

# DBE TECHNOLOGY NEWS

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2015

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für Generationen

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for Generations

**DBE TEC**  
DBE TECHNOLOGY GmbH



For DBE TECHNOLOGY GmbH the activities of its International Cooperation Department provide far more than increased business opportunities outside the German markets. More importantly, international cooperation brings increased experience and know-how as well as international perspectives and new ideas to the company and our pool of experts.

The experience gained through working for clients all over the world has significantly enhanced our capabilities related to developing technical solutions for other disposal concepts and geological and/or political environments than those considered in Germany so far. This international cooperation with clients and business partners ensures that the qualifications and competencies of our experts remain state-of-the-art in the area of radioactive waste disposal, thus continuously expanding DBE TECHNOLOGY GmbH's area of expertise.

One particular field of work where DBE TECHNOLOGY GmbH has gained extensive know-how through its international activities is the development of innovative technological solutions for near-surface and surface disposal facilities and their safety assessments. Since its founding DBE TECHNOLOGY GmbH has been involved in the planning and/or safety assessment of ten such facilities located in eight different countries and has estab-

lished itself as a recognized leader in this area. The technical design and safety assessment of the future National Disposal Facility near Kozloduy in Bulgaria, which is described in more detail in this newsletter, is one of the most recent examples from this area.

There is another reason for us to participate in international projects: In the same way we profit from working together with other institutions, our international partners benefit from the sharing of our know-how and experience as well. This is very important to us because we feel we have the obligation to increase the level of radiological safety, and for us this obligation does not end at the borders of our home country. In addition, poor practices in radioactive waste management in other countries are likely to cast a bad light on the entire industry. We have therefore a strong interest in supporting the successful implementation of waste disposal projects around the world. Consequently, we welcome international cooperation activities that allow us to provide such support.

To summarize, we believe that the exchange of experience through international cooperation is highly beneficial to all participating parties and supports all of us in our common endeavor to find safe and technically feasible solutions for the disposal of radioactive waste.

Some of the international projects, where we have recently contributed to the development of such solutions, are described in more detail in this newsletter. Should you be interested to learn more about our role in these projects or other projects that we carried out in the past, just contact us via our website.

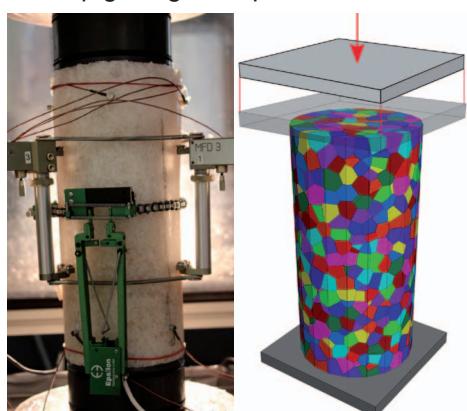
Happy reading!

Dr. Bernt Haverkamp

Deputy Head of  
International Cooperation Department  
DBE TECHNOLOGY GmbH

## Contribution to repository safety: sealing of the EDZ in rock salt

The integrity of the host rock is a fundamental issue with regard to the retention of radionuclides in a deep geological repository. But the construction of the repository will impair the host rock. Therefore, with regard to long-term safety, special attention has to be paid to mine openings and the excavation damaged zone (EDZ) at their contour. The EDZ is a disintegrated zone around mine openings that is characterized by microfractures forming a highly connected fracture network. Compared with tight host rock, the EDZ has a significantly increased permeability thus compromising the post-closure safety of deep geological repositories.



Left: Mechanical measurement of a salt rock sample, Right: 3 D-model of a rock salt sample for re-calculation of laboratory test for calibration.

The objective of a corresponding R&D project founded by BMWi / Project Management Agency Karlsruhe is to develop a modelling approach that can be used to simulate the mechanical deterioration of rock salt at grain scale. Many methods used to describe the hydro-mechanical processes inside the EDZ are based on continuum mechanical approaches where several



Construction work at Konrad mine (Germany)

mechanical processes are homogenized over a defined volume. Rock salt, however, consists of individual grains that are connected by grain boundaries, thus forming a complex crystalline microstructure. The deterioration at grain scale is primarily due to an opening along grain boundaries. In order to simulate the crystalline microstructure and analyze the fracture and damage behavior the discrete element method (DEM) was used in combination with polyhedral shaped elements. In order to simulate the damage, contacts between the polyhedral shaped elements were allowed to break. In contrast to the continuum approach, DEM provides the possibility to consider discontinuities explicitly.

