Current Problems and Solutions for the Long-term Storage of LLW in Germany - 17512

Jörg Markhöfer, Joachim Bluth
Ministry for Environment, Energy and Climate Protection of Lower Saxony, Germany

ABSTRACT

The primary aim of the Lower Saxony regulating authority is that all radioactive waste in long-term interim storage is made safe and their contents precisely documented. The requirements for regulating authority include: documentation, recovery, inspection, reconditioning, longer-term interim storage with full accessibility for inspection and transfer to the national disposal facility.

The waste acceptance requirements of the disposal site Konrad as well as requirements for the interim storage facilities have to be met for all stored waste packages. Beside this, some challenges came up in the last few years, e.g. waste products with restrictions concerning the stability because of corrosion, fouling or fermentation processes. Some of these examples are shown.

INTRODUCTION

In Germany, the principle applies that radioactive waste must be delivered to a state-run disposal facility. Conditioned waste products from nuclear power plants go in the end to the federal authority, which is responsible for disposal. The federal states are obliged to collect radioactive waste from medical, research and technical facilities and to place it in interim storage. The Federal State of Lower Saxony is affected more than any other by the interim storage of radioactive waste. Through to the end of 1978, radioactive waste was stored in the ‘Asse II’ shaft mine. From the beginning of the 1980s until the present, low-level radioactive waste has been collected and placed in interim storage. Since the acceptance requirements for the Konrad disposal facility are more stringent than those specified in 1980, much of the radioactive waste that had been collected and prepared for disposal according to 1980s requirements do not meet the current requirements. This waste is considered ‘legacy waste’ that must be subjected to ‘improved certification’.

Specifically, the radioactive contents and waste composition of the drums in interim storage must be more precisely documented and declared than was the case almost 40 years ago. Furthermore, it must be guaranteed that the drums do not contain any free liquids and the content is sufficiently dry. The approximately 5,000 drums stored at the Lower Saxony collection facility are of very diverse types; each and every drum must therefore be individually examined and documented.

The drums at the Lower Saxony collection facility were collected around 15

years ago and stored in a very congested storage facility. One can assume that the disposal facility will not begin operating before the year 2022 at the earliest. Even when it is commissioned, it may take many more years to put all the waste into storage. Because of the very long storage period some drum have rusted and more and more are corrosion is visible from the outside. The restricted space in the storage facility means that retrieving these drums is very difficult. Similar rust has been found in drum stores of the nuclear industry. Here, too, the task is to remove the drums from the stores and continue the inspection and certification work. In the remaining interim storage time the safety, security, supervision and monitoring requirements at the sites must be maintained to the necessary standards. Where the current requirements cannot be met, storage conditions must be improved to the necessary standard.

The primary aim of the Lower Saxony regulating authority is that all radioactive waste in long-term interim storage be made safe and their contents precisely documented. The requirements for regulating authority include: documentation, recovery, inspection, reconditioning, longer-term interim storage with full accessibility for inspection and transfer to the national disposal facility [1].

INSTITUTIONAL WASTE IN GERMANY

The radioactive waste disposal policy in Germany has been based on the decision that all types of radioactive waste are to be disposed of in a repository in a deep geological formation. Near-surface disposal or shallow land burial is not practiced in Germany because of the high population density and climatic conditions; furthermore appropriate deep geological formations exist.
In performing its federal supervision, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) is supported by the Federal Office for the Regulation of Nuclear Waste Management (BfE) in all matters regulating nuclear safety and radiation protection of disposal facilities.

Another institution in the area of the BMUB is responsible for the construction and operation of repositories for radioactive waste. The Federal Association for Final Disposal (BGE) is a private legal entity fully owned by the federal government, which will shortly take over the operational business of final disposal on behalf of the Federal Government. The Federal Office for Radiation Protection (BfS), which has been responsible for the past few years, will continue to do so only temporarily.

As mentioned the BGE is responsible for the construction and operation of nuclear waste repositories. Therefore, all methods for the treatment of radioactive waste and for the conditioning of waste packages for disposal have to be approved by the BGE. All other radioactive waste management steps, i.e. the treatment of operational waste or the spent fuel interim storage, are within the responsibility of the waste producers. In the next few years, the transfer of responsibility for radioactive waste packages that meet the disposal requirements, from nuclear power plants to a government agency will also be foreseen on the basis of amended legislation in Germany.

Apart from that the federal states in Germany – called ‘Laender’ - have to construct and operate regional state collecting depots for the interim storage of radioactive waste originating in particular from radioactive applications in industry, universities or medicine. The owners of this institutional waste have to deliver the waste to the state collecting depots and they have to pay a fee. With this payment the ownership and the responsibility for the safe storage and the conditioning is transferred to the Laender.

