BGE TECHNOLOGY NEWS

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2025

DENKMAL: Development and testing of a device for vertical emplacement of HLW canisters (2011)

BGE TEC

BGE TECHNOLOGY GmbH

- ADVANCEMENTS IN FLOW BARRIERS FOR THE CLOSURE OF THE ASSE MINE
- BOREHOLE SEALING IN EVAPORITIC ENVIRONMENTS
- THE SECOND SIX YEARS OF DBE TECHNOLOGY GMBH (2007–2012)

For 25 years, BGE TEC has been supporting repository programmes worldwide and contributing to the international state of science and technology through its research. This milestone serves as an opportunity for us to reflect in this year's editions of our newsletter.

In this edition, you will find the progress achieved during the particularly stable phase from 2007 to 2012, presented both on the last page and in the image scroll bar.

2007
Construction supervision for sealing structure in Asse mine

Evening of Arts and Sciences

Dear Readers, Dear Colleagues,

As BGE TECHNOLOGY GmbH (BGE TEC) celebrates its 25th anniversary, the motivation for establishing it may come as a slight surprise. Following Germany's decision to phase out nuclear energy in 2000, all projects of DBE were halted. These developments led to the layoff of more than a third of DBE's staff, risking the loss of unique and critical expertise. To retain this valuable knowledge and provide attractive employment opportunities to key personnel, DBE TECHNOLOGY GmbH (DBE TEC) was founded.

Focusing on the acquisition of third-party contracts, the new subsidiary steadily grew into a stable and economically sound company, centred on four strategic pillars:

- R&D in HLW disposal
- International cooperation, including contributions to repository projects abroad
- Specialised mining engineering services
- Key scientific support for DBE's projects

Synergies between these pillars, combined with strong cooperation with both German and international partners, enabled the company to gain advanced expertise and ensure its practical application.

For example, in close collaboration with BGR and GRS, several R&D projects led to the development of an advanced safety assessment approach – focusing on containment demonstration rather than conservative release scenarios. For the Asse mine, major components of the sealing concept were developed and implemented to ensure safe closure. Across Central and Eastern Europe, and in consortium with Andra (FR), Covra (NL), Enresa (ES), Posiva Oy (FI), and SKB (SE), numerous EU-funded assistance projects were successfully delivered.

In less than a decade, DBE TEC grew to nearly 80 employees – until DBE recalled many of them to meet its own increasing needs. Vacant positions were gradually filled with well-educated and highly motivated university graduates. By then, the company had firmly established itself in both the German and international arenas, proving to be a small but highly flexible and capable source of added value.

However, in 2017, the company's future became uncertain when Germany's radioactive waste management system was reorganised, and DBE was restructured into the newly founded BGE. This challenge was met successfully with support of DBE and its supervisory board, allowing a smooth transition into BGE TEC.

Unfortunately, some of the company's efforts did not achieve the desired outcomes, due to factors beyond its control. Among the most disappointing setbacks were the effective loss of EU-funded assistance projects for Ukraine and the cancellation of a long-standing R&D cooperation with Russian scientists – both consequences of Putin's aggression against Ukraine. Additionally, several contributions to Germany's repository projects are affected by their slow progress, marked by crucial uncertainty in terms of timelines and costs. These challenges are largely due to a highly complex and sometimes contradictory regulatory framework. While the issues are well understood, it may be time to re-evaluate this framework – without compromising safety objectives – especially in light of the new federal government's commitment to eliminating bureaucratic obstacles for cost- and time-efficient infrastructure development.

With these reflections in mind – and inspired by how the younger generation is continuing to lead BGE TEC forward – I extend my heartfelt wishes for your continued success and personal well-being. I am deeply grateful that my youthful dream of working on challenging and meaningful tasks in a highly qualified, motivated team came true through this company.

Thanks to collaboration with colleagues from many nations, I have had the privilege of experiencing outstanding international cooperation in radioactive waste management – an inspiring model in a world that urgently needs better, and above all, peaceful collaboration to meet global challenges.

And so, enjoy working toward mastering the challenge you have been entrusted with.

Dr. Jürgen Krone
DBE/BGE TECHNOLOGY GmbH
Executive Manager (2001 – 2013) /
Managing Director (2013 – 2018)

Advancements in Flow Barriers for the Closure of the Asse Mine

Since 2002, BGE TEC (then DBE TECHNOLOGY GmbH) has been involved in constructing flow barriers in the Asse mine as part of the emergency concept. In case of an uncontrollable solution inflow, these barriers guide solution movements to hinder flow through the emplacement chambers.

