Note:
This is a translation of the statement entitled “Stellungnahme zu Fragen des BMU zur möglichen Rückholung und Konditionierung von radioaktiven Abfällen aus der Schachtanlage Asse II”.
In case of discrepancies between the English translation and the German original, the original shall prevail.

E S K

Statement

on questions of the BMU on the potential retrieval and conditioning of radioactive waste from the Asse II mine

CONTENTS

1 Background of the statement

For the decommissioning of the Asse II mine, various options were considered. The discussions focused on the options of retrieval of all the waste, relocation of the waste to another area of the Asse II salt structure to be excavated and complete backfilling. On behalf of the Federal Office for Radiation Protection (BfS), feasibility studies /1/, /2/, /3/ were carried out. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) states the following on the current status /4/:

"In the comparison of options [/5/] carried out on the basis of 18 criteria in five assessment areas, complete backfilling ranked first in four assessment areas. However, the BfS concluded that presently there are serious doubts as to whether long-term safety can be demonstrated for the option of backfilling. Therefore, based on the assessment of long-term safety, the BfS considers "retrieval of all waste" as the option to be preferred. Nevertheless, there are still open issues related to the option of retrieval that might render realisation more difficult than planned."

Furthermore, it is stated:

"Fundamental uncertainties are, in particular, the condition of the emplacement chambers and waste packages, the radiological and chemical-toxic inventory and the possibility of developing a safety case for the option of complete backfilling. Due to these considerable uncertainties, the BMU decided, in agreement with the BfS, to take no final decision on the decommissioning of the Asse II mine at this stage."

A first preliminary assessment by the ESK regarding the three decommissioning options and on the aspects of underground and above-ground treatment of radioactive waste associated with the option of retrieval is given by the letter to the BMU of 05.01.2010 /6/.

Since an examination of the technical feasibility and concrete planning of the conditioning of retrieved Asse waste should take place as early as possible, if retrieval of all radioactive waste from the Asse II mine will be pursued, this statement deals with the aspects, associated with this option, of characterisation, conditioning, transport, storage and disposal of the low level waste (LLW) that may have to be retrieved.

2 Request for advice

On 25.11.2009, the BMU commissioned the Nuclear Waste Management Commission (ESK) to prepare an "Assessment of the possibility of retrieving the LLW from the Asse mine" /7/. The starting point for this request for advice was a study of 25.09.2009 on assessing the possibility of retrieval of the LLW from the Asse II mine /1/.

Within the framework of request for advice, the ESK is requested to give a statement on the underground and above-ground treatment of the waste that may have to be retrieved with reference to the feasibility study /1/, addressing, in particular, the following issues according to five questions:

- Condition of the retrieved waste and necessary measures for a safe transport to the surface,
- measures of conditioning to produce waste packages that meet the requirements for interim storage, transport and disposal,
- periods of time for the construction and operation of necessary facilities,
- consideration of incidents for the option of retrieval, and
- radiation exposures of personnel and the population.

The individual questions of the request for advice are dealt with in Chapter 5 in separate sections. Here, the respective facts of the feasibility study /1/ are presented in the context of the individual questions and then evaluated with respect to the questions.

3 Consultations

At its meeting on 09.12.2009, the ESK consulted on the request /7/ of the BMU and commissioned the Committee on WASTE CONDITIONING, TRANSPORT AND INTERIM STORAGE (AZ) to prepare a statement by the end of February 2010 on the aspects of underground and above-ground treatment of the Asse waste that may have to be retrieved. At its 7th meeting on 20 and 21 January 2010, the Committee AZ intensively discussed the condition and the underground and above-ground treatment of the radioactive waste on the basis of current knowledge. This statement was prepared based on the consultations at the 7th meeting and adopted unanimously at the 8th AZ meeting on 24 February. At its meeting on 25 March 2010, the ESK discussed and adopted the statement.

4 Assessment basis

This statement is mainly based on the feasibility study on the retrieval of the LLW from the Asse II mine /1/. In addition, the comparison of options of the BfS /5/ was referred to. To answer the questions of the BMU's request for advice /7/, in particular, the following assessment criteria are used as a basis:

- Radiation Protection Ordinance (StrlSchV) /8/,
- Konrad plan approval, waste acceptance requirements and product control measures for radioactive waste /9, 10, 11/,
- RSK safety requirements on the interim storage of low and intermediate level waste in the longer term /12/,

and the state of the art in science and technology with regard to radioactive waste management.

