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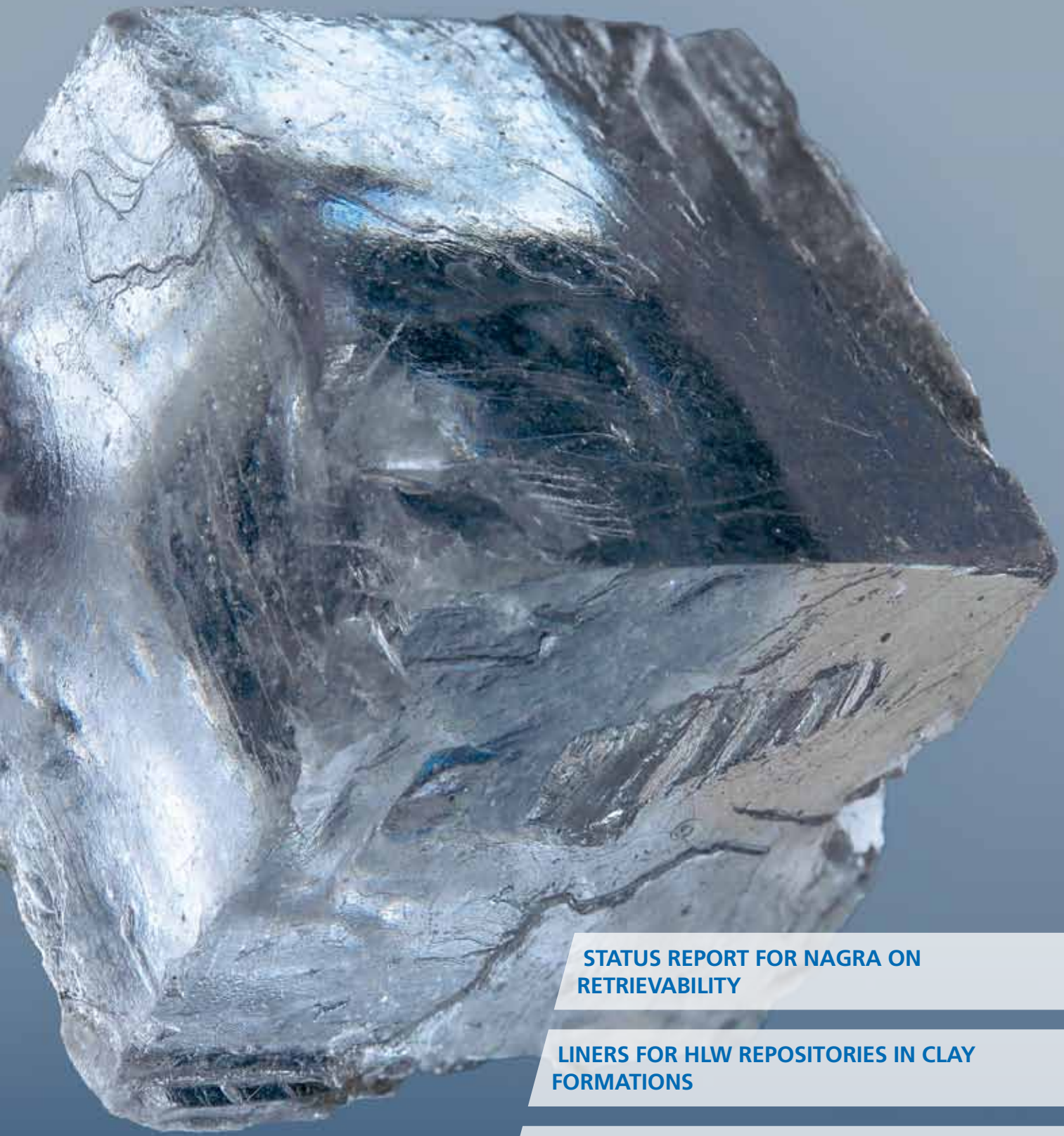

STATUS REPORT FOR NAGRA ON RETRIEVABILITY

LINERS FOR HLW REPOSITORIES IN CLAY FORMATIONS

BACKFILL DEVELOPMENT FOR DIFFERENT GEOLOGIC ENVIRONMENTS AND WASTE TYPES

INFLUENCE OF CONSTRUCTION AND OPERATION OF A HLW REPOSITORY ON ITS LONG-TERM SAFETY

BGE TECHNOLOGY GmbH

Team of BGE TECHNOLOGY GmbH

Mine work and lining in clayey and marly formations at Konrad repository (Germany)

