

Background

Since the 1970's, the Belgian Nuclear Research Centre SCK•CEN has played a leading role in international research on the geological disposal of radioactive waste. SCK•CEN's foremost position in this domain has been confirmed in the Sixth Framework Programme (European Commission), where SCK•CEN coordinates the Integrated Project NF-PRO. NF-PRO is a multi-disciplinary project integrating European research on the near-field of geological repositories for high-level waste disposal. With a total budget of more than 20 million EURO and a consortium consisting of 40 major nuclear research organisations, radioactive waste management agencies/implementing organisations, universities and consulting companies, NF-PRO is the principal and most comprehensive international R&D project on the near-field system.

Objectives

The near-field of a geological repository for high-level radioactive waste and spent nuclear fuel is an essential component of the disposal system: its principal safety function is to confine radionuclides and to minimise/retard radionuclide release from the waste to the host rock. The near-field is a complex environment consisting of multiple engineered barriers and repository components including the waste form, the waste canisters, backfills, seals, plugs and the disturbed zone of the host rock. Repository construction and operation as well as waste emplacement will disturb ambient conditions of the disposal site. After repository closure, the near-field environment will evolve as a result of geochemical interactions between various repository components, heat generation and radiation effects. The combined effects of processes occurring in the near-field will affect radionuclide transport and retardation.

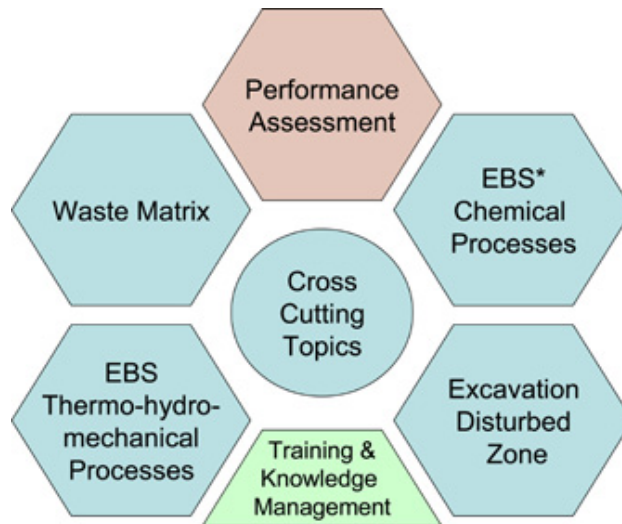
In recent years, substantial progress has been made in the scientific understanding of individual near-field processes. The main objective of NF-PRO is to strengthen knowledge on key processes affecting the barrier performance of the near-field and to apply results from detailed process investigations (experimental studies in surface and underground laboratories and detailed process modelling) into evaluations of the overall near-field system. Knowledge generated by the project is applied in the national waste management programmes to optimise repository designs and to make barriers functional and resource-efficient. NF-PRO addresses various host rocks (salt, granite and clay) and different repository concepts currently considered in EU Member States. The level of integration achieved by NF-PRO has not been accomplished by previous European research projects.

Principal results

NF-PRO has addressed a wide range of processes and materials interactions affecting the overall performance of the near-field system. Main emphasis has been on the following five topics:

- processes affecting the waste matrix (vitrified high-level waste and spent nuclear fuel);
- chemical processes and interactions in the Engineered Barrier System;
- coupled thermo-hydro-mechanical processes;
- the initiation and the evolution of the excavation disturbed zone;
- the evaluation of the overall performance of the near-field system, based on a series of reference cases taking into account various repository designs and host rocks.

The figure below gives an overview of the main research areas covered by NF-PRO.



*EBS: Engineered Barrier System

NF-PRO's main project components and structure

NF-PRO has made major contributions to advancing knowledge on the near-field system and has led to new insights in, among others, the dissolution of vitrified waste in the presence of bentonite buffer materials and iron corrosion products and the effect of hydrogen gas on the dissolution of UO_2 . New information has also become available on the evolution of the porewater composition in the near-field system, chemical alteration processes, the formation of secondary phases and corrosion products and the impact of new-formed phases on sorption and radionuclide mobility. Substantial progress has been made in investigations on the combined effects of thermal, geomechanical and hydrological processes on the performance of bentonite buffer and crushed salt backfill and on the development and the evolution of the excavation damaged/disturbed zone. Also, NF-PRO has conducted integrated analysis of the near-field evolution. These analyses have been performed for different European geological disposal concepts and host rocks and have resulted in new insights in the release of radionuclide from the waste matrix and radionuclide transport in the near-field. Results from these calculations have confirmed that the near-field displays a high degree of robustness and redundancy.

Future developments

The Integrated Project NF-PRO means a major step forward in European research on the geological disposal of vitrified high-level waste and spent nuclear fuel. NF-PRO has integrated scientific disciplines and research teams that essentially worked independently in previous Community-supported Programmes. Also, a strong link has been established between detailed process investigations and assessments of the performance of the overall near-field system.

The Integrated Project NF-PRO was concluded in 2007 and final reports will be published in 2008.

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Main reference

Alain Sneyers, Bernd Grambow, Pedro Hernán, Hans-Joachim Alheid, Jean-François Aranyossy, Lawrence Johnson (2007). *"The Integrated Project NF-PRO: Recent advances in European research on the near-field system"*, Proceedings of the 11th International Conference on Environmental Remediation and Radioactive Waste Management, ICEM2007, September 2-6, 2007, Oud Sint-Jan Hospital Conference Center, Bruges, Belgium.

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