RADIOACTIVE WASTE IN LOWER SAXONY

With an area of about 48,000 km² (18,400 sq. miles) and nearly eight million inhabitants, Lower Saxony (Niedersachsen) lies in north-western Germany and is second in area and fourth in population among Germany's sixteen states (Laender). In Lower Saxony radioactive waste packages from power plants are stored in several facilities at the NPPs. Beside these facilities, waste packages from power plants and the industries is stored in a central facility located in Gorleben. These facilities are operated by the industries. As a result of the planned decommissioning of the NPP’s, an increasing volume of waste which has to be stored must be expected.

Radioactive waste produced in Lower Saxony outside of the nuclear industry needs to be transferred to the state collecting facility for treatment. After treatment and package in drums or containers, the waste is stored in the state collecting facility of Lower Saxony, called ‘Leese’.

REQUIREMENTS FOR INTERIM STORAGE

Since the waste packages have to be suitable for a long term interim storage, the treatment of the waste and the production of the packages have to be qualified for the interim storage. This is carried out at the above mentioned facilities on behalf of the Ministry for Environment, Energy and Climate Protection of Lower Saxony.

At the same time, the waste treatment process has to be qualified for disposal according to the German radiation protection ordinance by the BGE, as mentioned before. The evaluation of reports for the qualification of waste treatment processes for storage and disposal is done by independent experts. Waste packages for the interim storage have to be kept within the dose and contamination limits of the transport regulations and the mass limits according to the licensing of the waste packages [2].

Additionally, the drums have to be suitable for long term storage. Therefore the corrosion protection of the coating has to be assessed. I will now report on the aspects of corrosion, gaskets and inspections.

CORROSION

At the Gorleben site, approximately 1,200 drums with conditioned radioactive waste drums were stored since the late 1990s. The oldest waste drums dates back to early 1980s. The drums have to be packed into containers for the disposal at the Konrad site within a qualified procedure [3]. This packaging shall be done in an outside conditioning facility. During the preparation for the transport of the drums to the conditioning facilities, corrosion in some of the drums was noticed. Examples of corrosion are shown in Figure 1.

Fig.1: Examples of corrosion at Gorleben, Lower Saxony, (Photo: GNS)

As the storage facility at Gorleben is not equipped with air conditioning systems to control the humidity within the building, condensation of water on the drum surfaces has been observed. If the surface coating of drums are damaged (e.g. by handling), the condensation leads to surface corrosion of these drums. Furthermore, the surface coating of older waste drums originating from the early 90s do not meet current requirements. Therefore, surface corrosion of the drums can be expected. Additionally, a program has been implemented to investigate the possible corrosion from the inside of the drums.
In the Leese storage facility, about 5,000 drums are stored. These range from

200, 280 and 400 liter capacity drums. The oldest drums were produced in the same way as in Gorleben in the early 1980s. In the expectation that the Konrad disposal site will be put into operation soon, drums were stacked very close to each-other some 15 years ago. This has made the inspection of these drums very challenging. Figure 2 show this closely packed storage configuration in the storage hall.

Fig. 2: Storage of 200 liter drums from medicine, research, industry at Leese, Lower Saxony, (Photo: J. Bluth)

Some of the particularly old drums showed a drastic loss of integrity over the past 15 years. One such drum was recovered from the stack and inspected to determine the cause of corrosion. This was performed in a protected cell. It turned out that the contents of the drum did not correspond to the declaration. In particular, free liquids were found in plastic bottles, despite the fact that liquids were not permitted during the time the waste was placed in the drum. This is shown in Figure 3.

Year 2000,
before storage at Leese

Year 2013,
with heavy corrosion

Year 2016,
after opening

Fig. 3: Loss of integrity of a 200 liter drum from the 1980s with undefined liquids inside at Leese, (Photos: NMU, EZN)

In Leese, a few drums have been found with a bulging lid, as shown in Figure 4. This could be due to a number of reasons. Gas formation within the drum can result in a pressure built-up and lift of the cover, if the gasket is intact. It may also be that the cement used to fill the drum has experienced a volume increase during setting. Here, gas samples should first be taken to determine the cause. However, such investigations are hampered by the difficulty in getting access to these drums.

Fig. 4: 200 liter drum with domed lid at Leese, Lower Saxony, (Photo: EZN)

GASKETS

In the interim storage facility Gorleben there are some waste packages with volatile radio nuclides like C-14 and H-3. The lids of these waste packages need to be air tight to ensure containment of such volatile nuclides before the transport to the interim storage. Airtight seal has been achieved by the use of gaskets made of rubber and elastomer. Due to the degradation of these gaskets with time, the airtightness of the seals is questionable and needs to be confirmed before transport. For this purpose, annual leak tests are carried out on representative samples. This aging process is an issue which is focused by the Lower Saxony regulating authority being responsible for the surveillance of the interim storage facility.

