



# BGE TECHNOLOGY NEWS

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BGE TECHNOLOGY GmbH

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Participants of the US–German Workshop



Dear Readers,

Since its foundation in the year 2000, BGE TECHNOLOGY GmbH has been carrying out fundamental research and development work in the area of HLW and SNF disposal. These R&D activities – funded by the German Ministry for Economic Affairs and Energy (BMWi) – entail the development of safety and safety demonstration concepts for repositories in different host rocks with a focus on salt formations. It also comprises the design of such repositories, including demonstration tests for transport and emplacement techniques. Similar R&D work for repositories in claystone and crystalline rock lags behind in Germany. This flyer, however, introduces two new examples of such R&D activities. The first project – called TREND – focuses on an update of the existing transport and emplacement technologies for different waste packages into a repository in a salt formation. At the same time, such technologies are to be developed for repositories in claystone and crystalline host rock. The other project – called KOREKT – concentrates on retrievability solutions for waste packages disposed of in a repository in crystalline rock. The results of both projects will provide important basic data to BGE, the German

implementer, which it needs for the comparison of repositories in different host rocks.

The development of repository concepts, which have to meet the safety requirements, includes the assessment of operational safety as well. Lessons learned during R&D work in this area were applied for a repository concept in the Belgium boom Clay.

Together with the US partner SANDIA and the Project Management Agency Karlsruhe, BGE TECHNOLOGY GmbH has been organizing the US–German workshops on repository research, design and operation for repositories in salt formations for 9 years. The idea is to exchange information and discuss new results of R&D work in this field. This year’s venue was the School of Mines in South Dakota, USA.

Since last year, BGE TECHNOLOGY GmbH has been supporting BGE’s Site Selection Department. The first task was to identify the R&D needs for the siting process for a repository for HLW and SNF. The results were summarized, published, and discussed in a workshop with the German scientific community in spring this year. The second task included conceptual design work for repository systems in 3 different host rock formations (project RESUS). This project will be continued jointly with BGR and GRS.

More details are given in the following chapters. Happy reading!

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## Support of BGE’s Site Selection Department

According to the German Site Selection Act for a repository for heat-generating radioactive waste and spent nuclear fuel, a comparison of suitable sites is required in order to identify the site that best meets the safety requirements. In this context, BGE launched various projects to generate and gather data for this decision process. Approximately one year ago, BGE TECHNOLOGY GmbH was asked to support BGE’s Site Selection Department in relevant R&D activities.

The first task was to identify R&D needs and to establish a research plan for BGE with regard to the siting process. In a first step, the tools and information necessary for BGE to carry out safety assessments of potential sites were compiled. In a subsequent screening process, the tools available were determined, which in turn led to the identification of the R&D gaps that still need to be closed. The results of this work were published by BGE and discussed in a workshop with the scientific waste management community in spring this year. The focal points identified by BGE TECHNOLOGY GmbH were confirmed to a large extent by the workshop participants. However, several suggestions for additional research areas (e.g. geochemistry) were provided. The comments and recommendations were incorporated into a revised report. BGE TECHNOLOGY GmbH will continuously support BGE in updating the R&D needs according to the evolution of the state of the art.

The second task was part of the R&D project RESUS, which is to identify the relevance and sensitivity of geoscien-



Transport equipment for disposal casks

tific weighting criteria for the site selection process. In this context, BGE TECHNOLOGY GmbH mainly carried out repository design work. Our know-how and experience concerning repository design and thermo-mechanical calculations was applied to selected repository systems in the host rock formations salt, claystone, and crystalline rock. This ongoing project will deliver recommendations for the site selection process and will in particular provide support for setting up suitable safety investigations.

## Transport and Emplacement Technology for a HLW Repository

In January 2019, the Project Management Agency Karlsruhe (PTKA) commissioned BGE TECHNOLOGY GmbH on behalf of the Federal Ministry for Economic Affairs and Energy (BMWi) with the further development of the technology needed to transport and emplace high-level radioactive waste in deep underground repositories (R&D Project TREND).

The aim of the project is to bring the existing concepts of the transport and emplacement technologies for the various waste packages and different emplacement options up to a comparable level of development. A largely homogeneous state of development shall be achieved across the various combinations of emplacement concepts, waste casks, and host rocks.

The designs of the already tested technologies for the drift emplacement of POLLUX® casks and for the vertical borehole emplacement will be reviewed

taking into account current regulations and the state of the art in technology. Where necessary, they will be updated. The conceptual idea for horizontal borehole emplacement is to be improved so that essential dimensions and technical data of the technology will be available. The technology for the direct disposal of transport and storage casks will be further developed.

