2017

Annual Report

BGE TECHNOLOGY GmbH

Balance Sheet as of December 31, 2017

Assets

	Notes	31.12.2017 T€	31.12.2016 T€
A. Fixed assets	(1)		
I. Intangible assets		7	8
II. Tangible assets		113	114
III. Financial assets		(€ 250,00)	(€ 250,00)
		120	**122**
B. Current assets			
I. Inventories	(2)		
1. Work in progress		1.748	4.204
2. Advance payments		63	19
		1.811	4.223
II. Receivables and other assets	(3)		
1. Trade receivables		31	496
2. Receivables from affiliated companies		600	92
3. Other assets		18	75
		649	663
III. Cash on hand, bank balances		3,009	2,897
		5,469	**7,783**
C. Prepaid expenses and deferred charges		**12**	**13**
D. Deferred tax assets		**0**	**7**
		5,601	**7,925**

Equity and Liabilities

	Notes	31.12.2017 T€	31.12.2016 T€
A. Equity			
I. Subscribed capital	(4)	511	511
II. Capital reserves	(5)	179	179
III. Revenue reserves	(6)	1,229	569
IV. Net profit for the year		694	660
		2,613	**1,919**
B. Provisions			
1. Provisions for pensions		118	119
2. Tax provisions	(7)	150	0
3. Other provisions	(8)	406	379
		674	**498**
C. Liabilities	(9)		
1. Advance payments received • of which with a remaining term of up to one year 2,008 T€ (4,295 T€)		2,008	4,295
2. Trade payables • of which with a remaining term of up to one year 57 T€ (890 T€)		57	890
3. Payables to affiliated companies • of which with a remaining term of up to one year 106 T€ (96 T€)		106	96
4. Other liabilities • of which with a remaining term of up to one year 143 T€ (227 T€) • of which taxes 138 T€ (220 T€)		143	227
		2,314	**5,508**
		5,601	**7,925**

Income Statement

for the period from January 1 to December 31, 2017

	Notes	2017 T€	2016 T€
1. Turnover	(10)	8,405	9,262
2. Changes in inventories	(11)	–2,456	–334
3. Other operating income	(12)	185	611
		6,134	**9,539**
4. Purchases	(13)		
a) Cost of raw materials, consumables and supplies and of purchased merchandise		7	34
b) Cost of purchased services		791	4,059
		798	4,093
5. Personnel expenses	(14)		
a) Wages and salaries		2,975	3,096
b) Social security contributions and expenditures for pensions		732	757
• of which for pensions 3 T€ (7 T€)			
		3,707	3,853
6. Depreciation		50	38
7. Other operating expenses	(15)	553	627
		5.108	**8.611**
		1.026	928
8. Other interest and similar income	(16)	0	16
9. Interest and similar expenses	(17)	–8	–17
10. Taxes on income	(18)	–324	–266
11. Result after taxes		**694**	**661**
12. Other taxes		0	–1
13. Net profit for the year		**694**	**660**

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Editorial

Dear Readers,

In view of the far-reaching organisational changes in the way the Federal Government assumed responsibility for the disposal of radioactive waste, the financial year 2017 was a special one for our company – in particular due to the merger of our previous shareholder, DBE, with Asse-GmbH and with parts of BfS into Bundesgesellschaft für Endlagerung mbH (BGE) and the associated change of shareholders. We are pleased that our confidence has been confirmed and that our small company now has a secure future as a subsidiary of BGE.

The decisive factor for this decision was not only our economic performance, but also the fact that we were able to contribute an active, diverse cooperation with numerous partners at home and abroad to the new BGE Group at a high scientific and technical level. This annual report is intended to give you a brief overview of our activities.

From our point of view, the new constellation opens up numerous opportunities for these activities to be continued and for our know-how to be incorporated into the solution of BGE's tasks, but also for considerable further development. As a sign of integration into the BGE Group, our company has been renamed BGE TECHNOLOGY GmbH. Thus, this company report is already published under our new company name, while the reporting on the work in 2017 is still for DBE TECHNOLOGY GmbH.

Securing the continued existence of our company and its future viability has been the decisive task for me. Now is a suitable time to put the management into other hands, in order to be able to dedicate myself primarily to private interests and obligations, which often had to stand back.

In this context, I would like to thank our numerous cooperation and business partners, most of whom have been with us for many years, for their trust and cooperation, and our employees for their dedicated work, and wish them a successful continuation of their cooperation.

Yours,

Dr. Jürgen Krone
Managing Director

Dr. Jürgen Krone
Managing Director, DBE TECHNOLOGY GmbH

Company Profile

From left to right: **Dr. Jürgen Krone** (Managing Director), **Wilhelm Bollingerfehr** (Head of Research & Development, Authorised Officer), **Dr. Nina Müller-Hoeppe** (Head of Repository Safety), **Dr. Thilo von Berlepsch** (Head of International Projects), and **Hartmut Bothe** (Head of Asse Projects)

Expertise and Know-how

DBE TECHNOLOGY GmbH was established in the year 2000 as a 100% subsidiary of Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE, *German Company for the Construction and Operation of Waste Repositories*) in order to focus and further develop the scientific and technical know-how of DBE and to make it available to interested parties both nationally and internationally. Already in the first decade of our existence, we became a nationally and internationally recognised engineering company in the area of radioactive waste disposal.

At the end of 2017, DBE, together with the operator of the Asse mine, Asse-GmbH, and the organisational units responsible for the German repository projects of BfS (*Federal Office for Radiation Protection*) were integrated into Bundesgesellschaft für Endlagerung mbH, BGE (*Federal Company for Radioactive Waste Disposal*). Thus, all tasks concerning the disposal of radioactive waste in Germany are now handled by a single Federal Company that can rely on the specific know-how of about 1,900 engineers, technicians, scientists, miners, and employees specialised in other fields. Consequentially, our company was renamed BGE TECHNOLOGY GmbH and remains a 100% subsidiary of BGE.

Thus, BGE TECHNOLOGY GmbH can rely on over forty years of experience gained in German nuclear waste repository projects as well as on the know-how gained through over three decades of collaborative efforts in national and international research projects. The company's main fields of activity include waste disposal strategies and activities, site characterisations and evaluations, concept, design, safety, and engineering of repositories, and their closure. On behalf of German research institutions and other public and private customers, BGE TECHNOLOGY GmbH provides services in the field of radioactive waste management, e.g., support in collecting and documenting waste data and demonstrating that the waste packages destined for the Konrad repository meet the corresponding technical acceptance criteria.

In Germany, the legal requirements for licencing a repository stipulate that the technical feasibility of the intended operational processes be demonstrated before a licence is granted. BGE TECHNOLOGY GmbH developed the systems and components required for operating a repository in salt, which were subsequently tested until ready for regulatory approval. BGE TECHNOLOGY GmbH develops safety concepts for the operating and post-operating phases of repositories and plans corresponding safety measures. The company is also involved in the development of safety cases for HLW repositories in salt and clay formations and crystalline rock and thus makes a vital contribution to mastering the scientific and technical challenges of the forthcoming German site selection process.

Thorough sealing of subsurface repositories is essential for ensuring the long-term safe containment of radioactive waste. In this context, the company develops sealing concepts that are adapted to the site-specific requirements, to the radionuclide inventory destined for disposal, and to the disposal concept.

Throughout the world, BGE TECHNOLOGY GmbH advises and supports public and private energy, waste disposal, and mining companies as well as testing organisations and governmental authorities in all issues concerning the disposal of radioactive waste, mining, and other related technical fields. The company supports IAEA, for example, in advising various countries regarding the development of national waste management strategies. Furthermore, the company develops and tests new materials, processes, and machinery for their practical application in repositories.

BGE TECHNOLOGY GmbH has gained extensive experience in research projects in underground laboratories in clay and claystone in Mont Terri (Switzerland) and Bure (France), and in crystalline rock in Grimsel (Switzerland) and Äspö (Sweden). Based on the knowledge accumulated in these projects, the company develops and analyses repository concepts for various host rocks (crystalline rock, clay, lime, and salt) and waste types (high-level, intermediate-level, and low-level radioactive waste). Furthermore, the company reviews repository concepts of other waste management organisations and gives recommendations for optimisation measures.

Based on its comprehensive know-how, the company supports governmental institutions in the development of national waste management strategies and gives recommendations for corresponding financing strategies and pertinent legislation.

A word of thanks to our employees

The management would like to thank all employees for their extraordinary commitment and cooperation in the business year 2017.

