BGE TECHNOLOGY NEWS

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2020

BGE TECHNOLOGY GmbH

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Transport cart with transfer cask containing disposal canister


Opalinus-Clay – a potential host rock considered in the PIONIER project

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. These concept developments showed that there are still several specific open questions to be answered prior to compiling the safety case.

One of these questions relates to clay as host rock and the mathematical (numerical) description of its long-term behaviour in response to excavations and heat release. The project PIONIER, funded by our parent company, BGE, covers the implementation and further development of coupled THM constitutive laws for clay rock as well as for sealing material like bentonite, taking into account the expected functional periods of the seals. The application of the new constitutive laws will allow reducing uncertainties during the safety demonstration.

Another important open question relates to the canisters enclosing the waste. Depending on the potential host rock, the design of a canister may be different with regard to the corresponding disposal concept. Due to the lack of specific design requirements for canisters in the different host rocks, the project KOBRA, also funded by BMWi, was launched. Its objective is to develop a systematic derivation of design requirements in accordance with rules and regulations stipulated in the current safety requirements.

Complementary to the work on safety demonstration concepts, BGE TECHNOLOGY GmbH discusses and evaluates on behalf of Öko-Institute e.V. different options for the management of high-level waste disposal, covering the individual steps interim storage, transport, conditioning, as well as underground disposal.

Sticking to the tradition of letting our experts describe their projects to you, please enjoy a short trip through a selection of our current activities and projects.

Happy reading!

Michael Jobmann
Deputy Head R&D Department

KoBrA: Requirements for Disposal Containers for HLW and Spent Fuel

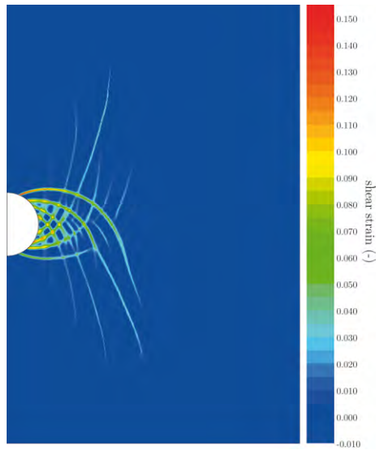
KoBrA is a joint project of BGE TECHNOLOGY GmbH and the Federal Institute for Materials Research and Testing (BAM). In the course of this project, BGE TECHNOLOGY GmbH and BAM identified requirements for waste packages for high-level radioactive waste and spent fuel elements for different host rocks and developed first ideas for suitable waste package concepts. For the work in KoBrA, BGE TECHNOLOGY GmbH and BAM first created a top-down approach for the derivation of container requirements and the development of waste container concepts. Important boundary conditions for the canister design – the radionuclide inventory, the surrounding geosphere, legal requirements, and demands from repository operation and long-term safety – were checked and necessary container requirements noted. Thus, container requirements regarding safe enclosure, necessary shielding, corrosion, gas production, temperature management, and general manageability and transportability were identified and mostly quantified. Finally, these container requirements were translated into first technical ideas for new waste container concepts. In addition to this, a literature study that summarises the majority of the waste container concepts existing throughout the world was compiled. The results will be published in a synthesis report with appendices in late summer this year.


POLLUX® cask at a maintenance station of the Pilot Conditioning Plant at Gorleben (Germany)

KoBrA was funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy.

Constitutive material modelling for clay materials

As mandated German Waste Management Organisation, Bundesgesellschaft für Endlagerung mbH (BGE) is contributing beneficiary of the European Joint Programme on Radioactive Waste Management (EURAD). EURAD is a European collaboration towards safe radioactive waste management, including disposal, through the development of a robust and sustained science, technology, and knowledge transfer programme that supports timely implementation and serves to foster mutual understanding and trust between Joint Programme participants. Beyond BGE's involvement in the EURAD activities on knowledge management and studies on uncertainty management, it contributes to two R&D work packages with the acronyms GAS and HITEC. GAS has the objective of improving the understanding of the mechanisms of gas transport processes in clay materials. In HITEC, the influence of temperature on clay host rock and clay buffer materials will be investigated. BGE intends to develop numerical instruments that are necessary for carrying out safety analyses for repositories in clay formations.



Results from hydro-mechanical modelling of a drift in claystone (PIONIER project)

This is why BGE TECHNOLOGY GmbH was commissioned by BGE with the project PIONIER, complementary to the EURAD work packages GAS and HITEC. Within PIONIER, BGE TECHNOLOGY GmbH will develop constitutive material models for claystone and bentonite materials. These models will subsequently be used in the framework of EURAD to carry out numerical modelling of laboratory and field experiments planned in the work packages GAS and HITEC.

In order to achieve this task, BGE TECHNOLOGY GmbH will work in close collaboration with several research institutions throughout the world. Technical assistance with the Geotechnical Institute of the Technical University Bergakademie Freiberg is planned for issues related to the numerical code OpenGeoSys. Collaboration with Prof. David Mašín of Charles University Prague was set up for the integration of his thermo-hydro-mechanical model for expansive clay into OpenGeoSys. Together with the Institute of Engineering of the National Autonomous University of Mexico, BGE TECHNOLOGY GmbH will develop – also in OpenGeoSys – an advanced time-dependent hydro-mechanical model for claystone and will expand it to consider thermal effects.

