

# DBE TECHNOLOGY NEWS

2014



OUR R&D TEAM

CONSEQUENCES  
OF RETRIEVABILITY

VIRTUAL UNDERGROUND  
LABORATORY FOR ROCK SALT

UPGRADE OF THE HOISTING  
EQUIPMENT OF SHAFT ASSE 4

SUPPORT FOR THE FRENCH  
CIGÉO PROJECT

Verantwortung  
für Generationen  
Responsibility  
for Generations

**DBE-TEC**  
DBE TECHNOLOGY GmbH



Dear readers,

Research and development is generally considered as the scientific key to a successful improvement and facilitation of the living conditions for human beings and to a continuous improvement for the protection of the environment. This is true for the field of radioactive waste disposal as well. Innovative developments in repository design and technology as well as in safety approaches lead to an increase in safety and will thus help in building trust in radioactive waste disposal.

From the very beginning, the HLW repository research & development activities in Germany focused on rock salt as host rock because of its unique containment potential. Since the 1980s, DBE/DBE TECHNOLOGY GmbH's R&D activities have concentrated on issues that are important for the safety of an HLW repository in rock salt. This includes the construction and operation as well as the long-term safe closure of such a repository.

DBE TECHNOLOGY GmbH was involved in the development, design, and construction of waste package transport and emplacement technologies and techniques for heavy POLLUX® casks (65 tons) and the emplacement of unshielded spent fuel canisters. This includes the successful demonstration of their feasibility and reliability. One challenging task was the development of a methodology to prove repository safety over long periods. In

this context, DBE TECHNOLOGY GmbH participated in R&D activities that led to the concept of safe enclosure of waste packages by the host rock in a so-called containment providing rock zone. These R&D activities were funded by the project management agency in Karlsruhe, by the European Commission, and – to a certain extent – by the German nuclear industry. The results provide the basis for site-specific repository design, construction, operation, and closure.

For more than ten years, our R&D activities have included clay as host rock as well. We have been involved in fundamental research on clay and buffer material behaviour as well as on generic repository design. Compared with rock salt, a repository in clay designed for the same types and amounts of radioactive waste may require much more space and – with regard to retrieval requirements – much more technical effort. Ongoing R&D activities show that the knowledge in Germany on the thermal, hydraulic, and mechanical behaviour of clay or on how to set up a safety concept for a repository in a clay formation is still incomplete and needs to be improved.

No matter what the plan for a site selection process for an HLW repository in Germany may involve, the lessons learned from our involvement in R&D activities confirm that prior to a site selection, it is of uppermost importance to develop a repository concept that is tailored to the geologic conditions of the envisaged site and takes into account the amounts and types of radioactive waste to be disposed of as well as an appropriate safety concept.

In this newsletter, we take the opportunity to introduce our dedicated R&D team and to present recent R&D achievements as well as an example of an ongoing project.

Happy Reading!

Wilhelm Bollingerfehr

Head of Research &  
Development Department

## Consequences of retrievability on existing emplacement concepts and requirements for new concepts

The German Federal Ministry for Economy and Energy funded a research and development (R&D) project to analyze the technical feasibility of the retrieval of disposed waste packages as required by the "Safety Requirements for the disposal of heat generating radioactive waste" (BMU 2010). An investigation has also addressed possible conflicts with other safety-relevant requirements and consequences on repository concepts in different host rocks. As retrievability is a legal requirement for licensing, the compliance of the appropriate state-of-the-art equipment as well as the corresponding operational and safety measures must be demonstrated in the licensing procedure.

The technical feasibility of retrieval has been analyzed for all kinds of potential host rocks in Germany, i.e., salt, clay, and crystalline rock; this analysis took into account the specific properties of the host rocks.

Retrieval of disposed waste packages through a re-mining concept (that is, the reopening of backfilled emplacement drifts and excavation of disposal casks) is technically simple in salt formations and does not affect the safety concept of safe containment of radioactive waste. A complex lining of the drifts is not necessary due to the high stability of the salt formations, but because of the high temperatures in the emplacement areas, an appropriate ventilation and cooling system is necessary for retrieval operation. Retrieval of waste packages is possible for drift and hori-

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zontal borehole emplacement by relying on a suitable excavation strategy and modified emplacement equipment. The concept of disposal in vertical boreholes includes measures for the simplification of retrieval, e.g., by means of a borehole lining and an appropriate canister design. Retrieval is possible by reversal of the emplacement procedures.

Retrieval of waste packages from clay formations requires the modification of the re-mining concept because a mine in such formations needs lining in all excavations. The emplacement drifts will be completely backfilled with clay. The removal of this clay and a possible preservation of the lining must be analyzed with regard to their safety relevance.