INSPECTIONS

Based on the experiences gained with the preparation for the packing in the containers an extended inspection program was established in Gorleben in order to detect all corrosion on the drums which were selected to be transported to the conditioning facility. This will be done to ensure the safety in handling and

transport of the waste packages.

In general, to improve the safe operation of the storage facility, an extended inspection program concerning the packages which will be stored in the interim storage facility for a longer time has to be implemented for each interim storage facility in Lower Saxony.

These extended inspection programs are in development and has to be approved by the supervising authority. In Leese it is planned to move some of the drums for temporary storage in another hall. This is to allow for visual inspection of the drums from all sides, which already show signs of degradation. It must also be mentioned that a large number of the drums in Leese still appear to be in good condition even after several decades of interim storage – no reconditioning would be required for these drums based on current requirements.

REQUIREMENTS FOR DISPOSAL

200 liter drums are not permitted for disposal in the planned Konrad disposal site in Germany. Therefore the conditioning for disposal will be done by packing these drums into rectangular containers with an approval by the BGE. For the institutional waste from the state collecting point in Leese, the use of type IV containers is planned.

Type IV containers made from carbon steel with a protective coating inside and outside. The container has enough space for packing of up to 14 drums. The activity limits for these containers have been determined using analysis of postulated accident scenarios for the Konrad disposal site. It is possible to fill the container with 14 drums of compacted low active waste. For packing of waste with greater inventories the waste product quality has to be improved, e. g. by cementation. It is also possible to condition the waste packages with an inactive outer layer of concrete to achieve an accident proof package. This accident proof package has space for only eight drums with a higher inventory of radio nuclides. According to these kinds of waste treatment different activity inventories were calculated. Figure 5 shows Konrad container, which were made ready for the Konrad disposal, at the site of Leese, Lower Saxony. An appropriate fee will be calculated for these standardized methods of treatment.

Fig. 5: Konrad Containers Type IV, conditioned for the repository, at Leese (Photo: J. Bluth)

QUALITY ASSURANCE OF WASTE PACKAGES

A qualification plan describes each planned waste treatment step and defines the tasks and the responsibilities of the various parties involved. It is submitted to BGE and to the state authority, the Ministry for Environment in Lower Saxony for approval. Additionally, independent experts – for example the TÜV Nord - perform an assessment on behalf of the BGE to verify the suitability of the waste products and waste packages for disposal in the planned Konrad disposal site. The qualification plan is assessed by independent experts on behalf of the state authority in relation of the requirements for long term interim storage in the facility of the state collecting depot in Leese. Approval of both authorities is required to implement the qualification plan.

The treatment of the waste will be performed in multiple campaigns. After the service company has received enough waste and sources for performing a campaign, the documentation of these materials, together with the details concerning the planned treatment (compaction or cementation), is sent to independent experts.

The treatment of the waste according to the approved qualification plan is verified by independent experts in the treatment facility of the service company. The properties of the treated waste and low active dry waste are documented. The documentation will be checked by independent experts. After verification of compliance of the waste properties with the requirements for long term storage in the interim storage facility in Leese and the acceptance criteria for disposal in

the planned Konrad disposal site approval is given by the authorities.

With regard to the oldest waste drums in Leese, documentation is particularly difficult. In the many cases, there are only general content such as "paper, equipment, etc.”. As previously stated, the content can deviate substantially from the declaration. In these cases an extended inspection of each drum will be required. For reasons of radiation protection, generating detailed information about the contents of the waste using non-destructive examination methods are preferred. If these methods are not sufficient, an opening of the drum and, in extreme cases, a segregating the content and repackaging must be considered.

CONCLUSIONS

The legal framework for the management of radioactive waste coming from the nuclear industry, medicine and research in Germany is summarized. The situation in Lower Saxony, one of the states in Germany, concerning the generation of several types of radioactive waste was analyzed. In view of the long interim storage expected and the not unavailability of the Konrad disposal site, there are increasing concerns about the corrosion and other abnormalities in 200 liter drums. These challenges are exacerbated by the climatic conditions in the interim storage facilities. In order to ensure safety during the long period of interim storage, it is necessary to shorten inspection intervals and simplify visual control. In some cases, older drums must be recovered and even opened in order to correct deficiencies in the documentation of the contents.

The goal is to pack the 200 liter drums gradually into containers, which meet 100% of the conditions of the Konrad disposal site and are also suitable for a longer interim storage phase.

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