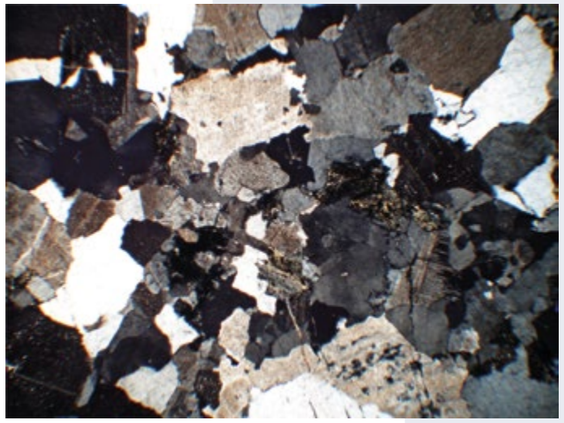
In an environment marked by change and transition, they applied their scientific know-how in numerous international undertakings and various research projects in an exemplary manner and beyond the normal measure, thus showing their high level of expertise and their loyalty to the company.

Germany

In Germany, the responsibilities and tasks for the disposal of radioactive waste are regulated by the *Atomic Energy Act* (AtG). According to Section 9a para. 3 of the Atomic Energy Act, it is the responsibility of the Federal Republic of Germany (Federal Government) to set up repositories for radioactive waste. The Federal Government assigned this task and the associated authorities to the *Federal Company for Radioactive Waste Disposal* (BGE). BGE was founded in 2016 and since 2017, it has been a merger of parts of the former Bundesamt für Strahlenschutz (BfS, *Federal Office for Radiation Protection*), of Asse-GmbH, and of Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE, *German Company for the Construction and Operation of Waste Repositories*). In accordance with the Atomic Energy Act, BGE operates the Asse II mine, the repositories Konrad and Morsleben, and the Gorleben mine. The Federal Government continues to be the supervisory authority.

The *Repository Site Selection Act* (StandAG) of 2017 defines the search and selection procedure for a site for a repository for heat-generating radioactive waste and spent fuel elements in Germany. § 6 stipulates the tasks of BGE as follows:

- Draw up proposals for possible regions for sites and their exploration
- Prepare site-specific exploration programmes and assessment criteria
- Carry out the surface and underground exploration of the selected sites
- Prepare the related preliminary safety assessments
- Recommend to the *Federal Office for the Safety of Nuclear Waste Management* (BfE) the site that is best suited for a repository for mainly heatgenerating waste



Example of a potential crystalline host rock: Thin section of an aplite vein in Piégut-Pluviers Granodiorits (Massif Central, France) (source: R. Pohl)

» MICHAEL JOBMANN
Geophysicist, age 60

Developing safety concepts for crystalline rock is a challenging task. However, we are not alone. An interdisciplinary team of BGR, GRS and DBE TECHNOLOGY is currently working on this task with great commitment. Having the opportunity to coordinate this pioneering work is my daily motivator and gives me a lot of pleasure.

Safety and Safety Demonstration Concept for a HLW Repository in Crystalline Rock – Project CHRISTA-II

Due to the political decision to restart the search for a site for a repository for heat-generating radioactive waste, salt, clay, and crystalline rock are to be investigated regarding their potential to host a repository (*Site Selection Act* – StandAG). Thus, in 2017, the *Federal Ministry for Economic Affairs and Energy* (BMWi), represented by the *Project Management Agency Karlsruhe* (PTKA) launched the research project CHRISTA-II in order to develop a safety and safety demonstration concept for a repository for high-level heat-generating waste in crystalline rock in Germany and commissioned DBE TECHNOLOGY GmbH together with GRS gGmbH and BGR with this task. In this context, generic, site-independent geological models that are plausible for the geology in Germany will be developed by the project partner BGR (*Federal Institute for Geosciences and Natural Resources*). These models will reflect the different types of containment providing rock zones (CRZ) that were identified as potentially suitable to host a repository in the preliminary investigations in project CHRISTA.

Furthermore, a generic FEP catalogue for crystalline rock in Germany will be developed, which – at a later stage – will be the basis for deriving both a reference scenario as well as alternative scenarios. Key elements of a safety demonstration concept are the demonstrations of the integrity of the geologic and geotechnical barriers and the radiological analysis. Within the scope of the project, a conceptual design of the geotechnical barriers will be prepared, and exemplary integrity analyses will be carried out. In addition to this, radiological safety indicators for the CRZ types in question will be calculated. To demonstrate the integrity, the integrity criteria that are defined qualitatively in the safety requirements will be quantified to such an extent that a mathematical verification can be carried out based on specific numerical values. From today's perspective, the results will be available in mid-2020.

PHILIPP HEROLD
Mining Engineer, age 33

Sealing shafts is not necessarily one of the most favourite activities of a miner; after all it ends the mining activities. However, for a responsible approach to the environment, it is indispensable. This is all the more important for a repository; an issue that fascinated me already during my studies. Project ELSA, which we carry out in collaboration with TU Bergakademie Freiberg, allows me to expand my knowledge.

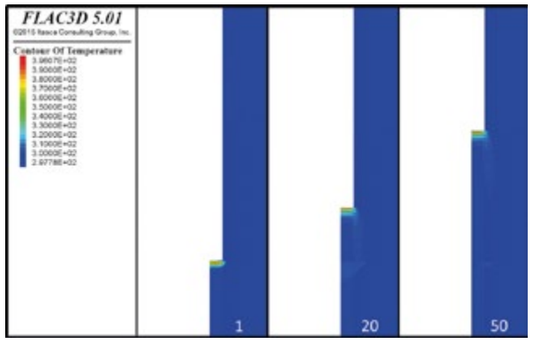
Numerical Analysis of the Excavation Damaged Zone around a Shaft in a Clay Formation – Project ELSA II

Within the scope of R&D project ELSA II (Shaft Seals for HLW Repositories), DBE TECHNOLOGY GmbH and TU Bergadademie Freiberg developed shaft sealing concepts for repositories in salt and clay formations. One aim of the work was to improve the understanding of how host rock and shaft seals influence each other during seal installation. There are still open questions concerning the technical necessity to partly remove the excavation damaged zone (EDZ) at the shaft contour and concerning the risks of additional damage due to the hot installation of bitumen. Thus, these processes were investigated by means of numerical analyses of a generic, 800-m-deep shaft with a diameter of 10 m in a clay formation. The main goals were a prediction of the thickness of the EDZ and a quantitative analysis of the changes in permeability of the EDZ. The permeability was modelled as a function of the effective stresses and the plastic deformation.

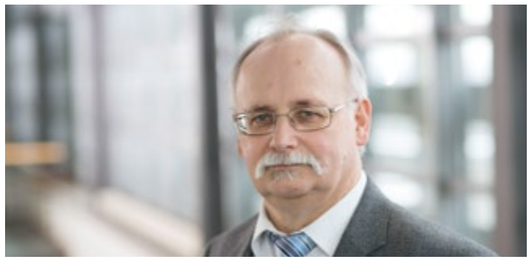
The THM analysis (thermal-hydraulic-mechanical) showed that the EDZ will expand by several metres into the host rock. As expected, this is connected with a significant change in permeability. An analysis of the permeability showed that the changes in permeability are mainly due to the shaft sinking. In initial state, the permeability parallel to the bedding is at least one order of magnitude higher than the permeability perpendicular to the bedding. Due to the shaft sinking, the permeability of the EDZ increases by a factor of 4 in the first 10 cm. In this highly damaged zone, the main flow direction changes from parallel to the bedding to parallel to the shaft contour.

An analysis of the thermal impacts of the hot bitumen installation and the partial removal of the EDZ showed that the damage caused by the hot installation is only marginal. The EDZ at the shaft contour, which is due to the shaft sinking, is already characterised by a considerably increased permeability. The extent and the properties of the EDZ are mainly due to the deformation and the stress conditions. Additional thermal impacts have only minor influence.

The numerical analysis increases our understanding of the boundary conditions in shafts in clay formations and of the conditions during closure of such shafts.



Temperature profiles during the layer-by-layer installation of hot bitumen



WOLFGANG FILBERT
Mechanical Engineer, age 63

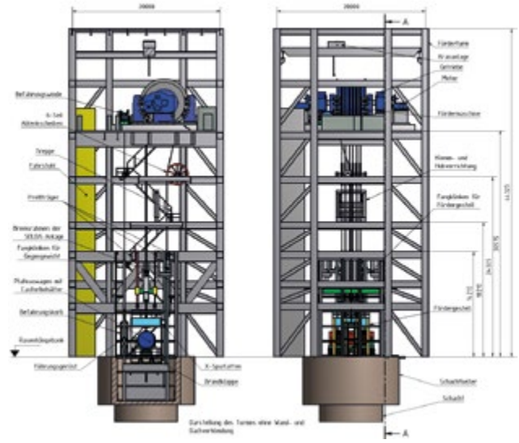
25 years ago, I was manager of a project that investigated the shaft hoisting of heavy loads (up to 85 t). It is encouraging to note that the approach we used at that time and the insights we gained are still valid today when it comes to a shaft hoisting system for a payload of 175 t. A review of the results showed that since then, further developments and enhancements concern minor details only.