The retrieval of waste packages from a repository in crystalline rock is principally possible due to the favourable geomechanical properties of the rock.



*Demonstration test for borehole emplacement: The spent fuel canister (below) can be caught by a grabber and retrieved from the borehole.*

A retrievability strategy has been developed and the requirements for retrieval from crystalline rock have been specified for a possible repository design. In summary the project has demonstrated the principal technical feasibility of waste package retrieval from different host rocks. More detailed planning and demonstration tests are still necessary in order to transform these concepts into state-of-art practices.

## Virtual Underground Laboratory for Rock Salt – VIRTUS

DBE TECHNOLOGY GmbH together with Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, the Federal Institute for Geosciences and Natural Resources (BGR) and Fraunhofer Institute for Factory Operation and Automation (IFF) are developing the “Virtual Underground Laboratory for Rock Salt”, VIRTUS, as a tool for visualizing and analysing coupled thermal-hydraulic-mechanical (THM) processes in geological repositories. The aim of the project is to develop a software platform that enables both a three-dimensional visualization of geologic structures and the design of subsurface facilities embedded therein. Using automated pipeline tools, the complete geological model can be prepared geometrically in VIRTUS and then be read directly into the numerical simulation code for calculation, which simplifies modelling considerably. With VIRTUS the calculation results can then be imported and – just like in a real underground laboratory – be analysed and visualized. By using 3D animations, VIRTUS is also able to increase public awareness by visualizing the results in a clearer and more transparent way. Depending on the underlying geological model,