Two pilot flow barriers (PSB) were built in 2003 (PSB A2) and 2006 (PSB A1). DBE TEC developed the technical concepts and oversaw construction. When PSB A2 was tested with pressurised solution, the excavation-damaged zone (EDZ) in the rock proved to be a significant transport path. To address this, test injections with various sealing agents were carried out at PSB A2. An ultra-fine binder based on MgO and sodium silicate was

2009
Occupational Safety Certificate:
Sicher mit System

2010
IAEA DISPONET Network meeting participants visiting Konrad mine

2011
Large-scale column experiment in the Asse mine

identified as a suitable injection material. PSB A1, however, did not require injections, as the EDZ had been sufficiently removed in advance and the structure met the injection requirements from the outset.

After testing sodium silicate for sealing injections and filing a patent in 2006, further test injections were carried out on PSB A2 and a dry abutment structure in 2007. The injections reduced solution flow in the exposed structure, though effects in dry rock could not be evaluated. This technique for sodium silicate injections and related permeability measurements led to another patent in 2008.

Results at PSB A1 showed higher impermeability than PSB A2 due to better EDZ removal verified by geotechnical measurements. Routine construction of flow barriers began in 2007, starting with those of lower complexity to build up experience. The initial contract with DBE TEC (2006) covered work on the first eight of about 60 planned barriers. During this, the standardised process chain of structural verification, specialist monitoring, and final inspection was gradually developed.

As complete EDZ removal at vertical barrier sites proved impractical, a framework agreement for injections was signed in 2008. With verified long-term stability of sodium silicate, a flexible multi-stage injection system was established.

This framework contract later included barrier construction, with a follow-up signed in 2021. To date, about 40 flow barriers have been built, and injections for six vertical barriers have been completed, with more underway. Typically, particle-based injections are done first, followed by sodium silicate injections, which enable geotechnical measurements and provide additional sealing.

These injections significantly enhance the Asse mine's emergency provisions and are continuously verified by measurements.

Borehole Sealing in Evaporitic Environments

Nuclear Waste Services (NWS) manages nuclear waste safely in the UK and is responsible for developing a Geological Disposal Facility (GDF) for the permanent disposal of higher activity radioactive wastes – one of the UK's largest environmental and infrastructure programmes.

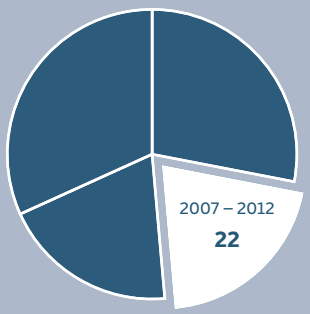
NWS is currently working on siting a GDF, which requires a willing community and a suitable site. In Cumbria, northwest UK, two Community Partnerships are considering the Mercia Mudstone Group (MMG) as a potential host rock. In future, NWS may drill site investigation boreholes to better understand the MMG. BGE TECHNOLOGY GmbH (BGE TEC) was recently commissioned by NWS to carry out desk-based research on sealing techniques for boreholes drilled in the MMG.

Considering the MMG's permeability, strength, and chemical composition, BGE TEC laid the groundwork for developing tailored sealing materials for an engineered barrier system. Experience from German and international borehole sealing projects was incorporated, and influencing processes and findings were identified. Cement, bentonite plugs, and other advanced materials were assessed for compatibility with MMG's properties, and their technical readiness levels were evaluated. A key result has been a multi-barrier sealing concept, combining sealing elements, backfill, and abutments to prevent fluid or gas migration. BGE TEC's report to NWS describes the entire process from drilling to closure, outlines technical hurdles, and recommends material handling and packaging best suited for MMG borehole closure.

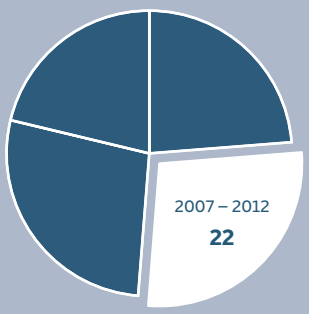
BGE TEC developed a sealing concept that uses the swelling effect and low permeability of bentonite clays and demonstrated how to engineer the bentonite composition to match the MMG's chemistry. Additionally, a backup concept for sealing without bentonite was prepared in case of mechanical or chemical incompatibilities.