Safety Investigations on the Shaft Transport of Heavy Loads – Project SULa

Failures during shaft hoisting can lead to a drop of a waste package down the shaft and thus to a release of radionuclides. In order to preclude such accidents, safety studies concerning shaft transport have been carried out in Germany for more than 20 years, however, shaft hoisting systems with payloads of 175 t were not included. In order to provide the basis for demonstrating the technical feasibility of such a shaft hoisting system, the *Project Management Agency Karlsruhe* (PTKA) on behalf of the *Federal Ministry for Economic Affairs and Energy* (BMWi) assigned the R&D project "Safety studies on the shaft transport of heavy loads up to 175 t" (acronym SULa) to DBE TECHNOLOGY GmbH. There is no internationally accepted approach to operational safety assessments of shaft hoisting systems. Regarding methods to demonstrate the safety of shaft hoisting systems, only limited experience exists from the operation of repository mines. Within the scope of the project, the transferability of probabilistic and deterministic methods used in nuclear power plants was thus analysed. Furthermore, corresponding assessment methods used in France, Belgium, Finland, and the United States were analysed.

A level-2 probabilistic safety analysis (PSA) as carried out for nuclear power plants uses event trees to determine, for instance, the amounts of radioactive material released due to undesirable events and to evaluate the related impacts. Most of the methods used in the PSA for nuclear power plants can be transferred to shaft hoisting systems, if the differences in the modes and processes of operation between these two systems are taken into account. Using a deterministic approach for an incident analysis is prudent, in order to assess if a shaft hoisting system meets the requirements.

Residual risks can be minimised by various means; e.g. by shortening the maintenance intervals in order to increase reliability or by using shock absorbers in order to manage the impacts of waste package drops down the shaft. The results of the project SULa, which was completed in 2017, show that sufficient basic information for a safety assessment of shaft hoisting systems is available.



Concept of a shaft hoisting system with a payload of 175 t

SABINE PRIGNITZ
Physicist, age 36

Without disposal container no disposal concept and, thus, no repository site. Compiling the requirements for disposal containers is an important and intriguing task, during which you notice that the container is part of an iterative process, because each change on the container affects long-term safety and operations.

Systematic Derivation of Requirements for Disposal Containers for a HLW Repository – Project KoBrA

On the one hand, disposal containers for a HLW repository are to ensure safe repository operations both during transport and during emplacement underground. Together with the host rock and other barriers, they are also to ensure the safe enclosure of the radioactive waste and spent fuel elements in the long term. For a repository in salt, a corresponding container with shielding, type POLLUX®, was developed and a prototype was built in the 1980s. It was to be emplaced on the floor of a horizontal drift in a repository mine. As an alternative, an unshielded spent fuel canister (BSK 3) was designed; however, a prototype was not manufactured. For a repository in clay and crystalline rock, only concepts of such containers exist in Germany. For this reason, the *Project Management Agency Karlsruhe* (PTKA) on behalf of the *Federal Ministry for Economic Affairs and Energy* commissioned DBE TECHNOLOGY GmbH and the *Federal Institute for Materials Research and Testing* (BAM) with the R&D project KoBrA.

The aim of this project is to develop requirements for waste packages for high-level radioactive waste and spent fuel elements for the host rocks rock salt, claystone, and crystalline rock and to develop suitable waste package concepts. Furthermore, the repository boundary conditions and the resulting loads acting on the canisters are to be identified. Based on the results of the study, generic container concepts are to be developed and possible impacts on the repository design are to be evaluated. All these considerations will take into account the legal regulations and non-mandatory guidance instruments.

The project started in June 2017 and focuses on:

- Research and analysis of the national and international state of requirements and concepts for disposal containers and compilation of safety-relevant container properties
- Determination of the relevant boundary conditions and load/stress parameters for disposal containers in the potential host rocks rock salt, claystone, and crystalline rock in Germany
- Systematic derivation and compilation of the requirements for disposal containers for a HLW repository
- Suggestions for possible container concepts

Mock-up of a spent fuel canister

ERIC SIMO
Civil Engineer, age 29

Investigating the technical feasibility of a repository in bedded salt formations in Germany is an important part of the search for a repository site. This task is handled in a multi-disciplinary team and in cooperation with US organisations. The results of project KOSINA demonstrate that disposal of radioactive waste in bedded salt formations and salt pillows is technically feasible.

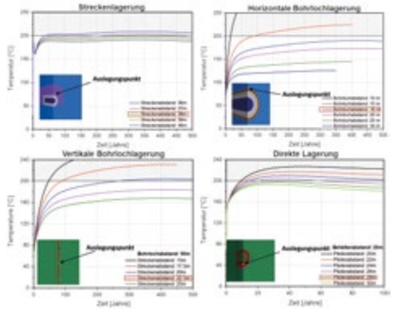
Designing a HLW Repository in Bedded Salt Formations – Project KOSINA

In Germany, the *Site Selection Act* (StandAG 2017) regulates the search for and selection of a site for a repository for high-level heat-generating radioactive waste and spent fuel elements. This requires that generic repository concepts and suitable safety and safety demonstration concepts for all potential host rock formations in Germany exist. Disposal concepts for a repository in a salt dome were developed in the 1980s whereas alternative host rocks like clay and crystalline rock were not taken into account until the beginnings of the 2000s. So far, bedded salt formations have never been the subject of comparable investigations.

Therefore, the *Federal Ministry for Economic Affairs and Energy* (BMWi) launched the R&D project KOSINA in summer 2015. KOSINA is an acronym for "Development of a concept for a generic repository for heat-generating waste in bedded salt formations in Germany as well as development and assessment of a safety and safety demonstration concept". The project served to develop a technical (site-independent) concept for such a repository in a bedded salt formation for the very first time and to prepare safety and safety demonstration concepts for the operational phase and for the long term. At the same time, this creates a further basis for a comparison of repository systems as implicitly stipulated in the StandAG. Together with her partners BGR, GRS gGmbH, and IfG, DBE TECHNOLOGY GmbH focused on the following issues:

- Development of generic geologic models and of corresponding material parameters
- Development of a safety and safety demonstration concept
- Development of repository designs and plans for four different emplacement concepts
- Geomechanical integrity analyses
- Studies on operational safety
- Analyses of the radiological consequences

In summary, two representative generic geological models for bedded salt formations (bedded salt and salt pillows) in Germany were developed within the scope of the KOSINA project. For each of these two models, two disposal concepts were developed based on a newly developed safety and safety demonstration concept. Corresponding mine workings were designed and thermal design calculations were carried out. By means of geomechanical integrity analyses and radiological consequences analyses, the safe containment of the radioactive waste could be numerically demonstrated for all four disposal concepts considered.



Results of thermal design calculations for four disposal concepts based on casks containing spent fuel elements

European Union

"Joint Programming" is one of the instruments for implementing the European Research Area (ERA). The aim is to increase the efficiency of research in Europe through voluntary, transnational cooperation between the Member States in "variable geometry" and the pooling of national resources.

This also applies to research into the management of radioactive waste, with a current focus on its disposal in deep geologic formations. Throughout the world, disposal in deep geologic formations is regarded as the most suitable solution for the long-term disposal of long-lived radioactive waste.

Since 2002, the EU has supported integrated projects aimed at the technical implementation of the disposal of radioactive waste, such as the IGD-TP "Implementing Geological Disposal of Radioactive Waste – Technology Platform" installed in 2009. The aim of the IGD-TP is to develop and implement strategic approaches at the European level that will enable a gradual approach to the safe disposal of radioactive waste in deep geologic formations. IGD-TP's 130 members include waste management organisations, research institutes, universities, and national authorities and institutions active in the field of radioactive waste disposal. DBE TECHNOLOGY GmbH is also a member of IGD-TP.

Since 2014, education and training measures have also been funded in addition to research work. These complement the EU Commission's Framework Programme for Research and Innovation (2014 – 2020) – Horizon 2020 – to which DBE TECHNOLOGY GmbH also contributes. There are three focal points in radioactive waste disposal research:

1. Development of long-term solutions in the field of disposal as well as development of separation and transmutation systems
2. Competence development through training and mobility measures

The tender for the European Joint Programming of Radioactive Waste Management and Disposal started in 2017. Our parent company BGE decided to participate in important research and networking activities taking advantage of the technical skills and of the extensive network of DBE TECHNOLOGY GmbH.