5 Statement on the questions of the request for advice

5.1 Answer to Question 1

Question 1:

In which condition would the retrieved waste be? Would the waste packages be (largely) intact or (substantially) damaged? What measures would have to be taken for a safe transport of the waste within the repository and to the surface or could the radioactive waste be transported to the surface without further treatment?

Does the above-mentioned report consider the measures to be taken in an adequate manner, or are there open questions?

Presentation of the facts in the report /1/

In Chapter 2.8.5 of the report /1/ it is stated that at present there are hardly any information about the condition of the waste packages. Only emplacement chambers 5/750 and 7/725 were kept open after waste emplacement, so that individual packages could be inspected in these chambers. These packages showed no significant deformation or damage. Here, both cylindrical concrete containers (lost concrete shielding/*Verlorene Betonabschirmung – VBA*) and sheet steel drums are concerned.

A boundary condition assumed in the feasibility study /1/ is that the packages met the waste acceptance requirements of the mine at the time of their emplacement. Presently, a failure of the container integrity is postulated. For the evacuation of the chambers, however, it is assumed that the packages can be removed out of the partially strongly consolidated salt as units.

The report /1/ therefore draws a distinction between the following four waste types to be retrieved: VBA (intact or damaged), drums manageable individually, destroyed drums, and crushed salt. VBA and intact drums are transported underground according to the specifications of the report with the help of transport racks and transfer containers. For destroyed drums and for crushed salt, the feasibility study /1/ envisages the use of special containers.

Assessment

There are many gaps in the knowledge about the current condition of the waste. Against the background of the former packaging technology, the quality of the drums and VBA is to be classified as low (drums with bolted ring seals, VBA partly without reinforcement). A VBA either contains a drum package (200 litre or 400 litre drum) or is directly filled with radioactive waste. In particular, in the chambers which were filled with crushed salt after emplacement of the packages, an increased number of damaged containers is to be

expected due to the rock pressure. The few packages of emplacement chambers 5/750 and 7/725, until recently accessible for inspection, are not representative of the other emplaced LLW packages and thus can not be referred to for a conclusion on the overall condition of the approximately 126,000 packages emplaced.

Taking into account pillar compression of about 50 mm/a in the area of the emplacement chambers also stated in the report /1/, and recorded microseismic events that are interpreted as the breaking of the concrete structures of the VBA, a larger number of destroyed packages in the individual emplacement chambers, exposed waste, and considerable contamination of the crushed salt is to be assumed. For this reason, there are strong concerns as to whether safe handling of the waste packages will be possible.

Some of the wastes in the LLW chambers are packages that were emplaced there with a shielding, for example as VBA or concrete lining in the waste drum, and therefore could have a much higher activity inventory. Integrity of this shielding is not ensured. Therefore, some of the waste to be recovered can only be transferred to the surface in containers with additional shielding.

For steel drums used in the late eighties before the introduction of product control measures, it was shown that after a longer period of interim storage integrity has been destroyed by corrosion from the inside resulting from the moisture content of the waste. This experience from surface facilities is therefore likely to apply to a large number of the steel drums emplaced in the Asse II mine.

Moreover, it can be assumed that the seals of the steel drums have lost their sealing effect.

Overall, handling of unsealed radioactive substances and any other pollutants (e. g. asbestos) is therefore to be expected.

A large number of the packages contain waste from research facilities, including the reprocessing of nuclear fuel in Karlsruhe. For this waste, contamination in particular by alpha emitters and Sr-90 is to be expected. This circumstance is not taken into account in the feasibility study /1/ to the extent required. The control of the activity inventory by dose rate measurements alone is not sufficient; here, other methods have also to be applied for activity determination. In view of the anticipated handling of unsealed radioactive substances and the α content to be postulated, a concept for incorporation monitoring is to be realised in addition to comprehensive precautions against uncontrolled spread of contamination.

A boundary condition of the study is that all waste packages emplaced met the waste acceptance requirements of the Asse II mine applicable at the time of their emplacement. However, this is not ensured for each individual waste package /13/. In addition, it should be noted that between 1967 and 1971, no acceptance requirements were stipulated and in the time following, exceptions subject to approval were also possible. Of decisive importance is that at that time, no product-specific control measures were implemented, so that no reliable statements on compliance with the Asse waste acceptance requirements are available.

According to the present knowledge it is to be assumed that in individual chambers areas with contaminated brine will be found. The feasibility study /1/ does not consider this case to the extent required and is not

applicable if there are larger amounts of brine in the chambers.

