste: progress from Australia's RD&D project

Around the world deep borehole disposal is being evaluated for intermediate level waste (ILW), high-level waste (HLW), spent nuclear fuel (SNF), separated plutonium wastes and some very high specific activity fission-product wastes. In Australia, long-lived ILW from research reactors and radiopharmaceutical production represents the principal waste stream that requires deep geologic disposal. Whilst the Australian Government has not yet made a decision on its preferred strategy for ILW disposal, deep borehole disposal of small volumes of ILW would be a more cost-effective, and modular, solution compared to a conventional geologic disposal facility (GDF). CSIRO, ANSTO and SANDIA have created an international partnership to execute a full-scale borehole research, development and demonstration (RD&D) project in Australia. The project will demonstrate the technical feasibility of, and hence will provide a strong foundation for, the long-term safety of borehole disposal in deep geological formations. The execution of this project could also demonstrate options for nuclear waste disposal that would reduce proliferation risks, potentially up to the termination of compliance with international safeguards requirements. The RD&D includes demonstration of surface handling and waste/seal emplacement capabilities, basic research on foundational science areas, and full-scale field testing in both a deep characterization borehole, and a larger diameter (0.7 m or 27.5 inch) 2000-m deep demonstration borehole.

The multi-barrier system designed for such deep disposal borehole concept places much less reliance on engineered barriers at the disposal zone to achieve safety as compared to a conventional GDF. It rather relies on geological features for waste containment. The concept being explored uses disposal containers with primary waste packages such as vitrified waste canisters inside; to be both cost-effective and fit-for-purpose, such container could have a mild steel based structural component with copper coating. So far, the RD&D has delivered novel enabling tools that assist with site screening, borehole design, and post-closure safety assessments. For instance, an automated geological fault mapping and meshing tool was developed that assists with ranking the suitability of potential disposal sites based on proximity to faults. New codes were developed for better representation of fault zones in 2D/3D numerical flow and transport models while also being more efficient to execute. Post-closure safety assessments tested the sensitivity of long-term safety with respect to disposal depth, rock permeability and sorption. Heat transport calculations explored the sensitivity of temperature evolution within the borehole to parameters such as heat load, borehole depth, geothermal gradients, and rock thermal conductivity.

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Mr

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Author: Dr MALLANTS, Dirk (CSIRO)

Co-authors: Mr PHALEN, John (CSIRO); Mr GRIFFITHS, Hef (ANSTO)

Presenter: Dr MALLANTS, Dirk (CSIRO)

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