Dear Readers,

An eventful year has come to an end: Our former parent company, DBE, has merged into the new implementer BGE of the national radioactive waste disposal programme. At the same time, the shares in DBE TECHNOLOGY GmbH were transferred to BGE, which keeps us close to all activities connected with the implementer. This fact is reflected by our change of name to BGE TECHNOLOGY GmbH. In both organisations, BGE and BGE TECHNOLOGY GmbH, there have been changes in management, and due to the merger of various organisations to form BGE, structures and processes, including those of BGE TECHNOLOGY GmbH, had to be adapted and partly redefined. This transformation process demands a lot from all employees and has not yet been completed, though considerable progress has already been made.

Despite these challenges, the daily work must continue. This happens with admirable calm and quality. BGE TECHNOLOGY GmbH continues to carry out various research and development activities and is involved in external and internal projects. Our clients benefit from the practical experience we gain in the work we carry out for the national repository programme in activities that range from desktop studies to performing work in the mines.

This issue of BGE TECHNOLOGY NEWS once again presents several examples of our activities. Two projects describe BMWi-funded research projects that benefit strongly from practical experience. One deals with the development of liners for HLW repositories in clay formations and the other one with the influence of the construction and operation of a HLW repository on its long-term safety. Knowledge from research projects combined with practical experience from the implementation of our national and international projects make up the immense expertise we have gained over the years. Two examples, where this expertise was imperative, are the status report for NAGRA on retrievability and the summary report of the backfill development for different geologic environments and waste types for the British implementer RWM.

But see for yourself and enjoy the first edition of our newsletter in year 1 after the renaming of our company.

Happy reading!

Dr. Thilo von Berlepsch
Managing Director
BGE TECHNOLOGY GmbH

Status Report for NAGRA on Retrievability

NAGRA is in charge of the long-term management of radioactive waste in Switzerland. The Swiss waste management concept relies on a deep geological repository. There are three regulatory licence milestones in repository licencing: general licence, construction licence, and operating licence. The operating licence for a HLW repository requires that retrievability of the waste be possible during the operating period of the repository. Furthermore, the technical feasibility has to be demonstrated by means of tests of retrieval techniques prior to the start of repository operation.

Therefore, NAGRA will integrate waste retrieval strategies in its deep geological repository concepts. These concepts have to be developed before submission of the general licence application, which is planned for 2024. As a starting point, NAGRA commissioned BGE TECHNOLOGY GmbH with the preparation of a status report on international experience concerning retrievability in different repository programmes. Thus, BGE TECHNOLOGY GmbH outlined the concepts and approaches for radioactive waste retrieval in selected international waste programmes, with special focus on Belgium, Canada, Finland, France, Germany, Japan, the Netherlands, Sweden, U.K. (excluding Scotland), and U.S.A. All national programmes consider retrievability for high-level waste from reprocessing or spent nuclear fuel only. The conceptual approaches for retrieval and, if existing, the technical concepts were summarised. Furthermore, the respective national regulatory boundary conditions were described.

Demonstration test for retrieval of a spent fuel canister (bottom) from a borehole by a grabber. Landesbergen (Germany)

Liners for HLW Repositories in Clay Formations

In October 2018, the Project Management Agency Karlsruhe (PTKA) commissioned BGE TECHNOLOGY GmbH and DMT GmbH & Co KG on behalf of the Federal Ministry for Economic Affairs and Energy with an R&D project to develop technical solutions for the design of support structures for mine openings in a repository for heat-generating waste (HLW) in clay formations (acronym AGENT). The installation of support structures is a major task in mine openings of a HLW repository in low strength rock as it increases operational safety. The construction of a repository in clay rock is not possible without ensuring excavation stability by means of suitable lining systems or support structures. The low to moderate strength, the creep behavior, the property changes, which depend on the water content, as well as the depth of the clay formations result in high demands on the bearing capacity of the lining system used. In mining and tunnelling, steel, concrete, reinforced concrete or fiber-reinforced concrete structures are common materials for lining. In repository concepts, a cement-based lining with a minimum steel content is preferred. In addition to mechanical aspects, possible corrosion processes of the steel and concrete lining, plus potential interactions between the cement-based materials and the host rock and/or bentonite backfill and sealing materials are important aspects that influence the design of support structures.