To transport the waste to the surface, special casks are to be developed with specified sealing effect (recovery containers) such that open activity and contaminated liquids are safely enclosed. The recovery containers also have to be designed – according to ERAM experience – against corrosion in view of salt adhesion together with humid above ground. When sizing these casks, it is to be taken into account that according to the ASSEKAT database, in addition to the types of containers considered in the study (VBA and drums) also other package types were emplaced, and that all package types may also be deformed.

Already under consideration of the above aspects, the underground compaction of the waste proposed in the feasibility study /1/ appears to be appropriate neither from the point of view of manageability nor radiation protection.

In summary, the ESK concludes that the report /1/ does not consider the measures to be taken into account to the extent required, since the requirements for the safe transfer of the waste to the surface can only be specified and finally evaluated if there are reliable information on the condition of chambers and packages. The waste and the potentially contaminated surrounding salt must be safely enclosed in special recovery containers still to be developed before they can be transferred to the surface. For part of the waste, these containers must have an additional shielding effect. For the handling of this part, special shielding measures are to be taken for the staff, especially underground.

5.2 Answer to Question 2

Question 2:

What measures would have to be taken for the conditioning of the retrieved radioactive waste to produce a waste package that meets the requirements for interim storage and transport, and could these waste packages be emplaced in the Konrad repository? Could a significant proportion of salts from the retrieval preclude a future disposal in the Konrad repository?

Does the above-mentioned report consider the measures to be taken in an adequate manner, or are there open questions?

Presentation of the facts in the report /1/

Regarding the conditioning of the retrieved waste, the report /1/ assumes the following:
The retrieved waste will be brought to the Konrad repository. The waste packages to be produced thus have to meet the waste acceptance requirements for the Konrad repository.

The waste is to be conditioned primarily above ground, since the Konrad packages cannot be transported

through the shaft. To reduce the number of waste packages and the waste package volume, Konrad containers are to be used that are as large as possible.

Sufficient interim storage capacity is to be provided, since even in case of operation of a repository it is not to be expected that the conditioned packages can be accepted by the repository within the time frame as they are retrieved. In addition, buffer storage capacity for the retrieved waste is needed before it can be conditioned.

The report /1/ assumes that the waste packages emplaced in the Asse II mine, met the waste acceptance requirements of the Asse II mine at the time of their emplacement and that the activity inventories and content descriptions in the ASSEKAT database are displayed correctly.

The feasibility study /1/ envisages the use of DBA-resistant packaging in the form of a sheet steel container Type V for the packaging of the waste products with the objective that only proof of compliance with the basic waste acceptance requirements for disposal will be required. The Konrad containers Type V with a 10 cm concrete inner lining is to be loaded with three VBA, with 18 200-litre drums, or directly with compacted waste pellets. It is assumed that on average a Konrad container Type V has a capacity for 30 pellets. An analysis of the activity data of the LLW packages for the relevant nuclides (alpha emitters, Pu-241, Co-60, Cs-137, Sr-90, I-129, Ni-63, H-3) conducted within the framework of the feasibility study /1/ shows that the activity limits (here in particular from the incident analysis) for the Konrad mine will not be exceeded also in case of maximum loading of the containers. According to the feasibility study /1/, optimum container filling is possible by filling of the container void volume with lightweight concrete.

Further, it is also explained how the fissionable content limits can be kept. The feasibility study /1/ shows that the waste products for disposal in the Konrad repository may contain material fissionable by thermal neutrons, except for natural uranium and depleted uranium, in a mass concentration up to 50 g per 0.1 m³ of waste product. According to the waste acceptance requirements of the Asse II mine, the nuclear fuel concentration for LLW was limited to 15 g per waste container. The feasibility study /1/ includes the assumption that the maximum loading of the Konrad container corresponds to the content of 30 Asse containers. It is stated that the maximum fissile material inventory of a container can therefore only amount to 0.45 kg. Considering the volume of 10.9 m³ of container Type V, a maximum total mass of 5.4 kg of nuclear fuel is possible when keeping the limit of 50 g per 0.1 m³ of waste product.

To determine the activity inventory of the Konrad containers to be produced, the feasibility study /1/ proposes the following approach:

- An averaged nuclide vector for VBA and drums is derived from the ASSEKAT database for each chamber. For activation products, Co-60 will be used as reference nuclide, and for fission products Cs-137.

- At the Konrad containers, the reference nuclides Co-60 and Cs-137 are measured by in-situ gamma spectrometry. Other nuclides are added by using the nuclide vector method.

- After completion of the conditioning of all VBA and drums of a chamber, the activities are corrected such that the activity sum of all Konrad containers corresponds to the decay-corrected activity inventory of the chambers for VBA and drums.