DR. NINA MÜLLER-HOEPPE
Civil Engineer, age 60

Within the scope of project DOPAS, surveys of expert opinions were carried out, which were organised as interdisciplinary workshops. Initial questions triggered discussions that were not only exciting, but also showed different points of view. As a result, questions still to be clarified were identified and bundled at an early stage.

Full-Scale Demonstration of Plugs and Seals – Project DOPAS

The European Commission programme DOPAS was carried from 2012 until 2016. Fourteen European waste management organisations and research and consultancy institutions (including DBE TECHNOLOGY GmbH) from eight European countries participated in the project. The focus was on research and development and on demonstration tests for full-scale drift and shaft seals in various underground laboratories in Europe. The disposal concepts in all host rocks include technical sealing systems – so-called Engineered Barrier Systems (EBS), which consist of special technical components; e.g. plugs and seals. These structures are made of artificial or natural building materials selected to perform a wide range of sealing and containment functions.

Within the European Technology Platform IGD-TP (Implementing Geological Disposal of Radioactive Waste – Technology Platform), the necessity to investigate plugs and seals was identified. For waste management organisations that were already focusing on the licensing and construction phase for a geological repository, the impetus for the research work came from the need to further improve the reference planning for sealing structures or to develop alternatives. For the waste management organisations, for which the licensing issues are still in the distant future, the motivation for participating in the DOPAS project was to support research and development.

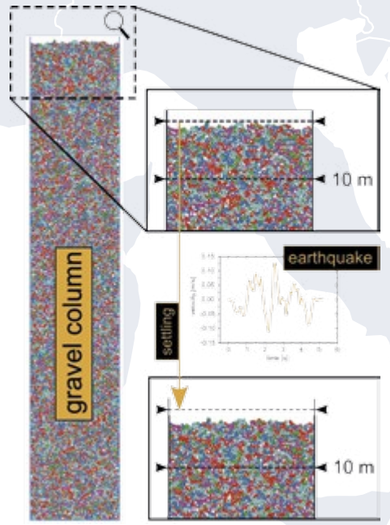


Illustration of the calculated impact of earthquakes on the stability (settlement behaviour) of a column filled with gravel

The DOPAS project was successful in improving the industrial feasibility of full-scale sealing structures, measuring their characteristics, controlling their behaviour under repository conditions, and their performance with respect to safety objectives. The corresponding activities and experiments carried out enable individual countries to raise their waste management programmes to a new state of the art. In addition, the knowledge and experience gained in the project provide the waste management organisations with a valuable basis for developing their own sealing construction solutions. The results of the modelling work carried out by DBE TECHOLOGY GmbH in the DOPAS project provided a sound basis for improving the modelling capabilities with respect to the constitutive laws to describe material compaction, which are stipulated for computational demonstrations by the German safety requirements for engineered barriers.

Iraq

In the past, Iraq had an extensive nuclear programme. A bombing in 1991 caused serious damage and looting of the ten nuclear sites. This particularly affected the Al-Tuwaitha site with 18 nuclear facilities. The subsequent actions by the International Atomic Energy Agency (IAEA) led to a further reduction in the use of nuclear facilities in Iraq. In 2004, IAEA launched the Iraqi Decommissioning Project (IDP) to assist Iraq in the planning and implementation of the decommissioning of the existing nuclear facilities, waste management, the rehabilitation of contaminated sites, and the development of the necessary regulatory framework. IDP is supported by the US State Department and coordinated by IAEA. Within the scope of the project, ten nuclear sites and two mines (Akashat and Abu Skhair) were evaluated, with a special focus on Al-Tuwaitha and Adaya. The European Union has supported the IDP with various projects since 2009.

The Ministry of Science and Technology (MoST) operates the nuclear facilities in Iraq, while the Ministry of Environment (MoE) is responsible for radiological environmental monitoring in the country. These two ministries are also responsible for the disposal of radioactive waste and for decommissioning activities. In 2013, MoST developed a national strategy for the disposal of radioactive waste. The plan is to build a repository for radioactive waste at the Al-Tuwaitha site. This repository is the subject of an EU INSC (Instrument for Nuclear Safety Cooperation) project and is intended for low- and intermediate-level radioactive waste from past and future (decommissioning/remediation) activities.

DR. BERNT HAVERKAMP
Geophysicist, age 61

I was very impressed by the strong commitment of our Iraqi partners, despite the critical situation in the country, to improve radiological conditions by decontaminating and decommissioning destroyed nuclear facilities and by the safe disposal of the resulting waste. It is very satisfying to be able to support them in this process.

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

DBE TECHNOLOGY GmbH, as part of a consortium of Western companies, supports the activities of the European Commission to develop an urgently needed repository for low-level radioactive waste (LLW) in Iraq. The disposal facility is needed for the ongoing decommissioning of nuclear facilities and related remediation activities in order to permanently and safely remove waste and material contaminated as a result of military attacks and subsequent looting during the two Gulf Wars from the environment.

The largest nuclear site is located at the Al-Tuwaitha Nuclear Center near Baghdad, where a total of 18 nuclear facilities are at various stages of decommissioning. Because of the ongoing security concerns in Iraq, the Iraqi Ministry of Science and Technology selected the well-fortified Al-Tuwaitha site as the best suited location for the needed LLW repository.

DBE TECHNOLOGY GmbH is responsible for developing the design of the repository as well as for the preliminary and intermediate safety assessment reports. Based on the results of a review of international disposal options conducted by DBE TECHNOLOGY GmbH, the Iraqi project beneficiaries and end-users selected a near-surface-type facility for the site.

The Al-Tuwaitha site is not ideal from a conventional site selection perspective. The Tigris River is only about a kilometre away from Al-Tuwaitha, and the proposed site location lies within the potential flood plain of the river. As a result, the base level of the facility will need to be raised to ensure a safe distance above a potential flooding event.

To provide the necessary clearance and to ensure a stable foundation, the facility will be constructed upon a raised platform constructed from a 4-m-thick soil cement cushion upon which a 2-m-thick concrete foundation slab will be poured prior to the construction of the repository.

Nuclear facilities in Iraq

Model of the Al-Tuwaitha repository (Iraq)

Belgium

In Belgium, ONDRAF/NIRAS (Organisme national des déchets radioactifs et des matières fissiles enrichies/ Nationale instelling voor radioactief afval en verrijkte splijtstoffen) has been responsible for the management of radioactive waste from the decommissioning of nuclear installations and their disposal since 1980.

The search for a site for a repository for low- and intermediate-level radioactive waste began in 1998 with the formation of local partnerships with municipalities on whose territory a nuclear facility was already in operation. In 2006, Dessel was confirmed as repository site by the government. The licence for the construction was filed for in 2013 and is expected in 2019.

For high-level radioactive waste, long-lived intermediate-level radioactive waste and spent fuel elements, the underground laboratory HADES in Mol was constructed between 1980 and 1984 and has been expanded several times since. Since 1997, work to demonstrate the feasibility of a repository in a clay formation has been carried out in HADES on an industrial scale. In 2011 – after extensive consultations – ONDRAF/NIRAS submitted the national disposal programme (Plan Déchets) to the authorities.

A final decision on the disposal strategy by the government is still pending.

MAXI HEROLD
Mining Engineer, age 32

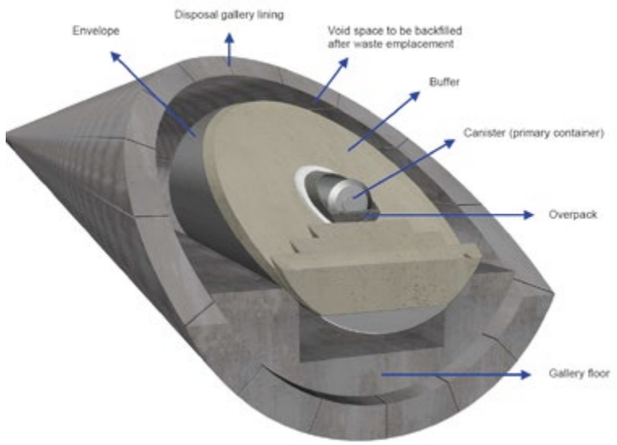
Currently, ONDRAF/NIRAS has no specific requirements for retrieval. This makes the task of developing a retrieval concept and evaluating all theoretically possible procedures all the more interesting. Particularly exciting was the search for the different methods to evacuate materials and also to transfer nonstandard procedures to the situation in a repository.