BGE TEC showed that borehole sealing in the MMG is feasible with existing materials and equipment, thus providing a basis for further research, new material development, and studies of material interactions.

107 International Projects in 25 Years



80 R&D Projects in 25 Years



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2011
International training course on "Practical Aspects of Repository Engineering for Disposal of Spent Fuel/HLW in Sedimentary Environments" in cooperation with IAEA and ITC

Contract signature for LILW surface repository design project in Bulgaria – joint project with Westinghouse Spain and Enresa, Spain

2012
Team members of MoDeRn, an international R&D project on monitoring in DGRs

During the period covered by this newsletter, DBE TECHNOLOGY GmbH (DBE TEC) established itself as a strong organisation within the waste management community, making many valuable contributions to waste management programmes in Germany and abroad. Under DBE TEC's leadership, a consortium with varying composition of WMOs from France, Belgium, the Netherlands, Spain, and the UK supported the EU in establishing WMO programmes in Eastern Europe. At the same time, DBE TEC began carrying out its first projects for the design of near-surface repositories.

From 2005 to 2010, the integrated EC project ESDRED (Engineering Studies and Demonstration of Repository Designs) and the associated German project DENKMAL were key initiatives for DBE TEC. The primary objective of ESDRED was to demonstrate the technical feasibility of specific techniques for HLW repositories on an industrial scale, including the construction, operation, backfilling, and closure of facilities. DBE TEC developed, constructed, and tested transport and emplacement equipment for a vertical borehole disposal concept. Tailored to the specific boundary conditions of a repository in a domal salt formation, a so-called emplacement device enabled disposal in up to 300-metre-deep boreholes. While the DBE department from which DBE TEC had spun off had already gained experience in carrying out similar large-scale tests in the 1990s, this was the first project of its kind for DBE TEC. The project's scientific and technical impact was recognised far beyond the company's borders. The successful demonstration experiments and reliability tests advanced the state of the art and the technical basis for radioactive waste disposal. Further concepts based on this technology were developed in subsequent projects.

A notable milestone in this period was the VSG ('Vorläufige Sicherheitsanalyse Gorleben') project (2010–2013). The project team, consisting of BGR, DBE TEC, GRS, IfG, iSTec, KIT, and various institutes from the universities of Frankfurt, Aachen, and Clausthal, conducted a thorough preliminary safety analysis of a potential HLW/SNF repository in domal rock salt formations. This analysis was based on existing data from the Gorleben site. Although the Gorleben salt dome is no longer considered a potential repository site, the VSG's work set a standard for future safety analyses in Germany. The VSG was primarily based on the ISIBEL I and II R&D projects, which provided the tools for safety assessment. As part of the VSG project, a safety assessment concept was developed based on site data, information on the quantities and types of waste, and repository planning and design. A FEP catalogue was created and scenarios were developed in the course of a system analysis, which were then considered in a performance assessment, including numerical integrity analyses of the geologic and geotechnical barriers.

The REPOPERM I and II R&D projects provided valuable insights that also supported the VSG. These projects demonstrated through mathematical modelling that combining short-term seals made from conventional building materials with long-term seals of moist crushed salt could achieve functionality within a few hundred years, enabling a safe containment concept without radionuclide release.

During this period, BGE's predecessor organisations BfS and DBE advanced with planning for the decommissioning of the Morsleben repository site (ERAM). As part of the safety concept, an in-situ test of a drift sealing structure in rock salt at a scale of 1:1 was conducted. The test dam, made of salt concrete, was constructed in 2010. DBE TEC supported its parent company in developing construction materials and ensuring quality during construction, as well as in providing numerical forecasts, back-analysis calculations, and an evaluation of accumulated measurement data. Although some local cracks were observed, which were unexpected, it was demonstrated that the 25-metre-long dam is sealed with a permeability of less than 1E-19 m². Even if the material used to build such structures has changed since then, the test provided valuable findings.

Another focus of DBE TEC's work was on reducing the hydraulic permeability of the excavation-damaged zone (EDZ), for example at drift or shaft seal sites. As part of the VERA R&D project, injection methods and sodium silicate-based injection materials were developed for this purpose. Furthermore, technology to assess the success of the injection process, i.e., the permeability achieved, was developed. This technology has been patented and has since been used for many sealing projects in the Asse mine.