The Construction of the Konrad Repository - Status and Perspective – 13034

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ABSTRACT

Due to the Atomic Energy Act of Germany the Federation is responsible for the construction and operation of installations for the safekeeping and disposal of radioactive waste. The Federal Office for Radiation Protection (Bundesamt für Strahlenschutz – BfS) is assigned with this duty.

In 1982 the abandoned iron ore mine Konrad near Salzgitter (Federal State of Lower Saxony) was proposed as a repository for low and intermediate level radioactive waste with negligible heat generation. After 20 years of plan approval procedure the license was granted by the Ministry for Environment of Lower Saxony in May 2002. This decision was finally confirmed by the Federal Administrative Court in March 2007.

The construction has started, but former assumptions about the beginning of waste emplacement tuned out to be too optimistic. In the course of the preparatory work and the implementation planning it turned out that many changes need to be done. As a matter of fact most of the documents and planning originate from the 1990ies and need to be revised because from that time on until now no adaptation was appropriate. The necessity to apply the state-of-the-art technology and other legal implications give rise to further changes and new licensing procedures, especially building licenses. Furthermore, the license from 2002 also includes a lot of collateral clauses that need to be fulfilled before radioactive waste can be emplaced.

With this in mind, the time frame for the construction of the Konrad repository was revised in 2010. As a result, the completion of the erection before 2019 doesn’t seem to be realistic.

INTRODUCTION

In Germany it is intended to dispose of all types of radioactive waste in deep geological formations. The current situation of all the repository projects in Germany was described in [1].

In 1982, the abandoned Konrad iron ore mine situated near the town of Salzgitter (Federal State of Lower Saxony) was proposed as a repository for low and intermediate level radioactive waste with negligible heat generation. After 20 years of plan approval procedure, the license was granted by the Lower Saxonian Ministry for the Environment in May 2002. This decision was

subject to several cases at the Lower Saxonian Higher Administrative Court in February/March 2006 where the legality of the license was confirmed. The Court denied a revision of the trial. This dismissal was brought to the Federal Administrative Court which finally confirmed the previous decision in March 2007. That means that from the legal point of view there is no breakpoint for the construction and operation of the Konrad mine as a repository for radioactive waste. Nevertheless, it should be mentioned that there is still one local farmer aiming for a case at the European Court of Justice.

Konrad is an abandoned iron ore mine located in Salzgitter in the Federal State of Lower Saxony. Two shafts were sunk from 1957 to 1962 and the extraction of iron ore started in 1960. Only 16 years later, in 1976, mining was stopped for economical reasons. Due to the fact that the Konrad mine is extremely dry a preliminary geological investigation program was already launched in 1975. Since this program revealed encouraging results for the suitability of Konrad, the PTB as the precursor of BfS applied for a license for the disposal of radioactive waste with negligible heat generation in 1982. In 1992 and 1993, a public hearing took place which, having lasted 75 days, was the longest one ever performed in Germany. Within this public participation about 200,000 objections were raised. In May 2002, the license was granted by the Lower Saxonian Ministry for the Environment. Then, it took another four years until the four cases filed by three municipalities and one local farmer were dismissed by the Lower Saxonian Higher Administrative Court in March 2006 and one more year until the Federal Administrative Court confirmed this decision in March 2007. That means that now , from the legal point of view, the way is free for Konrad to become a repository for 303,000 m³of LLW and ILW with a total beta/gamma emitter activity of $5 \cdot 10^{18}$ Bq and an alpha emitter activity of $1.5 \cdot 10^{17}$ Bq.

Presently the Konrad mine consists of two shafts and galleries of about 40 km in length. The mine openings comprise 6 levels ranging from 800 m to 1,300 m depth. Shaft 1 is the intake air shaft. The return air is completely released via shaft 2. In contrast to Asse and Morsleben, no existing mine openings will be used for the emplacement of radioactive waste. It is intended to dispose of the waste in galleries of about 400 m to 1,000 m length.