The technical properties of the transport and emplacement equipment for repository concepts in claystone and crystalline rock have so far been derived on the basis of already known machines for rock salt. Thus, the project also has to focus on the different host rock-specific requirements.

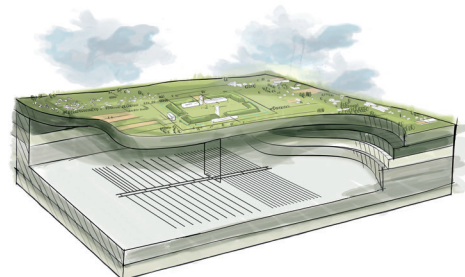
During the engineering process, it is generally planned to give preference to modular designs in order to facilitate future adaptations with regard to waste retrieval, changed boundary conditions, or progress in technology.

At the end of the project, full 3D models of all machines considered and descriptions of the transport and emplacement processes will be available.

## Operational Safety Assessment for the future Belgian GDF

For more than 40 years, ONDRAF/NIRAS (the federal agency responsible for managing radioactive waste and enriched fissile materials in Belgium) has been studying the concept of a Geological Disposal Facility (GDF) in poorly indurated clays as an option for the long-term management of both category B waste (low-level and intermedi-

ate-level long-lived waste – LILW-LL) and category C waste (high-level waste – HLW and spent fuel). In the absence of a policy decision, the proposed Belgian reference option for disposal of such waste is a GDF in poorly indurated clays, located at a depth between 200 m and 600 m.



The SFC-1 GDF reference layout (courtesy of ONDRAF/NIRAS)

Without any presumption about the exact location of the facility, the primary objective of ONDRAF/NIRAS at the current stage of the programme is to establish the safety and feasibility of constructing, operating, and closing a GDF at the conceptual design level. This will be evaluated in a first version of the safety and feasibility case (SFC-1 V1) for the geological disposal of category B and C radioactive wastes. Analysis of the operational safety is an important part of the SFC-1 V1.

BGE TECHNOLOGY GmbH has supported ONDRAF/NIRAS in preparing an operational safety analysis of the current GDF reference design and the processes taking place during the operation and closure period. Flowcharts that break down the operational processes into individual work steps have been developed, and a SWIFT methodology (Structured What If Technique)



Construction work at Morsleben repository

was used for each step to identify risks and measures required to mitigate their consequences.

In addition to this SWIFT analysis, specific attention was given to the fire risk, especially in the blind-ending disposal galleries (DG). Based on the results of the fire risk analysis, recommendations were given concerning a reduction of potential fire loads in order to minimize the fire hazard. In addition, strict working procedures were proposed to prevent the presence of workers between the DG dead ends and equipment presenting significant fire loads. The use of mobile refuge chambers has also been introduced into the safety concept.

## Retrieval from a HLW Repository in Crystalline Rock

Within the framework of the R&D project KOREKT, BGE TECHNOLOGY GmbH intends to develop suitable concepts for the retrieval of waste packages from future repositories for HLW and spent fuel in crystalline host rock. The work is based on recently developed repository concepts and on the results of a systematic review of the safety require-

ment "retrievability". This includes a more detailed planning of the retrieval technique and of the retrieval processes as well as a first estimate of the required time. The safety consequences and possible effects of the safety requirement "retrievability" on the design and layout of the repository will be clarified. The work will provide the basis for developing a technical solution for a repository in crystalline rock formations that will be ready for approval. For the technical implementation of retrievability, the two basic disposal concepts – drift disposal of self-shielding POLLUX® casks and disposal of unshielded casks in short vertical bore-



Demonstration test with a suction bell for the removal of backfill material from a disposal borehole

holes – will be investigated. All investigations related to the retrievability of waste packages are restricted by the facts that the motives for retrieval and the start of the process cannot be predicted. Thus, the exact boundary conditions at the time of retrieval are also unknown. Within previous R&D projects, it was assumed that retrieval will be carried out at the latest possible start of retrieval; i.e., at the end of the operating period of the repository. At that time, all waste packages will already have been emplaced and the main drifts will have been backfilled and closed. Only a few infrastructure areas and the shafts or surface connections will still be in operation. This scenario covers a wide range of possible retrieval scenarios.

The R&D project KOREKT will also investigate how "selective retrieval" can be taken into account. For this purpose, the term "selective retrieval" will be defined in more detail. Furthermore, characteristic retrieval scenarios in the various stages of the repository life cycle will be investigated and described. The aim is to create a system that is as modular as possible and allows easy adaptation to different boundary conditions and/or retrieval scenarios.

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



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