Development of a Retrieval Strategy for the Belgian Disposal Concept

According to the Belgian disposal concept, low- and intermediate-level radioactive waste is to be conditioned in monolithic concrete containers and high-level radioactive waste in so-called supercontainers. The disposal drifts are to be constructed with lateral concrete bases for positioning the waste packages. The recess in between is to be used as roadway. The design of the drift floor enables safe emplacement and possible retrieval of the waste packages before the voids are backfilled. After that, there is a sickle-shaped backfill section around the upper part of the waste packages and the backfilled recess in the drift floor.

DBE TECHNOLOGY GmbH was commissioned by ONDRAF/NIRAS (Belgium) with a study on the retrievability of waste packages in the Belgian disposal concept. If the waste packages are retrieved, safe working conditions have to be ensured. Furthermore, the backfill material has to be evacuated over a distance of 3 m to up to more than 6 m (depending on the type of container). The aim of the study was to identify a state-of-the-art technology to remove the backfill material without damaging the waste packages or the drift support.

Corresponding techniques commonly used in the construction and mining industries were compiled and grouped according to their mode of operation or the nature of their impact on the materials. As part of a benefit analysis, the techniques were evaluated based on a criteria checklist. The criteria for the techniques were their applicability, for example the space required by the machines and their tools, their controllability in order to avoid damage to the waste packages and the surrounding structures, as well as their capability and efficiency in removing the backfill material. For reasons of occupational health and safety, systems that can be remotely controlled via cable or radio were recommended. The preferred option is to remove the backfill material by milling. Based on these findings, a basic concept for retrieval has been developed. With the specified technologies and procedures, operational safety can be ensured and retrieval can be realised.



The supercontainer concept of the Belgian repository concept (Source: ONDRAF/NIRAS)

DR. HANS-JOACHIM ENGELHARDT
Geoscientist, age 55

The construction and decommissioning of a repository requires the transport of large quantities of building materials in the required quality to changing places of work. The planning of the logistics has to take into account the performance requirements of the technical facilities as well as the characteristics of the building materials. It requires the cooperation of specialists from different disciplines. As part of a team, I was able to meet this challenge.

Development of a Building Material Transport System for the Future Belgian Repository

In Belgium, medium- and high-level waste is to be permanently isolated from the biosphere in a geological repository. Residual cavities – except for the clay seals – are to be backfilled with cement-containing materials. The backfill materials are to minimise the volume of free solutions and their mobility, ensure favourable chemical conditions with regard to retention, and permanently passivate the steel surfaces of the waste packages containing high-level radioactive waste.

In order to avoid dust and noise emissions and the use of water in the repository, the building materials are to be mixed above ground. The location of the required mixing plant depends on the processing time of the building materials and the speed of the material transport. Generally, it is possible to transport the building materials by means of continuously and discontinuously working systems. The first group includes pipeline-bound systems, where the building materials are pumped to the place of installation. Discontinuous transport comprises the transport of batches, for example with vehicles. An assessment of the transport systems showed that – taking into account aspects of plant operation and occupational safety – the building materials can be transported via pipelines in the required quality and quantity.

Subsequently, an efficient conveying system for building materials was developed. The basis was the concept of the stationary conveyor system of the Morsleben mining hazard prevention measure, which was further developed and adapted to the specific requirements of the Belgian repository.

Storage tanks of the stationary conveying plant Morsleben with pipelines leading to the double piston pumps

Injection and flushing water line of the stationary conveying plant Morsleben

Injection and flushing water line of the stationary conveying plant Morsleben

NIKLAS JOACHIM BERTRAMS
Mining Engineer, age 29

In our project in Mol, I have the unique opportunity to play a decisive role in the designing process of a shaft hoisting system, from the first draft to its commissioning. At the moment, we are still in the planning phase, but I am looking forward to the theoretical planning becoming reality.

Modernisation of the Shaft Hoisting System of Shaft 1 of the Underground Laboratory HADES (Mol, Belgium)

As a result of a public procurement procedure, EURIDICE (European Underground Research Infrastructure for Disposal of nuclear waste in a Clay Environment) decided to commission a consortium of DBE TECHNOLOGY GmbH and Tractebel ENGIE to rehabilitate the shaft hoisting equipment of shaft 1 of the Belgian underground laboratory HADES.

The existing bobbin hoisting system has been in operation for several decades and is to be modernised in accordance with the customer's specifications. DBE TECHNOLOGY GmbH will mainly supply the conceptual planning for the new hoisting system.

In this respect, however, there are no applicable legal sources or technical standards in Belgium, as the Belgian mining law applicable to the original design and construction of the shaft hoisting system is long outdated. Therefore, the first task in the project is to submit a proposal to the client and the licensing authority specifying the legal and normative basis on which the work can be carried out.

DBE TECHNOLOGY GmbH has thus prepared an analysis of the possible options and is waiting for a decision from EURIDICE and the Belgian supervisory authority. When developing the technical design of the shaft hoisting system, the greatest challenge will be the guidance of the hoisting equipment. As the shaft is not perfectly vertical along its entire length, the design of the guide rails has to be adapted. A feasibility study carried out by DBE TECHNOLOGY GmbH as early as 2014 showed that rope guides are not technically feasible.

After completion of the concept preparation, the consortium consisting of DBE TECHNOLOGY GmbH and Tractebel ENGIE will assist in the public tender for the commissioning of the detailed planning and construction and will also support the client in construction supervision.

Shaft 1 of the HADES underground laboratory (Mol, Belgium)

United Kingdom

In a White Paper issued in 2014, the British Government set out the framework for the long-term management of higher activity radioactive waste (HAW) through geological disposal with preceding safe interim storage. At the same time, the political framework for the implementation of geological disposal was defined. The Welsh Government has been involved in the programme for the safe disposal of radioactive waste since its inception. It is obliged to ensure the long-term safe disposal of radioactive waste generated in Wales and to establish the corresponding framework conditions. The Scottish Government does not support the geological disposal programme, but is nevertheless obliged to ensure the disposal of radioactive waste generated in Scotland.

The White Paper identifies "Radioactive Waste Management Limited (RWM)", a 100% subsidiary of the "Nuclear Decommissioning Authority" (NDA), as the organisation responsible for implementing the government's policy on the geological disposal of higher activity radioactive waste. As developer of the geological disposal facility (GDF), RWM is responsible for safety and environmental protection during the project's duration. RWM carries out project-related research to support disposal. The results are published and reviewed by independent experts and the "Committee on Radioactive Waste Management" (CoRWM).

A wide range of host rocks potentially suitable for HAW repositories is being investigated in the UK. According to government policy, the siting process is to be based on the willingness of local communities to participate in the process. Accordingly, the site and thus also the host rock are determined in consensus with the local population. Possible repository concepts will be based on experience in other countries and studies of the framework conditions in the United Kingdom.

DR. THILO VON BERLEPSCH
Mechanical Engineer, age 49

The UK programme for the management of radioactive waste faces particular challenges due to its long and varied history. A network of service providers with a high level of expertise has developed around the programme. Being a part of it allows for exciting tasks and challenges in a very trusting environment.

Study for the Nuclear Decommissioning Authority (NDA) on the Availability of Materials for Conditioning Radioactive Waste

Methods for conditioning liquid and solid radioactive waste are immobilisation, solidification, or encapsulation with cement mixtures. Portland cements are usually used for this purpose. In recent decades, however, the use of this cement type has steadily declined, while latently hydraulic, pozzolanic, or limestone substances are increasingly used as cement constituents or additives. Furthermore, the building materials industry has developed innovative products, such as superplasticizers, with the aim of using ultra-high-strength or self-compacting concretes on a large scale. In addition, many alternative building materials, such as geopolymers, have been further developed to make them ready for use. So far, this progress has not been adequately taken into account in the field of radioactive waste conditioning. For this reason, there is a need for optimisation with regard to the availability of usable mixtures and their material properties.

In the United Kingdom, the NDA is responsible for the safe decommissioning of civil nuclear facilities. NDA commissioned DBE TECHNOLOGY GmbH as part of a consortium under the direction of EDEN Nuclear and Environment Ltd. (UK) with an analysis of the development of the building materials sector and the future availability of materials for conditioning radioactive waste.

Furthermore, an overview of the practical experience was to be given and the material requirements were to be summarised, taking into account the different disposal strategies of the European countries. The scope and characteristics of the quality assurance programmes and the procedures to be followed in the event of non-conformities were also analysed. This way, aspects that need optimising were identified. Thus, the foundations were laid to ensure the future availability of high-quality materials for the conditioning of radioactive waste.