Whereas the emplacement of 650,000 m^3 of radioactive waste was applied for in 1982, the waste volume was restricted to 303,000 m^3 in the license from 2002 due to the actual amount of waste with negligible heat generation being expected at that time until the year 2080. This was done because Germany had decided to phase out the use of nuclear power for electricity production. The emplacement of gaseous and liquid wastes is excluded. The term “negligible heat generation” means that the temperature on the edge of the emplacement chambers will not rise by more than 3 K on average due to the decay heat of the radioactive waste. The actual amount of radioactive waste with negligible heat generation in Germany is about 130,700 m^3 consisting of different categories (reference date: end of 2011).

TECHNICAL DESIGN

The two shafts of the Konrad mine are about 1.5 km apart. Shaft Konrad 1 (see Figure 1) serves for personnel and material transport. Shaft Konrad 2 will serve as emplacement shaft. A perspective of the buildings and installations to be erected at shaft 2 is given in Figure 2. The waste will either be delivered by train or truck. Main components are the reloading and transfer building with a drying plant being connected upstream (1), the new hoisting tower and shaft hall (2), the ventilator building with diffuser (3) and the storage building for the buffering of radioactive waste (4).

Six types of cubic and five types of cylindrical containers will be accepted in the Konrad repository, the latter being delivered on pool pallets with up to two cylindrical units in horizontal position. The container gross volume ranges from 0.7 m^3 to 10.9 m^3 with a maximum mass of 20 Mg. Konrad is designed for the acceptance of 6,800 transport units per year (cubic containers or pool pallets) within a two-shift operation. In this respect, an average shaft transport frequency of 17 per shift and 200 days of emplacement per year were adopted. Since up to 40 transport units can be accepted per shift and, due to possible disturbances in operation, the storage building is designed for buffering up to 258 waste containers.