The report addresses the possibility of taking samples from the packages and characterisation on the basis of the analysis results; however, it is stated that due to the high effort involved and the possibility of sampling errors, the above approach for inventory determination is to be preferred.

For conditioning of the recovered waste, the feasibility study /1/ envisages the following installations:

- A high-pressure compactor,
- drying facilities for pellets, drums, but also for VBA,
- an assembly area for the insertion of pellets, drums and VBA in Konrad containers,
- an in-situ gamma spectrometry measurement installation for the characterisation of the containers,
- an area for cementation of the voids in the containers (side walls and interior), which also serves to conduct the necessary measurements of the local dose rates, and
- an area for inspection of the VBA.

All areas are separated from each another by shielding walls as to prevent mutual impacts. The conditioning area is designed as a so-called caisson, i. e. its ventilation is independent from the other storage and lock areas and thus can only be reached through locks for personnel and equipment.

Assessment

For the production of waste packages from the retrieved waste that are suitable for interim storage and transport, at first, an appropriately dimensioned above-ground storage capacity is to be created for the loaded recovery containers. Due to the adhesion of crushed salt and the given risk of corrosion during exposure to atmospheric moisture, a special design of these containers or the storage building is required for storage /12/. If this interim storage capacity cannot be realised at the site of the Asse II mine, the recovery containers must also fulfil the requirements applicable under traffic law.

As defined in the Radiation Protection Ordinance (StrlSchV), the recovered waste is to be recorded and characterised in accordance with Appendix X /8/. Due to the emplacement methods and the nuclide inventory to be postulated, an adequate database can be obtained for the individual waste neither with the help of the ASSEKAT database nor with locally applicable measurement techniques. Accordingly, further radiological characterisation measures are to be provided for in addition to the dose rate measurements and in-situ gamma spectrometry. The transport of the waste to external locations and external interim storage may require further declarations in accordance with the relevant provisions to be applied.

Characterisation of the gamma spectrometry is at least not reasonably practicable for packages with additional shielding or with unfavourable nuclide distribution in the waste,. Since there is usually no information about the individual packages, a reliable characterisation of the waste is only possible via sampling.

The characterisation on the basis of nuclide vectors averaged over an emplacement chamber, as proposed in the feasibility study /1/, is not suitable to determine the activity of the individual packages. For transportation, storage and also disposal (limits from the analyses of DBAs and criticality safety), the activity inventory of the individual packages is relevant and not an average over a number of packages /9/.

The considerations in the feasibility study /1/ on the suitability of nuclear fuel containing packages for emplacement in a repository are not correct and complete either. Averaging over the entire volume of a repository container is not permissible /9/. In addition to the considerations in the feasibility study /1/, any additional requirements for fissile material containing waste from the Konrad waste acceptance requirements and the relevant provisions of the Konrad plan approval also have to be met /9, 11/. This includes, among other things, the requirement to show the fissile material concentration averaged over 100-l partial volumes. Furthermore, the feasibility study /1/ does not consider that waste material containing more than 15 g of nuclear fuel per waste container (200 l) were emplaced on the basis of a special agreement.

According to the feasibility study /1/, by the use of DBA-resistant packaging, only the proof of compliance with the basic waste acceptance requirements for disposal shall be required. This solely applies to waste products; for DBA-resistant packaging, the fulfilment of the basic requirements for waste containers and the additional requirements for DBA-resistant packaging will have to be demonstrated.

For material characterisation of the packages for the Konrad repository, averaging over the waste of a lot is permissible /11/. Regarding the material characterisation, the study /1/ includes no statements.

The steel container Type V, mentioned in the feasibility study /1/, as a container for the production of DBA-resistant packages has only been licensed so far for decommissioning waste in qualified, new inner containers and grouting of the interspaces with inactive concrete with defined properties. On the basis of adequate radiological and material characterisation, above-ground reconditioning of the Asse waste that meets the acceptance requirements for the Konrad repository is principally possible. However, the relevant statements in the feasibility study /1/ are incomplete, partly unfounded, and are not consistent with the waste acceptance requirements and the specifications of the product control for the Konrad repository. The ESK holds the view that reconditioning of recovered waste with contaminated crushed salt can only be carried out in specially equipped, surface facilities. A waste container (Container V designed as DBA-resistant packaging) is currently not available, and for individual waste streams (such as fixed ion exchange resins), proved conditioning methods have not been established yet.

In summary, the ESK concludes that the report /1/ does not consider the measures to be taken into account to the extent required and that the above-mentioned open questions remain to be clarified.