With respect to retrievability, a massive support structure could have advantages. The requirement of retrievability may add further requirements for the support structures. However, the presence of lining structures also has consequences for the long-term safety. For instance, the formation of fluid pathways may be influenced. On the other hand, chemical interactions of the lining materials with the clay rock and sealing / backfilling materials are possible and will thus be investigated. It is crucial to determine which alteration products arise, which properties these residuals have, and how long the mechanical functionality of the lining is given. The project's objective is to combine these – partly conflicting – design objectives to develop a suitable lining concept.

Backfill Development for Different Geologic Environments and Waste Types

In the United Kingdom (UK), geologic disposal is the Government's policy for the management of higher activity radioactive waste. In order to ensure that no harmful quantities of radioactivity will reach the surface environment, the closure of the geological disposal facility (GDF) will be based on a multi-barrier concept. Backfilling of the mine openings is an integral part of this concept, because by stabilising the cavities, the formation of flowpaths and a squeezing out of solutions are minimised. In addition, backfill can delay pressure build-up on barriers and can be used to control the chemical environment in order to prevent a degradation of barrier materials and to reduce radionuclide solubility.

Radioactive Waste Management Limited (RWM) has been established as the delivery organisation responsible for the ongoing siting process and GDF planning in UK. Due to the extraordinary importance of backfilling, RWM initiated an integrated project to develop backfill materials and backfill concepts for the range of GDF host rocks and waste types. BGE TECHNOLOGY GmbH is contracted as a member of this project team and leads the work within the rock salt scope, because of its extensive knowledge in the development and testing of backfill materials and in the planning and construction of barrier-backfill systems. A particular advantage for the project is that this experience

Pumping of concrete backfill at Asse Mine (Germany)

HLW expert group of BMWi visiting the Konrad repository

covers a wide range of materials, such as cement-based high- und low-pH mortars and concretes, magnesia binder, and bulk materials. The project gives BGE TECHNOLOGY GmbH the opportunity to utilise the strategies developed for the design of barrier and backfill systems, the associated material selection, and the development and implementation of quality assurance measures, which are an essential basis for the demonstration of functionality of the structures. Our company also supports work on backfill emplacement technologies and logistic considerations based on our experience in the operation of mixing plants and hydraulic and pneumatic conveying systems. This way, we can support RWM in getting a step closer to attaining the essential goal of safe, secure, and cost effective disposal of radioactive waste.

Influence of Construction and Operation of a HLW Repository on its long-term Safety

Nationally and internationally, there is extensive experience on how to demonstrate the safety of a repository for heat-generating radioactive waste and spent fuel, both for the operating phase as well as for the post-closure phase. But in the past, little attention was paid to the fact that there is a close interaction between the operating phase and the post-closure phase. In other words, the operating phase determines the starting conditions for the long-term safety analysis.

On behalf of the Federal Ministry for Economic Affairs and Energy (BMWi), the Project Management Agency Karlsruhe (PTKA) assigned the R&D project "Assessment of the influence of sound construction and safe operation of a HLW repository on long-term safety" (acronym: BASEL) to GRS and BGE TECHNOLOGY GmbH in 2016. The aim of the joint project was to compile the safety requirements during the operating phase of a HLW repository and the requirements of long-term safety and to develop a clear and transparent methodology to assess the mutual impacts of both. As this is a general question of safety assessment methodology, the corresponding investigations were not specific to a disposal strategy or a host-rock type but are generally valid.

Reflecting the common methodology for long-term safety assessment, first a FEP catalogue was developed, which describes all relevant components and processes of the construction and operation of a repository mine (only for underground facilities because an impact of operation in these facilities on long-term safety seems to be most probable). Possible events occurring during the operating phase were systematically derived by combining each component and each process. This approach increases completeness of the events considered. The consequences for operation were identified and countermeasures to reduce their probability of occurrence and/or to minimise their consequences were analysed. Afterwards, the impact of repository operation on post-closure safety as well as the impact of requirements for long-term safety on operational safety were analysed and evaluated.

Demonstration test for the shaft hoisting of a POLLUX® cask

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

BGE TECHNOLOGY GmbH

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