Fig. 1: Aerial view of shaft 1

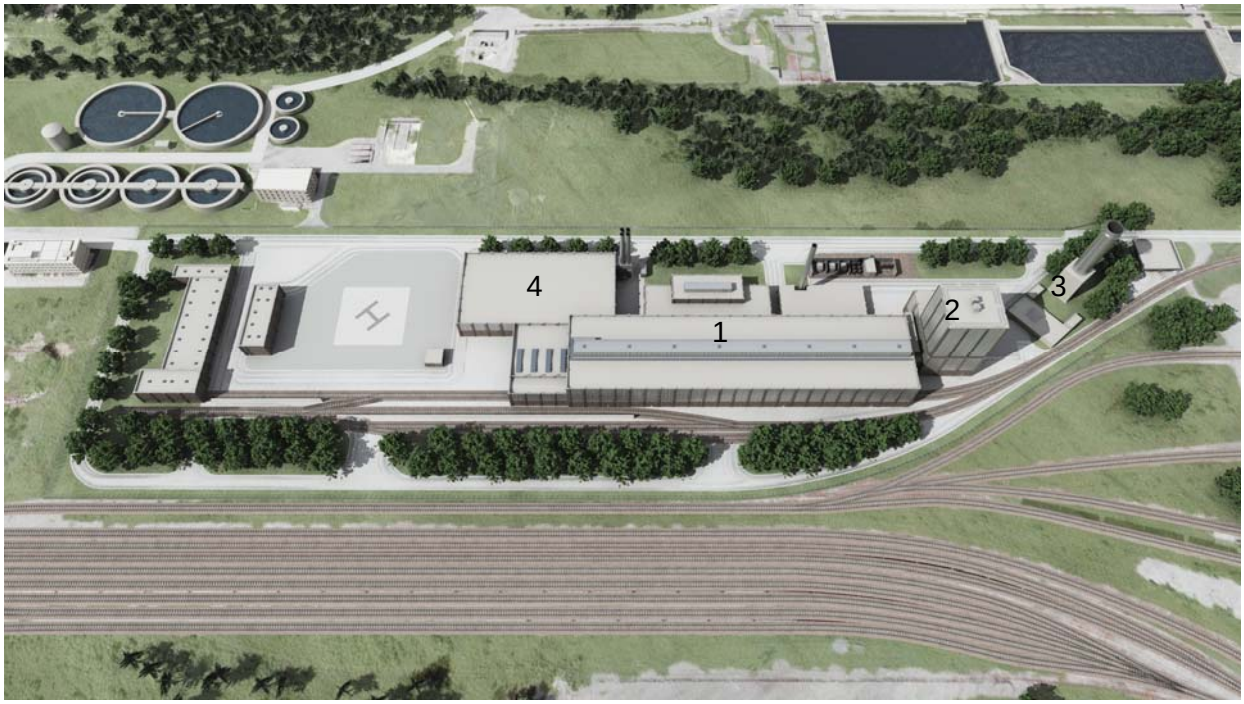

Fig. 2: Perspective of planned shaft 2

Inside the reloading hall the containers are unloaded from the respective vehicles and then placed on an internal flatcar conducted by railways. The transportation of these flatcars is remote controlled. After an automated contamination control and local dose rate measurements the waste containers are either fed to the shaft transport system or buffered inside the storage building with the help of a special forklift truck. Below ground at the 850 m level the containers are taken from the flatcar with a portal crane and then placed on an electric driven truck. After transportation below ground to the emplacement drifts a fork lift truck picks up the containers and stores them inside the stack.

Emplacement takes place in drifts 7 m wide and 6 m high. After a drift length of about 50 m is filled with waste a shotcrete wall is erected and the residual cavities behind the wall are backfilled. This is done with a mixture of about 70 % of Konrad debris (Ø ≤ 5 mm), 20 % of water and 10 % of cement plus retarder. The purpose is to ensure a tight enclosure of the waste packages, to minimize residual voids and to prevent any accumulation of explosive gas mixtures.

The emplacement of radioactive waste is illustrated in figure 3, where the three different stages “emplacement”, “sealing” with shotcrete wall and “backfilling” are visible. Once an emplacement drift is filled it will again be equipped with a sealing and then be backfilled from the exhaust air drift via the respective borehole.