Settlement test to assess the consistency of fresh concrete

International Atomic Energy Agency (IAEA)

The IAEA was founded in 1957 as an autonomous intergovernmental organisation and meanwhile has 168 member states. It reports regularly to the General Assembly of the United Nations and is obliged to call directly on the United Nations Security Council if a threat to world peace is identified (Statute, Art. III B 4). Germany has been a member of the Organisation since its founding in 1957 and is permanently represented in its controlling and steering body, the Board of Governors. IAEA's key responsibilities are nuclear energy, nuclear safety and security, as well as verification (safeguards).

Nuclear energy

IAEA promotes the peaceful use of nuclear energy worldwide through symposia, coordinated research contracts, services, databases, and comprehensive documentation and publication activities. It supports developing countries, for example, in the use of nuclear applications in medicine, water, and agriculture.

Nuclear safety and security

IAEA supports international cooperation and harmonisation in the field of supervision by developing safety standards and recommendations in the fields reactor safety, radiation protection, nuclear waste management, transport of radioactive materials, and securing nuclear facilities and nuclear materials. It promotes the physical protection of nuclear material against misuse, for example to prevent nuclear smuggling.

Safeguards

Within the scope of the Safeguards Agreements IAEA has concluded with its Member States, it controls the use and non-proliferation of nuclear material from nuclear installations. This is to ensure that the installations are used solely for the peaceful use of nuclear energy.

» GERRY NIEDER-WESTERMANN
Geologist, age 58

The IAEA event on site selection for a deep geological repository brought experts from all over the world together for a one-week working meeting in Peine – hosted by DBE TECHNOLOGY GmbH. In view of the current developments in the site selection process in Germany, it was exciting to participate in this meeting of experts in suppport of the ongoing IAEA efforts to accompany its member countries in this field.

IAEA Technical Meeting on Techniques and Methods for Site Investigations for a Radioactive Waste Repository

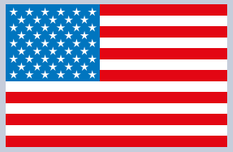
The selection and characterisation of sites for the disposal of radioactive waste in deep geological formations is a fundamental aspect in the waste management programmes of many countries. In a number of national waste management programmes corresponding site investigations have already been carried out, and the results and experience have been documented. For the IAEA Nuclear Energy Series, a report is to be prepared that summarises the current international status of site investigations and of the subsequent characterisation of repositories for radioactive waste.

In this context, a Technical Meeting (TM) was held from May 15 to 19, 2017, at DBE TECHNOLOGY GmbH in Peine on the topic of exploration technologies and techniques for disposal facilities for radioactive waste. 27 participants from 12 countries attended the meeting. The objective was to provide an opportunity to discuss site investigations and characterisations, to exchange experience, and to obtain feedback on a draft of the above-mentioned report.

After BGE Managing Director Dr. Thomas Lautsch had opened the meeting, a brief introduction to the development and current status of the report was given. Subsequently, participants from China, Germany, Finland, Japan, Korea, Ukraine, and Hungary presented their national site investigation plans and experience in conducting site investigations. During the meeting, the participants provided many valuable and practical comments and suggestions for the further development of the IAEA draft report. The participants also suggested several topics for the next IAEA activities related to site investigations and site selection procedures for radioactive waste repositories.

The IAEA expressly thanked DBE TECHNOLOGY GmbH for the hospitality, the organisation of the meeting, and the visit to the Konrad site.

Participants of the IAEA Technical Meeting in front of BGE's headquarters in Peine



USA

The Nuclear Waste Policy Act (NWPA) of 1982, as amended in 1987, lays down rules for the siting, construction, and operation of a geological repository for the disposal of spent nuclear fuel and high-level waste (HLW). The amendments in 1987 specified to the US Department of Energy (DOE) Yucca Mountain as the future site of a geological repository. The then President Obama announced in February 2009 that the proposed repository at Yucca Mountain was no longer an option. In January 2012, the Blue Ribbon Commission on America's Nuclear Future (BRC) published its final report evaluating alternatives to Yucca Mountain. In January 2013, the DOE published its strategy for the management and disposal of spent nuclear fuel and high-level radioactive waste in response to BRC's final report and recommendations.

Since 1999, the Waste Isolation Pilot Plant (WIPP) has been the final repository for transuranc waste (TRU). WIPP was established for the disposal of TRU waste from DOE sites throughout the country. The waste is emplaced permanently in drifts located at a depth of just over 500 metres in a salt formation. Events in 2014, which led to an interruption of emplacement, did not result in any unacceptable release of radioactive materials and did not call into question the concept of safe disposal of radioactive waste in salt formations.

The DOE carries out research and development (R&D) activities to implement the 2013 DOE strategy. The activities focus on the storage, transport, and disposal of spent fuel elements and radioactive waste and are carried out in nine national laboratories. In the field of waste management research, research and development activities are currently being carried out to evaluate the feasibility of deep boreholes for the disposal of several special types of waste and to demonstrate the feasibility of geological repository concepts in several geologic formations. International cooperation, which enables the US programme to benefit from the experience and possibilities of research in other countries, remains a high priority.

» WILHELM BOLLINGERFEHR
Civil Engineer, age 61

Every year I am delighted anew by the great interest in the workshop on disposal in salt. I enjoy working with my colleagues from KIT and SANDIA to put together a scientifically exciting and up-to-date programme. In addition, close ties have been formed by now, so that scientific exchange also takes place beyond the workshop.

8th US/German Workshop on Salt Repository Research, Design, and Operation

Not only the United States and Germany regard salt as a suitable host rock for the disposal of high-level radioactive waste and spent fuel elements, but also countries such as Poland and the Netherlands. In this respect, it was a pleasure for the more than 50 participants of the 8th US-German Workshop (September 5 to 7, 2017) that the Dutch company COVRA, which has been participating in the event together with other Dutch partners for years, acted as host this year. The successful cooperation between American and German scientists and engineers began in the 1970s. SANDIA National Laboratories, Karlsruhe Institute of Technology and DBE TECHNOLOGY GmbH were again the organisers of the workshop.

The seminar was opened by Tim Gunther from DOE (USA), Holger Wirth from BMWi (D), and Ewould Verhoef from COVRA (NL) and the scientific and technical programme was initiated with short presentations on the respective national waste management programmes. While the Dutch programme focuses on long-term interim storage, the US Congress continues to discuss the resumption of the Yucca Mountain project (repository in a tuff formation) and the operation of the WIPP (repository in a salt formation). The reorganisation of the responsibilities in the field of radioactive waste management in Germany (establishment of BfE – licencing and supervisory authority – and BGE as new repository operator) was presented as well as the financing system for the disposal of radioactive waste and spent fuel elements. The scientific and technical focal points of the workshop were new studies and results in the field of Safety Case, geomechanics as well as repository design and operation. The significance of crushed salt as part of the geotechnical barrier system was discussed in an explicit discussion session. Further discussion topics such as actinide and alkali chemistry, groundwater calculation models, and advantages and disadvantages of the disposal of radioactive waste in very deep (up to 5000 m) vertical boreholes completed the programme. As always, the presentations and discussion results will be documented and published in a workshop volume.

The 9th US/German Workshop will take place in Hanover on September 10 and 11, 2018, in conjunction with the 9th Conference on the Mechanical Behaviour of Salt (Salt-Mech IX).

Participants of US/German Workshop on Salt Repository Research, Design, and Operation

Management Report

Sphere of Activities

The main business area of DBE TECHNOLOGY GmbH, a highly specialized engineering company operating at both national and international level, continues to be engineering and consulting services for the disposal of radioactive waste. This includes national and international research and development projects for the safe disposal of these wastes, in particular of high-level waste and spent fuel. International projects on various aspects of the disposal of radioactive waste, in particular in deep geologic formations and in various host rocks (claystone in Belgium and France, rock salt in Poland and the USA as well as magmatic host rocks in Russia and Ukraine) are of particular importance.

Furthermore, DBE TECHNOLOGY GmbH is involved in international consortia – in some as leader – on behalf of the European Union. The work includes the design of a repository for the safe disposal of radioactive waste in Iraq and the development of repository concepts for all types of radioactive waste in Ukraine. In France, the Company is involved in the planning of the French repository for high-level radioactive waste and spent fuel, while in Bulgaria, the design for a low-level radioactive waste repository near the Kozloduy Nuclear Power Plant has been completed.

Of particular importance for developing know-how and in support of future tasks in Germany are the management of and participation in joint cooperation projects with other leading research institutes involved in radioactive waste disposal, e.g., concerning safety and safety demonstration concepts for repositories in various deep rock formations and concerning retrievability, cask designs, as well as the compaction of crushed salt.

Furthermore, the Company continued to provide services for Asse-GmbH on several major tasks related to hazard prevention and emergency planning activities. In addition to various typical mining engineering services and the provision of highly qualified specialist personnel, key activities were the planning and drilling of injection boreholes, performing the injection work, and developing measures to increase the strength of crushed salt backfill material.