First, the DEM models must be calibrated. The identification of the relevant input parameters is usually done by re-calculation of laboratory tests. For this purpose, the microscopic fracture events during the loading are recorded by means of acoustic emission measurements. The data are used to calibrate the mechanical properties and particularly the fracture pattern of the numerical models. Thus, the results of the project will contribute to the optimization of EDZ sealing in rock salt. Towards the end of the year a final report will be published, that describes the methodological approach of simulating the mechanical deterioration of rock salt at grain scale and the corresponding results.

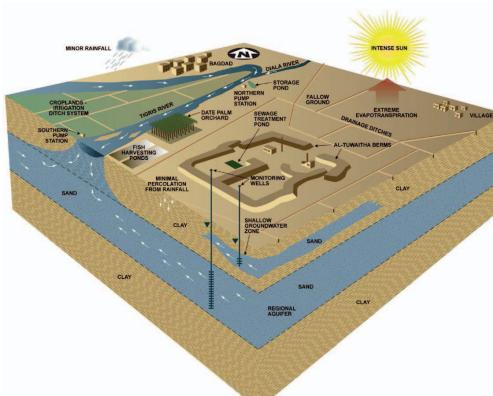
## Development of a Design of a Radioactive Waste Repository in Iraq

Iraq used to have a comprehensive nuclear programme in the past. As a result of a bombing in 1991, extensive damage and also looting occurred at

the nuclear sites, particularly at the Al-Tuwaitha site, where 18 nuclear facilities were located. With international support, significant progress has been made in the decommissioning of a number of nuclear facilities at this site. Currently, Iraq considers to locate a radioactive waste disposal facility at the Al-Tuwaitha site (about 30 km from Bagdad), which is the subject of this INSC (Instrument for Nuclear Safety Cooperation) project. The near-surface disposal facility is intended for the disposal of low- and intermediate-level waste from past activities in Iraq as well as for future radioactive waste produced in the country (e.g. decommissioning and remediation).

The design of the Iraqi repository was granted to a consortium consisting of NUKEM Technologies GmbH as leader, DBE TECHNOLOGY GmbH, and the Slovak Radioactive Waste Management Organisation JAVYS. The specific responsibilities of DBE TECHNOLOGY GmbH will be the development of the conceptual design and the safety analysis report.

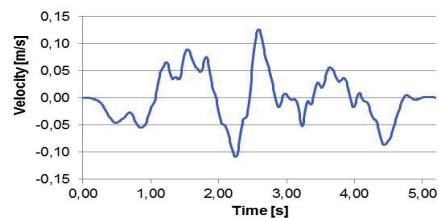
The duration of the project, which started in May, is three years.



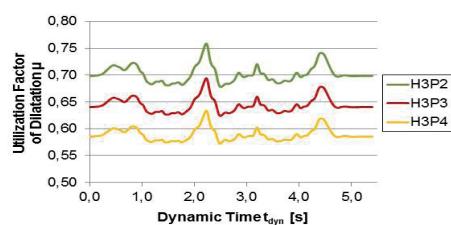
Conceptual site model of Al-Tuwaitha in Iraq  
(Source: Sandia National Laboratories)

## Integrity of a shaft seal under earthquake impact

Earthquakes cause much more damage to surface than to subsurface structures. Therefore, few investigations have been carried out on the earthquake resistance of geotechnical barriers. Most evaluations rely on experience from earthquake impacts on mines.



Velocity history for the S-wave-proportion of the earthquake, which is applied as a boundary condition to the base of the model



History of the utilization factor of dilatancy in the EDZ for the calculation with dynamic material properties. Values < 1 imply the integrity of the system

Internationally, the use of a FEP catalogue to establish scenarios that may affect the integrity of the geotechnical barriers of a final repository for high-level radioactive waste and spent fuel is being increasingly accepted. Following this method, the earthquake resistance of geotechnical barriers has to be demonstrated unless the FEP Earthquake is ruled out due to its low probability. In the course of a diploma thesis sponsored by DBE TECHNOLOGY GmbH and TU Bergakademie Freiberg (Germany), the performance of a shaft sealing system under earthquake loading was investigated numerically.