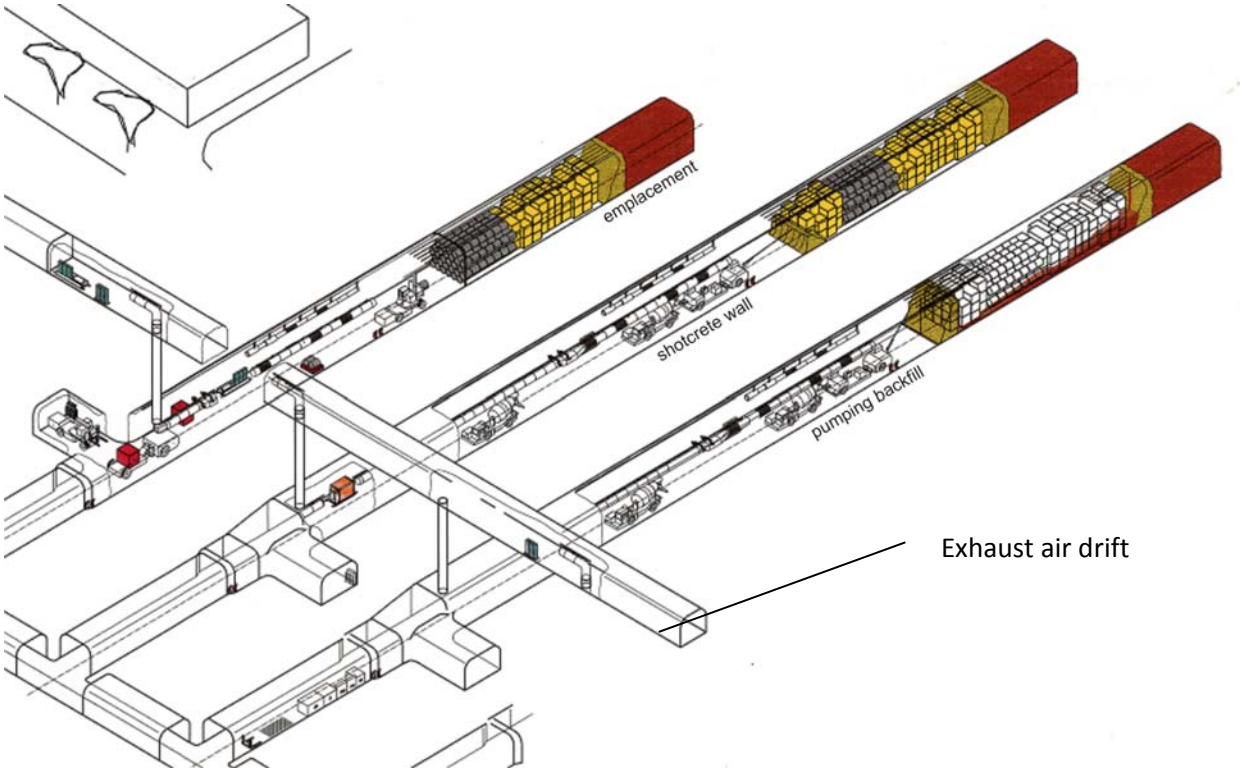

Fig. 3: Planned emplacement of radioactive waste at Konrad

CONSTRUCTION OF THE REPOSITORY

The necessary planning for the timely completion of the "Konrad Repository Construction" project began in 2007. This entailed invitations to tender and the awarding of planning and construction service contracts, as well as updating existing legal contracts with subcontractors involved in the conversion process.

Since most of the documents and planning originate from the 1990ies they need to be revised because from that time on until now no adaptation was appropriate. The last revision of some documents was necessary after the implementation of the new Radiation Protection Ordinance in 2001. For this reason significant changes are necessary in order to fulfill the requirements of the actual technical guidelines. Stipulations arising from the Federal government's "Meseberg resolutions" / the EnEV2009 requirements (Energy-Saving Ordinance) and conditions governing sustainable construction made it necessary to update the plans still further. In particular, the some 600 collateral clauses included in the plan approval decision, and the fact that some planning aspects dated from the nineteen nineties, were reason enough to subject the plans to a thorough update in line with the latest technological developments.

Construction site equipment and transport connections

A first important step of the preparations was the clearance of explosive ordnance around Konrad 2. There was evidence of unexploded bombs and the potential hazard of munitions from a former large-scale anti-aircraft gun emplacement in the area directly surrounding Konrad 2, affecting the transport connections and compromising the external areas. Following the first round of munitions clearance, preparatory investigations into the construction site were carried out, including surveying and staking out. Samples were taken from the open areas and buildings around Konrad 1 and 2 during the compilation of a pollutant survey. The results were analyzed and assessed. The investigations of the premises and transport connections have been completed.

At Konrad 2 the existing auxiliary power supply system was supplemented by a diesel substitute electricity generator and a construction site distribution board including cable runs to ensure the supply of electricity to the Konrad 2 building site. In addition to that, the security fence around Konrad 2 has been completed. Further work for the construction site equipment has been finished.

Aboveground construction

As part of the Konrad 1 South shaft winding system conversion process, the building housing the shaft sinking machinery has been demolished. This meant removing the archive located there. Serving as a replacement, a temporary archive was created in a modular container and the documents transferred to the new premises. In order to implement the qualified permission issued under water law, the upgrading and expansion of the existing Konrad 1 sewage treatment plant is in progress.

As a first new building the hoisting engine building Konrad 1 south was completely erected and equipped with the new hoisting engine including peripheral components (see figures 4 and 5).

Furthermore the construction of the sub-surface media channel at Konrad 1 serving for instance for the power supply of the hoisting engines is almost finished. Currently the security fence at Konrad 1 is under construction. The erection of further above ground buildings at Konrad 1 (shaft building and building for electronic power switching) is in progress. Temporary sanitary and corrosion protection measures at the pit frame have been finished. These measures have been necessary in order to ensure a safe manwinding even in cases of higher wind load.

The planning for the buildings at shaft Konrad 2 with nuclear relevance (i.e. higher quality standards with regard to nuclear safety and radiation protection) has been continued. This also applies for technical components, for instance cranes and the main exhaust fan. The necessary documents for the licensing procedures according to mining law are in preparation.

Fig. 4: Hoisting engine building Konrad 1 south

Fig. 5: New hoisting engine Konrad 1 south

Restoring the shafts and underground construction

The restoration work begun on the Konrad 2 shaft in 2007 was continued. This included the installation of a manwinding system including an inspection platform for conducting renovation work on the shaft and the dismantling of shaft fixtures (removal of the wooden guide bars).