The requirements of environmentally responsible action are taken into account by the Company's activities, which specifically focus on protecting the environment.

As part of the reorganisation of the disposal responsibilities in Germany, all shares of the parent company Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE) were transferred to the *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety* (BMU). Effective from July 1, 2017, DBE together with Asse-GmbH were merged into Bundesgesellschaft für Endlagerung mbH (BGE), the new German implementer, which is now the sole shareholder of DBE TECHNOLOGY GmbH.

RESEARCH & DEVELOPMENT

Research and development projects continue to be of major importance. In conjunction with BGE, DBE TECHNOLOGY GmbH thus ensures that the know-how for the planning, construction, operation, and closure of radioactive waste repositories is preserved and further developed based on the state of the art in science and technology. In the reporting period, the Company was involved in a total of 15 national and international research and development projects.

Financial Report

BUSINESS DEVELOPMENT

The Company continued its successful development over the past financial year. Turnover amounted to T€ 8,405. The net profit for the year amounted to T€ 694.

As of December 31, 2017, the Company had orders on hand amounting to T€ 7,695. Because of the extremely specialist nature of the Company's activities, the macro-economic situation does not have any major impact on the development of business and the volume of incoming orders.

RESULTS OF OPERATIONS

Turnover decreased by T€ 857 to T€ 8,405 compared with the previous year. The decrease is primarily due to the final settlement of two major contracts with foreign business partners in 2016, which resulted in a particularly high turnover that year.

Other operating income amounted to T€ 185. The main item is a reimbursement of T€ 111 from the *German Social Accident Insurance Institution for the raw materials and chemical industry* (BG RCI).

Personnel expenses decreased by T€ 146 to T€ 3,707 compared with the previous year. This was mainly due to a slight reduction in the average number of employees.

The cost of materials includes expenses for purchased services, mainly from project assistance by the parent company as well as maintenance costs for assistance to orders relating to the Asse mine.

Other operating expenses amount to T€ 553.

The income tax expense amounts to T€ 324.

At T€ 694, net income remained at the previous year's level.

NET ASSETS AND FINANCIAL POSITION

Compared with the previous year, the balance sheet total decreased by T€ 2,324 to T€ 5,601 due to the decrease in advance payments received.

On the assets' side of the balance sheet, inventories decreased by a total of T€ 2,412 as a result of a decrease in work in progress.

Compared with the previous year, receivables and other assets remained constant. Receivables include entitlements from BGE as part of intercompany performance accounting.

The item "Cash on hand and bank balances" has increased by T€ 112 to T€ 3,009 compared with the closing date of the previous year.

On the liabilities side of the balance sheet, shareholders' equity increased to T€ 2,613 due to the undistributed net profit 2016.

Provisions include tax provisions from the income tax calculation 2017 and increased by T€ 176 to T€ 674. Furthermore, they mainly comprise personnel-related provisions.

Compared with the previous year, liabilities have fallen by T€ 3,194 to T€ 2,314. The largest individual item at T€ 2,008 relates to customer advances received in the form of financial advances for orders which have not yet been completed and not yet invoiced.

At 46.7 % (previous year: 24.2 %), the equity ratio of DBE TECHNOLOGY GmbH has risen due to the decrease in advance payments received and the increase in shareholders' equity. On the balance sheet date, equity completely financed the fixed assets as well as the inventories (previous year fixed assets and 42.6 % of inventories).

The Company was solvent at all times during the past financial year and remained so thereafter.

Personnel and Social Report

As of December 31, 2017, the Company's workforce consisted of 30 employees. Support for handling the tasks of the Company is provided by employees of BGE under the terms of an agency and service agreement that has been concluded with BGE. This primarily involves the provision of commercial services. The Company is integrated into the industrial safety concept and compliance organization of BGE.

Forecast, Risk and Opportunity Report

Reporting and risk management are carried out in line with the systems that exist at BGE. Risks from order processing are controlled on a timely basis by way of checks carried out in the course of an order. There is adequate insurance cover for risks which the Company can usually expect to encounter. This is primarily achieved through contractual integration into the insurance cover of BGE. There are no risks that pose a threat to the going concern assumption.

The order volume as of December 31, 2017, amounting to T€ 7,695 continues to be at a high level. Utilization of employee capacity is almost fully assured for 2018 and partially for 2019. The Company's activities continue to focus on developing and expanding the unique know-how of the BGE/DBE TECHNOLOGY GmbH group in order to be able to offer high-quality services on a national and international level. In 2018, it is intended to expand and intensify activities to further attractive and interesting markets and to support BGE in the selection of a site for a repository for heat-generating waste by providing scientific and technical experts.

Together with a sustained business development, the focus is on consolidating the Company's ability to continue as a going concern – also in view of the changes in the organizational framework conditions for disposal in Germany. It can be assumed that a continuation and expansion of the Company's business areas will be possible even with the reorganization of the radioactive waste management sector.

With a consistent level of orders on hand but without taking into account extraordinary incidents, the Company expects a positive level of earnings of approximately T€ 200, which is a sign of economic stability but is not the determining corporate purpose. A positive annual result is also expected in the medium term.

Annual Financial Statements/Notes

General Information

DBE TECHNOLOGY GmbH has its registered office in 31224 Peine, Eschenstraße 55, and is registered with the commercial register at the Local Court of Hildesheim, HRB no. 101385.

The Company is a small corporation within the meaning of Section 267 (1) HGB. The annual financial statements of DBE TECHNOLOGY GmbH are prepared voluntarily in accordance with the regulations applicable for large corporations.

In order to improve the overall clarity of presentation, individual items in the balance sheet and income statement have been combined and are shown separately in the notes to the financial statements.

Due to the restructuring of disposal in Germany, the chart of accounts within the BGE Group was adjusted. In this connection, reclassifications were made, in particular of services, from other operating expenses to cost of materials. The previous year's figures were adjusted by T€ 429.

In the context of uniform accounting of the Group, deferred taxes are not reported, as was the case in previous years. Differences between commercial law and tax law arise in particular with regard to pension provisions.

The other accounting and valuation methods have remained unchanged as against the previous year.

The income statement was prepared according to the total expenditure format.

Accounting and Valuation Methods

Figures shown in the balance sheet for intangible assets and tangible assets are based on the cost of purchase. Intangible assets – consisting exclusively of software – are written off by straight-line method over a period of three to five years, and tangible assets are written off by straight-line method over their expected useful life. Minor value assets with acquisition or production costs of more than € 150 but not more than € 1,000 are combined into an annual collective item and written off uniformly over a period of five years.

Orders that have been commenced (work in progress) are valued at the directly attributable production costs in accordance with the minimum valuation threshold under commercial law.

Advance payments are recognized at nominal value.

Receivables, other assets, and cash and cash equivalents are reported at nominal value.

Identifiable individual risks are taken into account by value adjustments on receivables. Other assets are reported at nominal value.

Prepaid expenses and deferred charges consist of payments made before the balance sheet date insofar as they relate to a specific period after that point in time.

Subscribed capital is reported at nominal value.

Provisions are reported at the amount deemed necessary for the fulfilment thereof according to sound business judgment.

Other provisions with a term of more than one year are discounted at the average market interest rate prevailing over the past seven financial years corresponding to their remaining term.

Notes to the Balance Sheet

Provisions for pensions were calculated on the basis of actuarial calculations using the projected unit credit method taking into account the *"Mortality Tables 2005 G"* of Prof. Dr. Klaus Heubeck, Cologne. The reported pension obligations for individual commitments are governed exclusively by the benefit regulations and the contribution-based pension plan of Bochumer Verband (*Bochum Association*). Provisions for pensions are discounted at the average market interest rate of the past ten financial years as published by Deutsche Bundesbank (Section 253 (2) HGB), i.e. 3.68 %. Salary dynamics remain unchanged at 2.5 %, while pension dynamics continue to be taken into account at 1.0 %. In accordance with Section 253 (6) Clause 2 HGB, the difference of T€ 15 calculated from the different interest rates is not blocked from disbursement due to sufficient free reserves.

Provisions for archiving costs serve to fulfill legal and contractual archiving obligations for business documents and records. The provisions were calculated based on average archiving periods of ten years and an estimated increase in costs of 2.5 % p.a. The provisions are discounted at the average market rate of 2.4 % (previous year 2.84 %).

The other provisions also take into account all identifiable risks and contingent liabilities.

Liabilities are reported at the settlement amount.

Assets

1. FIXED ASSETS

The financial assets consist of a cooperative share acquired in 2012.

Movements of individual items of fixed assets are shown in the fixed assets movement schedule.