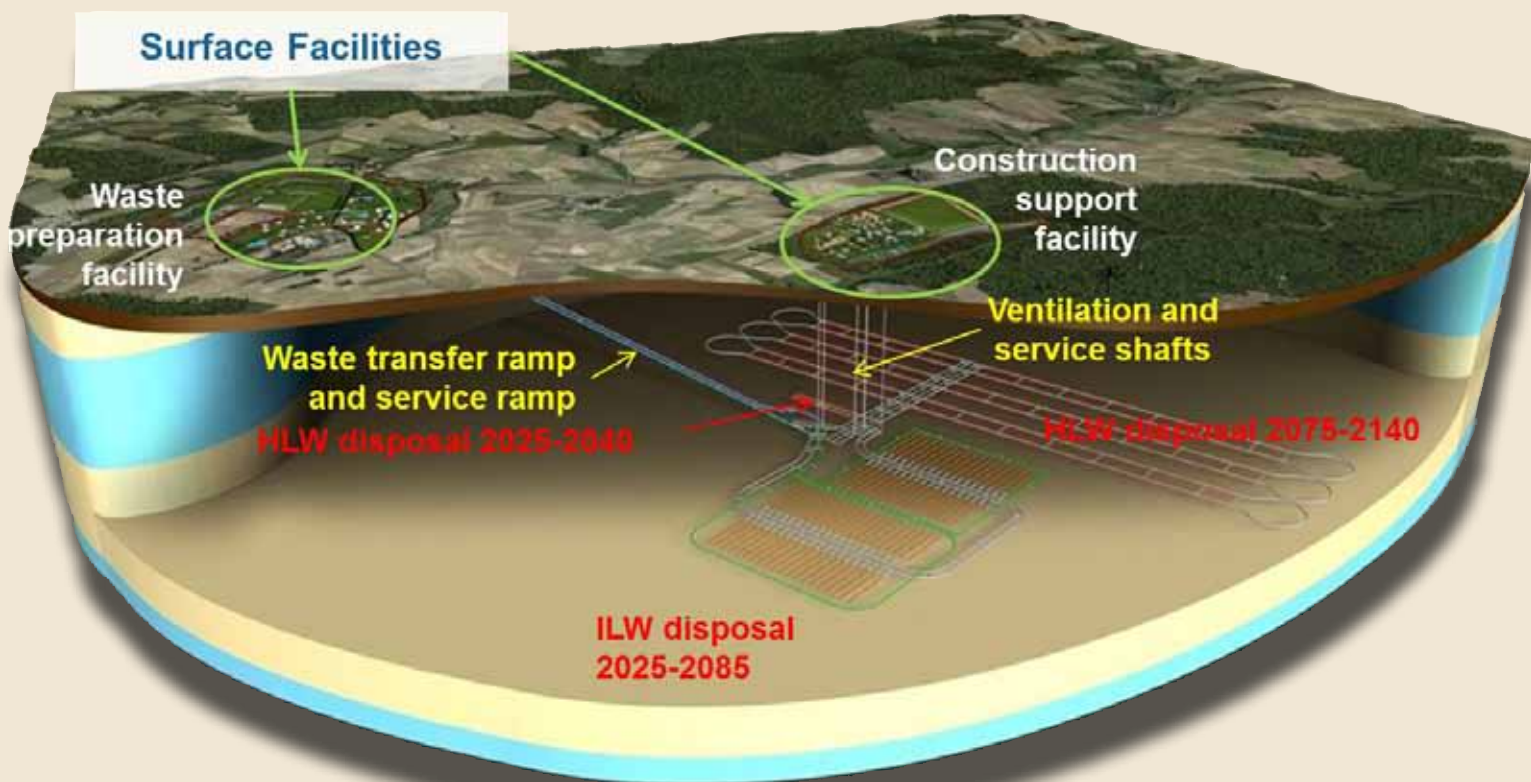


*3D model of repository excavations and disposal boreholes embedded in a geological structure (salt formations).*

VIRTUS can be used for different host rock types; initially, however, the project is limited to rock salt formations.

## Upgrade of the hoisting equipment of shaft Asse 4

On behalf of the Federal Office of Radiation Protection (BfS), Asse GmbH operates the Asse mine, which has been used for radioactive waste disposal from 1967 to 1978. An evaluation of the boundary conditions (intrusion of solutions in the mine) by BfS has shown, that the long-term containment of the waste in the mine cannot be ensured. Therefore BfS came to conclusion that a retrieval of the waste will be necessary to ensure the compliance with the radiological safety goals. The retrieval operations will run several decades. Therefore the availability of all necessary electrical and technical components must be guaranteed for this period. In this context, the relevant components of the hoisting equipment of the Asse shaft 4 required replacement. Asse shaft 4 is a fresh air intake shaft and is equipped with a small hoisting cage for the transportation of personnel (three men per ride) and materials. The technical measures for replacing the hoisting equipment include mounting new rope winding equipment, installing a new SELDA (strain energy linear ductile arrestor) braking system, and installing new electro-technical controls. Furthermore, a new rescue concept has been developed and adapted to the safety provisions of the SELDA system. DBE TECHNOLOGY GmbH was tasked with the coordination and supervision of the electro-technical work. The requirement to complete the electro-technical refitting work within three weeks at the



3D model of the French geological repository design (CIGÉO) (Source: ANDRA)

same time that limited mine operations resumed were special challenges in successfully completing the project. A new control room equipped with electro-technical installations has been installed to allow installation tests during forward construction. Prior to the final installation of the new hoisting equipment, the necessary cables have already been positioned in the shaft. The main installation and commissioning took place from December 14, 2013 to January 5, 2014. A condition of the installation was to ensure that rescue of personnel could occur within two hours. On January 5, 2014, the new hoisting equipment was approved by the experts of the mining authority. Mining work resumed the next day.

### Support for the French project for the development of the conceptual design for a deep geologic repository

In 2006, France's Parliament chose deep disposal as the only solution for ensuring the long-term safety of inter-

mediate level long-lived (IL/LL) and high level (HL) radioactive wastes. A respective Deep Geological Repository (DGR) is currently planned to be built along the border of the Meuse and Haute-Marne districts in eastern France, where research conducted since the 1990s has identified a site with geology favourable to the siting of such a disposal facility. The DGR for HL and IL/LL waste, otherwise known as the Industrial Centre for Geological Disposal (Centre industriel de stockage géologique – Cigéo) will include surface installations for controlling and conditioning waste packages, as well as underground installations for waste disposal purposes and connecting infrastructures between surface and underground.

In 2012, ANDRA, the French National Radioactive Waste Management Agency, contracted the consortium Gaiya to initiate design studies for Cigéo. A draft layout has been put forward for public debate in 2012. The design of the DGR shall now be developed further on the basis of specific Governmental guidelines as well as on the outcome of the

public debate. For this purpose support for Gaiya has been acquired in order to enable the production of licensing documents in 2013.

A consortium led by TRACTEBEL GDF SUEZ has been chosen for the design of the underground facilities. Due to its experience from planning, constructing and operating of DGRs in Germany DBE TECHNOLOGY GmbH was subcontracted by TRACTEBEL for the development of a conceptual design of shaft internals including the respective hoisting systems for the currently foreseen five shafts of the repository and for the simulation of the so-called co-management – the parallel erection of the mine and operation of the repository. The main objectives to be achieved by the simulations are the confirmation of the general feasibility of the project according to the current conceptual planning and its optimization.

For further information visit our website [www.dbe-technology.de](http://www.dbe-technology.de) or scan the QR code below.

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