The necessary operations and maintenance work in the Konrad 1 and Konrad 2 shafts and the mine building continued. In addition work began on renovating underground sections of the site. The excavation of the transport drift and the waste galleries is in progress. The first two waste galleries have already reached their final length of about 400 and 570 m, respectively.

In various drifts and transformer rooms cables and illumination is installed (see figure 6). Planning the full inventory of machinery, equipment and vehicles needed for the underground conversion work continued. In the process, invitations to tender were issued and machinery, equipment and vehicles supplied.

Fig. 6: Underground construction work

UPDATING THE TRANSPORT STUDY

The transport study published by the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) on the Konrad repository in 1991 was updated in 2009 using current available data on delivery scenarios and waste types. It concluded that the transport of radioactive waste to the Konrad repository poses no danger to the general public, transport staff, or the environment. Research was conducted into the levels of radiation exposure that might occur in the Salzgitter region as a result of normal transport activities and any potential accidents during transportation. The findings revealed that residents along the waste transport route would be subjected to a maximum of 0.02 mSv of additional radiation exposure per year. That is just two percent of the current legal threshold of 1 mSv. With regard to potential transport accidents, the study established that, in the least favorable case scenario, which statistically speaking is likely to occur approximately every 10 million years, radiation exposure could reach levels of approximately 8 mSv at a distance of 150 meters from the scene in question. This is still well within the accident planning value of 50 mSv used for orientation purposes. Overall the potential for radiation exposure detailed in the updated transport risk analysis is considerably lower than the corresponding findings of the 1991 study.

REVIEW OF THE KONRAD WASTE ACCEPTANCE REQUIREMENTS

The construction of the Konrad final repository also includes any adjustment to the Konrad waste acceptance requirements. In the process the collateral clauses pertaining to waste from the legislative text (in this case: A III. 1.2 Collateral clauses conc. waste) and from Appendix 4 (Qualified Permission issued under Water Law) of the Konrad plan approval were implemented. This was described in more detail in [2].

Konrad radionuclide spectrum adaption

The site-specific safety analysis for the Konrad repository was based on a radionuclide spectrum comprising 156 different radionuclides. From the safety assessments activity limits were derived for 108 radionuclides; these have already been included in the Konrad waste acceptance requirements, status: December 1995.

Meanwhile more information has become available on the radionuclides found in radioactive waste with negligible heat generation. In the papers submitted for the monitoring of such waste, the waste producers have specified limited levels of 52 radionuclides, which are not found in the Konrad waste acceptance requirements, status: December 1995. Moreover another 30 radionuclides need to be taken into account, that, according to information submitted by the

waste producers, could potentially exist in radioactive waste with negligible heat generation. Prior experience has shown that these radionuclides occur extremely irregularly and with extremely low activity in individual waste containers, drums, or batches. That means that such radionuclides are very unlikely to be considered of safety-related significance.

The Konrad waste acceptance requirements now take account of the occurrence of additional radionuclides. An appropriate addendum has been included on the delivery and storage of waste containers containing radionuclides that do not belong to the radionuclide spectrum on which the site-specific Konrad safety analysis is based. This should ensure that, during the operational phase and at the time of closure of the Konrad repository, the activity inventories of the 82 additional radionuclides are so negligible compared with the activity levels for radionuclides and radionuclide groups specified in the Konrad waste acceptance requirements, that they will be considered insignificant in safety terms.

REVISION OF TIME FRAME

After the legal basis for the construction of the repository has been established by the decision of the Federal Administrative Court in March 2007 it was intended to construct the repository within a preparation period of 2 years and a subsequent erection phase of 4 years.

At the beginning of 2010 it became evident that this envisaged time frame was not realistic. Throughout the updating process it tuned out that the assumptions for the construction of the repository, sometimes originating from the 1990ies were no longer valid but had caused unrealistic expectations. In the course of a 3-days workshop the time necessary for the different processes and operational procedures was re-estimated. In the sense of a realistic risk assessment in some cases a sequential arrangement of processes instead of a parallel one was established where necessary. As a result the finalization of the construction works cannot be expected before 2019.