2. INVENTORIES

	31.12.2017 T€	31.12.2016 T€
Work in progress	1,748	4,204
Advance payments	63	19
	1,811	**4,223**

The decline in inventories is due in particular to the final settlement of the major Kozloduy order and the Asse activities.

3. RECEIVABLES AND OTHER ASSETS

	31.12.2017 T€	31.12.2016 T€
Trade accounts receivable	31	496
Receivables from affiliated companies	600	92
Other assets (thereof with a remaining term of more than one year)	18	75
	649	**663**

All receivables have a remaining term of less than one year.

Receivables mainly include claims against the parent company from the settlement of the Asse activities. As a result of the merger, the claims against Asse-GmbH reported in the previous year under receivables and assets (T€ 65) are now reported under receivables from affiliated companies.

Other assets relate primarily to tax refund claims.

Equity and Liabilities

4. SUBSCRIBED CAPITAL

Subscribed capital remains unchanged at T€ 511. It is fully paid up and is held to 100 % by Bundesgesellschaft für Endlagerung mbH (BGE), Peine.

5. CAPITAL RESERVES

Capital reserves originate from other contributions according to (Section 272 (2) No. 4 HGB).

6. REVENUE RESERVES

Revenue reserves amount to T€ 1,229. Of this, T€ 1,100 consist of retained earnings from previous financial years and T€ 129 from a conversion in compliance with the *German Accounting Law Modernization Act* (Bilanzrechtsmodernisierungsgesetz / BilMoG) as of January 1, 2010.

The net profit for the year 2016 amounting to T€ 660 was allocated in full to revenue reserves in accordance with the resolution of the sole shareholder of June 9, 2017.

7. TAX PROVISIONS

The tax provisions relate to expected payments for corporate income tax and trade tax for the financial year 2017.

8. OTHER PROVISIONS

	31.12.2017 T€	31.12.2016 T€
Employee-related provisions	360	314
Archiving costs	21	35
Other obligations	25	30
	406	**379**

Employee-related provisions amounted to T€ 360 and include in particular costs for special compensations and vacation remunerations.

9. LIABILITIES

Advance payments received consist primarily of contractually agreed prepayments for work in progress, primarily from foreign customers.

Payables to affiliated companies are due in full to the sole shareholder and are the result of current business operations.

Other liabilities consist primarily of value-added tax and wage tax obligations, which are still outstanding to an amount of T€ 138.

Contingencies and other Financial Obligations

As of the balance sheet date, there were no significant contingencies or other financial obligations.

Notes to the Income Statement

10. TURNOVER

	2017 T€	2016 T€
Project assistance and engineering services for industrial companies	4,679	3,614
Revenues from billing domestic research and development contracts	1,232	1,294
Revenues from international contracts	2,494	4,354
	8,405	**9,262**

Revenues from project assistance and engineering services for industrial companies were generated exclusively in Germany.

11. CHANGES IN INVENTORIES

The decline in inventories amounting to T€ 2,456 is due in particular to the final settlement of the major Kozloduy order and of the settlement of the Asse activities carried out by the balance sheet date.

12. OTHER OPERATING INCOME

Other operating income decreased by T€ 426. In the previous year, expenses relating to other accounting periods from the release of provisions for revenue risks amounting to T€ 476 had to be taken into account. In 2017, expenses relating to other accounting periods from a contribution refund from the *German Social Accident Insurance Institution for the raw materials and chemical industry* (BG RCI) for the financial year 2016 (T€ 111) and from the release of provisions (T€ 31) are recorded.

13. COST OF MATERIALS

	2017 T€	2016 T€
Cost of raw materials, consumables and supplies and of purchased merchandise	7	34
Expenses for purchased services	791	4,059
	798	**4,093**

The cost of materials mainly includes expenses for purchased services from project assistance by the parent company as well as maintenance costs.

14. PERSONNEL EXPENSES

Compared with the previous year, personnel expenses decreased by T€ 146 und corresponds to the slightly decreased number of employees.

15. OTHER OPERATING EXPENSES

This item mainly includes rents and travel expenses as well as general administrative expenses. As in the previous year, they do not include any expenses relating to other accounting periods.

16. OTHER INTEREST AND SIMILAR INCOME

	2017 T€	2016 T€
Other interest and similar income	0	14
Income from discounting other provisions	0	2
	0	**16**

Interest income in 2016 resulted primarily from interest refunds in connection with the tax audit.

17. INTEREST AND SIMILAR EXPENSES

	2017 T€	2016 T€
Interest for pension provisions	–5	–4
Interest and similar expenses	–3	–13
	–8	**–17**

Interest expenses decreased by T€ 9 and in 2016, they included T€ 12 in payments resulting from the tax audit.

18. TAXES ON INCOME

Taxes on income relate primarily to corporation tax (incl. solidarity surcharge) at T€ 164 and trade tax for the current financial year at T€ 154.

Furthermore, T€ 6 from the reversal of deferred taxes is recognized in the income statement.

Other Disclosures

ANNUAL AVERAGE NUMBER OF EMPLOYEES

On average, the Company had 33 employees over the year (previous year: 38 employees).

REMUNERATION OF CORPORATE BODIES

Details concerning total remuneration of management have been omitted with reference to Section 286 (4) HGB.

AUDITOR'S FEES

The total auditor's fees charged for the financial year are shown in the consolidated financial statements of BGE.

As there are sufficient free reserves, distribution restrictions do not apply.

Appropriation of Net Income

Subject to the approval of the sole shareholder, the net income for the year of T€ 694 is to be allocated to revenue reserves.

Group Affiliation

DBE TECHNOLOGY GmbH, Peine, is subject to the uniform management of BGE. In its capacity as parent company, the latter prepares consolidated financial statements for the smallest and largest group of companies in which the annual financial statements of the Company are included. The consolidated financial statements are submitted to the operator of the *Electronic Federal Gazette* (Bundesanzeiger) and are published in the *Electronic Federal Gazette*.

Management

Dr. Jürgen Krone
Peine

Peine, April 25, 2018
Dr. Jürgen Krone

Fixed Assets Movement Schedule

	AT COST					IMPAIRMENTS					NET BOOK VALUES	
	As of 01/01/2017 T€	Additions T€	Disposals T€	Retransfers T€	As of 31/12/2017 T€	Accumulated depreciation 01/01/2017 T€	Additions T€	Disposals T€	Retransfers T€	Accumulated depreciation 31/12/2017 T€	As of 31/12/2017 T€	As of 31/12/2016 T€
I. Intangible assets												
1. Purchased concessions, industrial, property and similar rights and assets, and licenses in such rights and assets	144	5	6	0	143	136	5	5	0	136	7	8
	144	**5**	**6**	**0**	**143**	**136**	**5**	**5**	**0**	**136**	**7**	**8**
II. Tangible assets												
1. Other equipment, factory and office equipment	325	44	41	0	328	211	45	41	0	215	113	114
	325	**44**	**41**	**0**	**328**	**211**	**45**	**41**	**0**	**215**	**113**	**114**
Sub-total	**469**	**49**	**47**	**0**	**471**	**347**	**50**	**46**	**0**	**351**	**120**	**122**
III. Financial assets												
1. Other loans	(250 €)	0	0	0	(250 €)	0	0	0	0	0	(250 €)	(250 €)
	(250 €)	0	0	0	(250 €)	0	0	0	0	0	(250 €)	(250 €)
Total fixed assets	**469**	**49**	**47**	**0**	**471**	**347**	**50**	**46**	**0**	**351**	**120**	**122**

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PHOTOS

Christian Bierwagen, Peine, and others
Cover picture: Ursula Ahlers

Evening of Arts and Sciences

Following a long tradition, DBE TECHNOLOGY GmbH hosted its Evening of Arts and Sciences on October 16, 2017.

About 140 guests of the business and research communities and of government institutions took up our invitation. In connection with the merger of DBE and BGE, Managing Director Dr. Jürgen Krone pointed out in his welcoming speech the new task of finding the best suited site for a repository taking into account various host rocks. The necessary basis has been created by DBE TECHNOLOGY GmbH with its work since 2000. It will contribute its know-how to the corresponding future work.

The scientific contribution was provided by Christian Schülke, Managing Director of an Internet Security Consulting Company, who spoke about cyber security, data protection, and industrial espionage. In his lecture, he also discussed the question whether and how the race with the constantly growing cyber risks can still be won.

After the lecture and subsequent discussion, the guests enjoyed the culinary and cultural programme. Entertainment was provided by the Dixiland band "Marshmallows" and the juggler Leinado. The event was framed by an exhibition of photos made by geologist Dr. Diem on minerals from the Konrad mine.

Sciences ...

... meet the Arts.

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