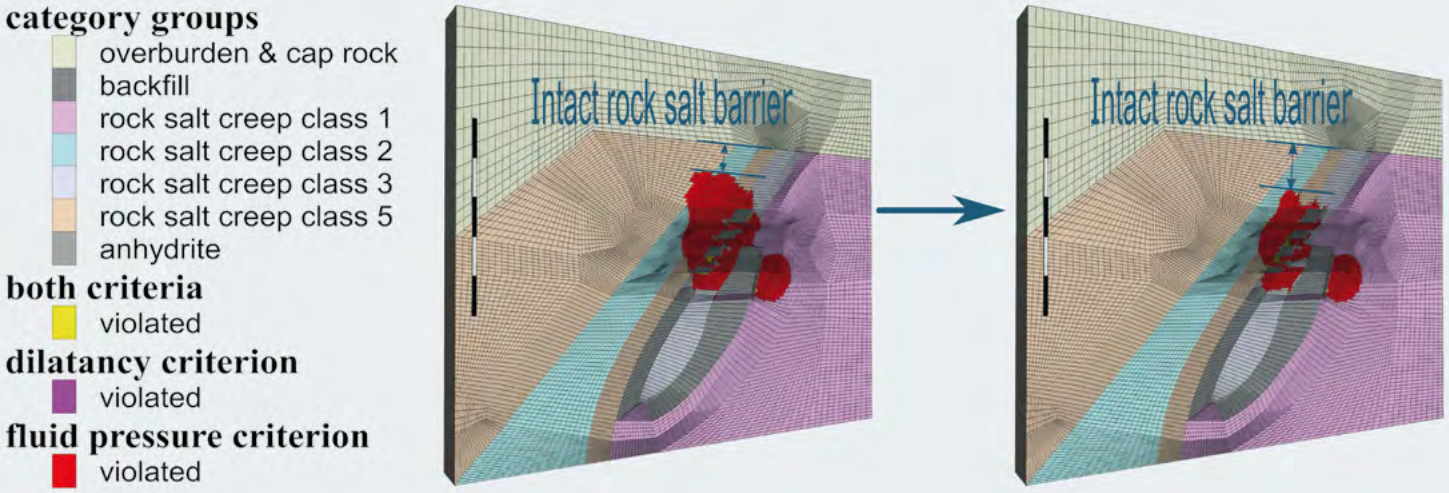
Treatment of uncertainties concerning geomechanical modelling

Within the framework of the plan approval procedure for the closure of the Morsleben Repository (ERAM), a safety case is currently being prepared by BGE. Part of the safety case is the modelling of the geologic barrier in order to provide evidence of its integrity. This safety-relevant task is jointly carried out by BGE and BGE TECHNOLOGY GmbH.

In the case of rock salt, the integrity of the geologic barrier is affected if certain geomechanic load states and induced mechanisms apply, which in turn leads to damage and loss of the initial tightness of the rock salt. These integrity-relevant processes are:

(1) the fluid-pressure-driven opening of grain boundaries if the pressure exceeds the normal stress and adhesive forces at the boundaries, and/or

(2) generation and growth of (interconnected) cracks due to deviatoric loads.



Thermo-hydro-mechanical modelling for two time steps for the Morsleben repository (Germany)

To assess the geomechanical loading of the geologic barrier and the barrier's short- and long-term evolution, numerical calculations are carried out. As a result of these calculations, a statement on the structural stability and barrier integrity can be given. The calculation results are influenced by model assumptions, simplifications as well as by data, parameters, and model uncertainties and variabilities.

To treat these uncertainties of geomechanical modelling, a stepwise approach was used to show the range of possible solutions and to identify relevant issues and parameters. First, a catalogue of uncertainties was compiled after systematic screening of the whole modelling sequence from input data to output. The uncertainties and possible relevant issues identified cover categories, i.e. mine and geological/geomechanical model, backfill planning, numerical codes and models used, including their simplifications, boundary and initial conditions, constitutive models and model parameters. These uncertainties were quantified and bandwidths were assigned. In a second step, the impacts of individual uncertainties on the barrier integrity were analysed by means of bandwidth studies. These studies use several generic models, each representative of specific conditions in different mine areas. The calculations evaluate the long-term evolution of the geomechanical state within the rock salt barrier, e.g., the evolution of the thickness of the intact rock salt barrier. This allows identifying relevant uncertainties and quantifying the impact of each uncertainty on the barrier integrity.

Potential steps for HLW management in Germany

BGE TECHNOLOGY GmbH was commissioned by Öko-Institut e.V. with providing its expertise for R&D project WERA, which is funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy. The main goal of the 18-month project WERA is to identify potential steps and needs for action with regard to the waste management routes for spent nuclear fuel and high-level radioactive waste in Germany while integrating the different waste management steps; i.e. interim storage, waste conditioning, transport, and eventual disposal. In addition, future R&D needs are to be identified, and a basis for considering specific waste management options from an economic point of view is to be developed.

In its first task, BGE TECHNOLOGY GmbH has briefly described the waste management steps "waste conditioning" and "waste disposal" and identified links and dependencies with preceding and following steps. What became obvious is that the delivery of sufficient waste packages to the conditioning facility in due time is one of the most important steps that impacts the processes waste conditioning and disposal. Another result was that the concentration of several waste management steps; e.g., interim storage, waste conditioning, and waste disposal, at one single location minimises the amounts of waste transport and consequently the amounts of potential complications.

In a second and third task, BGE TECHNOLOGY GmbH will act as a consultant to Öko-Institut e.V. and will give advice and recommendations for developing waste management step scenarios and for deriving courses of and needs for action. The project results will be published in spring 2021.

For further information, visit www.bge-technology.de or scan the QR code below.

BGE TECHNOLOGY GmbH

Published by: BGE TECHNOLOGY GmbH
Eschenstraße 55 · D-31224 Peine
www.bge-technology.de
July 2020
Edited by: Dr. Andree Lommerzheim
Production: Agentur Spezial, Braunschweig