It should be mentioned that BfS and the “Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH“ (DBE) operating company are subject to various dependencies from other authorities and institutions. This applies in particular for building licenses and caused a significant delay in the planning process. Because of the necessary adaption of the implementation planning with regard to the state-of-the art regulatory framework it is expected that for almost every building a new licensing procedure is necessary. Some other licensing procedures are necessary with regard to atomic law, water law, and immission control law. There are for instance two licensing procedures necessary for converting the planned coal heating system of the two shafts into a state-of-the-art wood pellet heating system.

In the following some special topics giving rise to changes and delay are discussed.

Building licenses

Because BfS is a federal authority it was intended to make use of the privilege according to § 74 of the Lower-Saxonian Building Ordinance (NBauO). If such authority is equipped with personnel with a certain qualification instead of a building license from the local community, i.e. the City of Salzgitter, a simplified approval of the Lower-Saxonian Ministry for Building (NMS) is necessary. The first application of this type was rejected by NMS and the appropriate qualification of the BfS staff was denied. In order to get a license a new application was filed for the local community, the City of Salzgitter. Unfortunately this City had filed a lawsuit against the Konrad repository and still refuses the project for political reasons. Therefore, the City did not deal with the BfS application and was aiming for the privileged procedure according to § 74 NBauO.

It took about one and a half year and lots of discussions on the ministerial level to solve this conflict with the aid of the Federal Ministry for Environment, Nature Conservation, and Reactor Safety (BMU) and the Federal Ministry of Transport, Building and Urban Development (BMVBS). Since the beginning of September 2011 the situation is clear and the privilege of BfS was confirmed from the other authorities involved. Meanwhile five approvals were filed by NMS and the procedure is well established.

Special Market Situation

Already in 2009 an invitation to tender for sanitary works in the two shafts had to be cancelled and re-launched. This caused a fist delay of about one year and, consequently, the envisaged start of operation moved from 2013 to 2014. The offers obtained had a financial volume of more than a factor of 4 above the expected values, which was more than € 100 million above the budgeting. For this reason not only the time frame but also the financial budget had to be adjusted.

Moreover it became evident that in Germany the current market situation is characterized by a low number of companies acting in the field of mining. It is obvious that for this reason prices are likely to exceed the projected values. As a consequence in these cases additional negotiations with the Federal Ministry of Finance are necessary.

Extension of existing buildings and sanitary measures

There are numerous sanitation measures necessary which, due to the lack of boundary conditions, have been delayed until the license became unappealable on March 26, 2007. Furthermore, at shaft Konrad 1 there are some buildings that need not be demolished but to be renovated and extended. As it was already the case, it is possible to find unexpected structures in the existing buildings which have not been visible before (for instance the shape and size of fundaments) or the amount of sanitation measures turns out to be higher as expected before. In both cases there are implications for the further construction works or sanitation works.

In order to properly deal with all these difficult circumstances a risk management system was developed together with the operating company DBE.

COSTS

Until 2007, the costs for the whole plan approval procedure and scientific investigations including safety assessments have summed up to € 916 million (approx. $ 1,200 million). Previous estimates put the additional cost of constructing the Konrad repository (from the necessary preparation work through the post-plan approval construction phase to commissioning) at approx. € 900 million [3].

Meanwhile, several steps of readjusting the project costs have been done. This includes the change of boundary conditions, i.e. the increased necessity of sanitation and the special market situation in the field of mining. Accordingly the cost of constructing the Konrad repository during the period from 2007 to its projected conclusion in 2019 was calculated to approx. € 2.1 billion (approx. $ 2.8 billion). According to that planning status, the cost to the Federal authorities involved and other contractors were estimated to be in the region of additional € 76 million (approx. $ 100 million).

CONCLUSIONS

The above and underground construction of the Konrad repository is in progress. The first building measures at shaft Konrad 1 have already been completed as well as the excavation of two waste galleries. The construction works at the emplacement shaft Konrad 2 are going to start in 2013. A risk management system was established in order to properly deal with existing risks. However, the revision of the time frame carried out in 2010 revealed that the finalization of the construction works cannot be expected before 2019.

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