DBE TECHNOLOGY GmbH booth at the Annual Meeting on Nuclear Technology 2015

The model and the demonstration concept for the investigation were based on the "Preliminary Safety Analysis for the Gorleben Site". The shaft seal, composed of salt concrete type Asse, was assumed to be located in Leine-rock salt at a depth of 650 m to 780 m. The numerical simulation is based on the loads (velocity-histories, i.e. stress-histories) of the design earthquake of the Gorleben site. To obtain information about the integrity of the sealing system during the earthquake impact, the dilatancy criterion according to Cristescu/Hunsche, the fluid pressure criterion, and the Drucker-Prager yield criterion were examined for the excavation damaged zone (EDZ) and for the sealing element itself.

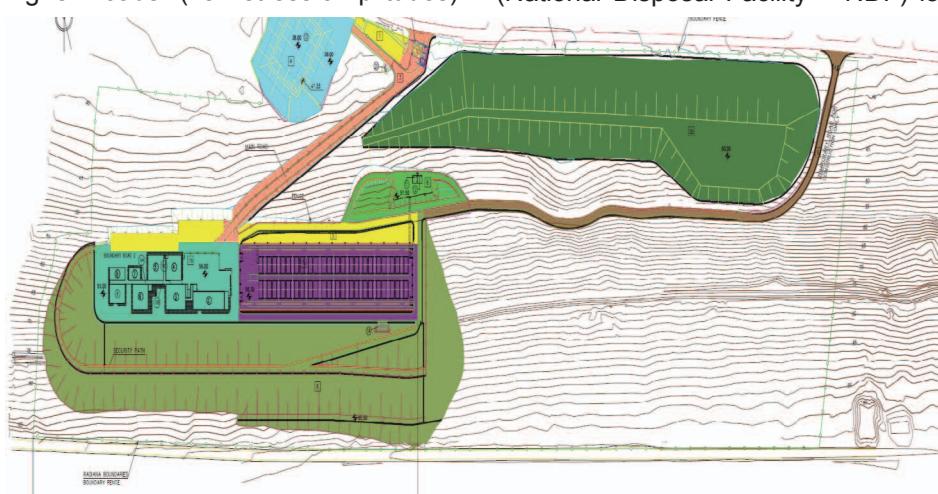
The numerical analyses were carried out with static material properties, which can be up to ten times lower than dynamic properties. The results showed that an earthquake would have only little influence on the barrier and would not impair its integrity. If dynamic properties are used for the simulations, higher loads (i.e. stress-amplitudes)

can be expected. Dynamic material properties derived from ultrasonic measurements were used in a further investigation. The corresponding results showed much more fluctuation in the state variables during the earthquake, but again the integrity of the sealing system was not affected negatively. These calculations show exemplarily that earthquake loading does not affect the integrity of a geotechnical barrier. Thereby, a gap in the quantitative verification of the functionality of geotechnical barriers was closed.

cated adjacent to the Kozloduy Nuclear Power Plant, has reached a major milestone. The technical design has been approved by a relevant authority, the National Center for Radiobiology and Radiation Protection. The design and licensing project for the Bulgarian State Enterprise Radioactive Waste (SERAW) is carried out by a consortium of DBE TECHNOLOGY GmbH, Westinghouse Electric Spain SAU as consortium leader, and the Spanish radioactive waste management agency ENRESA, with local expert support provided by EQE Bulgaria AD.

The NDF design work initially focused on the conceptual design of the repository. In December 2012, the Bulgarian Nuclear Regulatory Agency (BNRA) and SERAW approved the conceptual design and authorised the consortium to start developing the technical design of the repository. Under the responsibility of DBE TECHNOLOGY GmbH and in close cooperation with the consortium's Bulgarian subcontractor, EQE Bulgaria AD, the technical design work was completed and summarised in 19 separate chapters, filling about 50 folders and totalling approximately 7,000 pages. Despite the tight time schedule and various challenges, e.g., new regulatory requirements in the course of the design development, SERAW was able to accept the technical design in spring this year and to submit it formally to the relevant authorities.

Currently, SERAW is planning to finish the project in order to start building the repository in about one year. For this purpose, the consortium will be tasked with preparatory activities, like the necessary work to define the design for just the first construction phase.



First construction phase of Bulgarian NDF (Source: SERAW)

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



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