

Risks of Hazardous Substances in Radioactive Waste for the Konrad Repository in Germany - 17522

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ABSTRACT

When disposing of radioactive waste with negligible heat generation, the activity of the radionuclides is limited. However, the waste including radioactive material comprises a certain proportion of non-radioactive material. The risk of hazardous contamination of the groundwater by non-radioactive substances must be taken into account. It must be ascertained that the non-radioactive material cannot affect near-surface groundwater, which is a resource for drinking water supply. To achieve this, limit values on the amount of hazardous substances in the total waste volume shall be determined.

In 2002 a regulatory approval was granted to the 'Konrad' final storage facility for radioactive waste with negligible heat generation according to the German Water Resources Act. This approval is embedded in the license (plan-approval decision) based on the German Atomic Energy Act.

The approval is based on the model of a possible discharge of contaminants from the final storage facility. In a long-term simulation spanning 300,000 years, contact of the waste with the groundwater in the surrounding rock formations over the post-operational phase was conservatively assumed. The maximum amount of allowable disposal of substances – such that no concern of affecting the near-surface groundwater arises – can be derived from the solubility of the respective substances.

Implementing the permit according to the Water Resources Act requires:

- classification of the waste through delivery declaration obligations
- monitoring the substance inspection in the waste to assess its suitability for the disposal, and
- stock keeping procedures for the disposal waste by the operator.

While the repository is operated by the Federal Office for Radiation Protection (BfS) (http://www.bfs.de/EN/home/home_node;), reporting to the Federal Environment Ministry, the statutory water permit is issued and applied by the State of Lower Saxony as responsible state authority.

A waste package/container list supplements a comprehensive list of substances. From this – depending on the respectively conditioned waste – material vectors can be derived. For this purpose, BfS provides a database with a substances and container list to the waste owners.

In the meantime, first experiences have been collected in applying the approval. More than 540 waste containers with a total mass of almost 6,000 Mg have been controlled and are ready for disposal. In our presentation we will show the recent development in supervising the preparation for the disposal of mixed waste.

INTRODUCTION

In Germany, radioactive waste disposal is a federal responsibility. An approved repository for radioactive waste with negligible heat generation from industry, medicine, and public sector already exists. The Konrad repository is a geological repository in an iron-ore formation. This repository is operated by the Federal Office for Radiation Protection (BfS). Currently this abandoned iron-ore mine is being converted into a repository [1].

In Germany, the approval for the construction and operation of nuclear facilities, including the geological repository for radioactive waste at the Konrad repository, is carried out by that Federal State in which the facility is located.

Regarding the approval of the Konrad geological repository, potential risks to humans and to the environment through the handling and the storage of radioactive waste components shall be seriously considered. Since disposable radioactive waste with negligible heat generation also contains chemotoxic waste components of non-radioactive substances, the licensing procedure for the Konrad final repository was to be examined not only according to aspects of nuclear law but also with respect to the water law. As a water law related safety objective in such projects, it is necessary to ensure that planned measures do not lead to adverse changes in the near-surface groundwater, which would have a negative impact on the concerned habitats and on humans.

In 2002, the Lower Saxony Ministry of the Environment granted the approval for the operation of Konrad repository by the "plan-approval decision for construction and operation of the Konrad geological repository at Konrad mine in Salzgitter as a facility for the final disposal of solid and solidified radioactive waste with negligible heat generation" [2]. Several permissions with regard to water law have been added to the annexes of this approval with regard to ground water requirements. Regulations for the protection of humans and the environment are included in these permissions as a result of the requirements of the safety analyses. The most important one is the "Qualified permission issued under water law for the disposal of radioactive waste at the Konrad repository" [3]. It ensures that exposure of near-surface groundwater to the disposed radioactive and non-radioactive substances after long observation periods can be excluded.

In order to implement the requirements from the approval, the Ministry of Environment of Lower Saxony as the licensing authority has commissioned the Lower Saxony Water Management, Coastal Defense and Nature Conservation Agency (NLWKN) as a supervisory authority. The regulatory technical supervision remains within the Lower Saxony Ministry of the Environment.

NLWKN employs approx. 1,400 employees and performs essential tasks of water management in Lower Saxony. These tasks include coastal and floodwater protection, nature conservation, protection of surface waters and groundwater, as well as the provision of a high quality water supply for the population. Furthermore included is the protection of the aquatic environment against impurities, for example by possible emission of radioactive or other harmful substances in the operation of nuclear facilities.

MODEL ASSUMPTIONS KONRAD REPOSITORY

The “Qualified permission issued under water law for the disposal of radioactive waste at the Konrad repository” was issued on the basis of safety analyses results of the hydro geological conditions and the results of the hydraulic model calculations. The requirement that deep groundwater may not cause harmful effects on near-surface groundwater is the decisive factor (fig. 1).

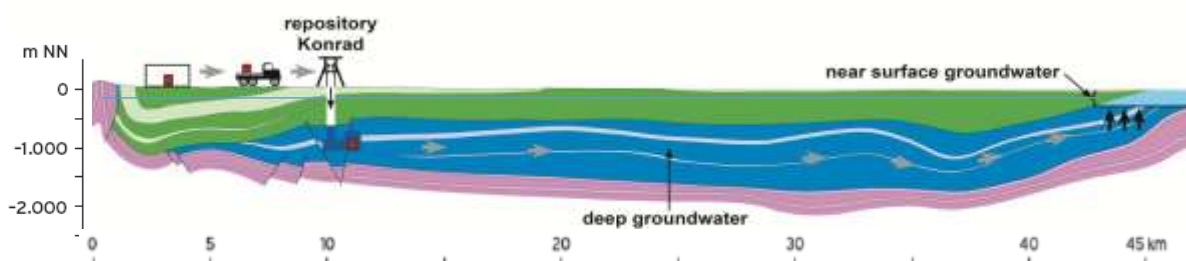


Fig. 1: Konrad repository and groundwater in geological formation (schematic view)

The following facts or model assumptions specifically have underlain the procedure achieving the license and therefore the water law permit:

It is assumed that the existing cavities of the backfilled repository will fill with deep ground water after the decommissioning of the Konrad repository; the soluble components of the disposed radioactive and non-radioactive waste will dissolve therein and spread in the storage chambers surroundings. A further assumption is that the soluble components will dissolve in a total of approx. 1,000,000 m³ deep groundwater (free volume of the repository) before they will be diluted in the ratio 1: 10,000 on the transport route to the near-surface groundwater.

Based on current knowledge of the hydro geological conditions it was estimated, that for the soluble components of the stored substances a transport time into the near-surface ground water of approx. 300,000 years has to be assumed.

In order to avoid a possible detrimental effect on the near-surface groundwater, a permissible concentration in the deep groundwater for each individual water-endangering substance will be calculated according to the legal requirements for the maximum permissible pollution of the near-surface groundwater. The maximum permissible mass of the substance which may be disposed in the repository is determined from this maximum permissible concentration in the deep groundwater, taking into account the model assumptions. Compliance with the boundary conditions for a declaration of the waste is ensured by means of the licensing procedure of the Konrad repository.

Additionally, the condition affecting the legal requirement of the "Qualified permission issued under water law" contains limiting values for maximum of masses and activities for different radioactive and non-radioactive substances. These masses derived from the former estimations.

In order to comply with the safety objective, the operator must record the disposable masses. At the same time, product control steps must be validated by the operator. This prevents the risk of a larger mass being disposed of than is permitted under water law. These procedural elements are also supervised in the water law supervising process by NLWKN.

This approach in the approval and operation phase of the repository has, inter alia, the advantage that there is no necessity to demand the monitoring of the near-surface groundwater within the area of influence of the repository during operation, and especially after its closure.

IMPLEMENTATION OF THE FINAL DISPOSAL PERMISSION

Radioactive waste to be disposed of in the Konrad repository must meet the general waste acceptance requirements for waste packages. Furthermore the requirements derived from the safety analyses for waste product, cask, radionuclide inventory and masses of non-radioactive substances have to be met. Finally, the waste must be conditioned by the waste suppliers in accordance with the final storage conditions [4]. In order to verify the compliance with the waste acceptance requirements important characteristics of radioactive waste provided for disposal, need to be checked prior to the delivery of waste packages to the Konrad repository as part of the product inspection.

Quality Control Procedure

BfS operates the quality control procedure on behalf of the Federal Government. The quality control procedure creates the preconditions for the clearance of a conditioned waste package suitable for disposal in the Konrad repository. Essential requirements for the waste package must be met prior to release for final disposal. These are:

- radiological qualification of waste package for disposal
- material qualification of waste package for disposal
- qualification of casks

In this context, NLWKN supervises the approval-compliant application of the water legislation requirements of the laws pertaining to water and water ways for the non-radioactive harmful substances to be disposed of.

The procedure exercising the water law permit for qualification of radioactive waste packages has the following structure (fig. 2):

- Material to be disposed of shall be standardized under water law, if necessary, summarized in material groups, and described in a so-called material list entry.
- BfS receives requirement notifications for material or material groups to be disposed of from the waste deliverer.
- BfS complies a material list entry based on the data provided by the waste deliverer.
- NLWKN verifies the material list entry and gives his acceptance for application.
- Now these material list entries can be used by all waste suppliers for the description of their material flows with radioactive waste.
- The same applies to the material description of casks.

After the approval of the submitted material and cask list entries by NLWKN, these are registered by BfS in a database and are released for use to all the waste suppliers. The verifications of NLWKN are supported by an independent expert.

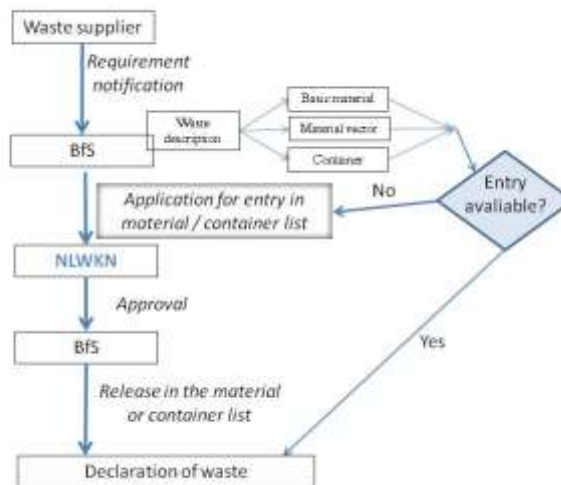


Fig. 2: Structure of the water law permits procedure

The implementation of the process consists of three steps:

1. Characterization of waste by determining threshold values:

The waste supplier reports at BfS the need for disposal of radioactive waste. The waste supplier describes the waste for disposal in its basic properties in the requirement notification. Based on the provided data, BfS complies appropriate material list entries in a specially created database (material and cask list). Depending on requirements, these entries may refer to individual material (e.g. copper), general mixtures of substances (e.g. electronic waste), specific mixtures of substances (electronic waste from a singular waste deliverer), or, as a special case, cask for radioactive waste. In the cause of the process these entries are referred to as material or cask list entries. Prior to the use of the database entries by waste deliverers for material description of the waste, an inspection by an independent expert, approval by NLWKN and release by BfS are necessary.

By determining threshold values for description and balancing as well as quality control measures, it is ensured that the further testing steps in the water law part of the quality control procedure can be carried out on a basis tested or endorsed by the experts and the regulatory authority NLWKN.

2. Material qualification of the waste packages to be disposed

On the basis of the mentioned above substance and cask list entries and specifications, the waste and the relevant water legislation relevant composition of the waste can be registered in a quality controlled manner by the waste deliverer. In order to provide a proper description of the waste composition, the waste deliverer must document it.

The control function for the correct execution of all quality control measures by the waste deliverer is the responsibility of BfS (BfS commissioned by the Federal Government). The waste packages ready for disposal fulfill consequently the requirements for the final disposal [4] with regard to the radiological and material requirements as well as with regard to the requirements for the casks.

The material product control procedure is concluded for the waste deliverer, if BfS has confirmed that the final disposal conditions [4] have also been met with regard to the water legislation requirements after examining the submitted documentation.

3. Stock keeping and validation

BfS is keeping stock of the radioactive and non-radioactive waste with regard to its composition and can prove that the permissible quantities and activities defined in the qualified permission issued under water law for the final disposal of radioactive substances are not exceeded.

In addition to the characterization of waste and quality control, a validation process ensures that the maximum masses for disposal resulting from the relevant legal requirements are observed.

Stock keeping and validation is the responsibility of BfS and is supervised by NLWKN.

CURRENT STATUS OF PROCEEDINGS

In 2007 as plan-approval decision was confirmed effective and enforceable [2], BfS has developed a concept for the implementation of the "Qualified Permission Issued under Water Law for the Disposal of Radioactive Waste in the Konrad Repository". After NLWKN officially approved this concept in 2011, BfS was able to create and apply the first basic material list entries so that the corresponding entries could be released. Based on these entries, more complex entries could then be added gradually to the material list (e.g. concrete, rubble).

Basic material list entries are still being applied for or revised. It is of prime importance to release a large number of concrete entries into the material list for the waste streams of the individual waste deliverers, so that they can be used for the description of the waste composition in the context of material quality control.

Currently, there are 445 material list entries and 71 container list entries in BfS material and container list. NLWKN has so far approved the use for approximately 70% of these entries. So far (as of 31.12.2016), it has been confirmed for 557 containers that they meet the final disposal conditions for the Konrad repository from the point of view of water law.

FUTURE PROSPECTS

The complete procedure with all parameters, assumptions, calculations and entries in the material list has progressed to such an extent that both BfS and the German waste producers can prepare material vectors so that all waste considered can be declared and documented in accordance with the requirements of the water law. This means that older waste can be handled in the same way as waste which will be produced in the future. It is advantageous to have conditioned the waste years ago in such manner, that present disposal conditions are a priori fulfilled with respect to water law. With new wastes it is easier to carry out the required steps in radiological quality control procedures simultaneously to material control procedure and therefore to develop a complete documentation.

Legacy waste can also be declared and documented accordingly. It is of advantage here that the legacy waste has been conditioned according to the requirements for the final storage conditions [4]. In these cases, a review of the existing documentation regarding the water legislation requirements – as well as the radiological requirements if the waste certification procedure was not approved - might be sufficient for approaching the qualification.

In addition to the technical implementation of water law, possible ways of transferring the responsibility of waste producers to the Federal Government are currently being discussed at political level, so that the state can dispose the waste duly and carefully. Delivering the waste to the Federal Republic of Germany might be one option, if the waste packages meet the disposal requirements [4].

Until the Konrad repository is ready for disposing, the conditioned waste has to be stored in the nuclear power plant directly or in separate buildings onsite or in central interim storage facilities.

CONCLUSION

The required long-term safety of the Konrad repository can be achieved on the basis of a plan-approval decision and related qualified permission issued under water law, as well as on the basis of the quality control procedure developed for this purpose. Furthermore, the current state of the art and science must be ensured. In this context a particular challenge is related to older waste, since it must be taken into account that its declarations may be erroneous.

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