5.3 Answer to Question 3

Question 3:

Are the periods presented in the above-mentioned report for the construction and operation of necessary facilities appropriate or would considerably longer time periods for each step have to be expected?

Presentation of the facts in the report /1/

Besides the recovery of the waste, the feasibility study /1/ describes the following activities for its underground handling.

The VBA will be recovered from the chambers and then pretreated in the repackaging and partial conditioning facility for further transport through the shaft hoisting installation. For this pretreatment, /1/ specifies the following times:

- Removal of crushed salt and conveyance through the separation 1 min
- Dose rate measurement 1 min
- Packaging in foil 1 min
- Conveyance to the transfer cask and reloading 2 min

Thus, the pretreatment of VBA takes 5 minutes per package. It is postulated that after packaging of the first VBA (i. e. after 3 min), treatment of the next unit can be started and it then undergoes cleaning. Accordingly, a processing capacity of up to 20 units/h is determined for VBA or, taking account the postulated efficiency of 80 %, of up to 16 VBA/h.

For the processing of the recovered drums in the repackaging and partial conditioning facility, the following times are assumed:

- Removal of crushed salt and conveyance to the compactor 1.5 min
- Compaction (optionally) 1.5 min
- Packaging in foil 1 min
- Dose rate measurement 1 min
- Conveyance to the transfer cask and reloading 1 min

This results in a total treatment time of 6 minutes with compaction in the underground, or without compaction of 4.5 minutes per drum. Taking into account an efficiency of 80 % a capacity of 16 drums/h is determined for the treatment of drums with compaction.

It is envisaged to remove deformed or otherwise damaged drums and damaged VBA, as is the case for contaminated crushed salt, in bulk from the chamber to be emptied and packaged in special containers for transport out of the mine. The times determined for the treatment of bulk material are as follows:

- Conveyance in special container 1.5 min
- Dose rate measurement, in-situ gamma spectroscopy 1 min
- Putting cover on container and packaging in foil 1 min
- Conveyance to the storage area 0.5 min

It is stated in the report /1/ that the time required for filling of the special containers strongly depends on the good conveyed. The specified time required for the conveyance of the bulk material in the special containers is therefore only to be regarded as an average value. For postulated overlap in the activities and taking into account the assumed efficiency, the capacity of the repackaging and partial conditioning facility determined in the report amounts to 32 special containers/h.

For conveyance of the retrieved waste to the surface, the following capacities are determined in the report:

- VBA: 88 units/day or
- 400-l drums: 264 units/day or
- 200-l drums: 440 units/day or
- Crushed salt: 264 m³/day.

For the conditioning above ground, the report /1/ does not include considerations on the quantitative capacity, since these are not time-critical for the retrieval process. As stated in the report, the packages transported to the surface can be put down in the storage area in adequate number and then be transported to the conditioning plants. The report states that the storage areas and the areas in the storage facility for conditioned packages meeting the requirements for disposal in a repository are designed such that they can be adjusted to the respective space requirements.

Assessment

The following considerations in this statement are limited – in accordance with the question to be answered – on the presentation and assessment of the time frames for the construction and operation of facilities that are needed for the conditioning of the retrieved waste into packages suitable for disposal in a repository. For example, the time required for opening and securing of the emplacement chambers is not considered in this statement, since this does not directly affect the conditioning of the waste.

The time required for the licensing of the necessary underground and above-ground measures is only dealt with qualitatively, since this depends, among other things, on the type of the legal procedure (e. g. plan approval or an order), which is not addressed in this statement.

- Underground treatment of the waste and transport to the surface

Construction and operation of underground facilities for treatment of the containers after recovery require appropriate planning and licensing. This issue is dealt with in /1/.

Moreover, the proposed underground packaging measures require qualification or a cask certification procedure, and the production of the containers for recovery mentioned in Chapter 5.2. Specifications regarding the time needed for this are not included in /1/.

Based on more detailed plans it would have to be assessed which of the preparatory activities is the time-determining step when making use of the approach of parallel activities and which time requirement is to be taken as a basis.

For underground operation, one of the factors being decisive for the time requirement is the hoisting cycle of the shaft hoisting installation. For the transfer of all waste, including crushed salt, transport through the shaft is the only feasible option (transport through pipeline is not possible). The limiting boundary conditions are: 44 transports per day, maximum load, 3-shift operation. The assumption that the historic shaft hoisting installation will be available 300 days a year around the clock with 100% of its load capacity without extensive upgrading measures appears to be unrealistic. The planning of the recovery concept is to be based on realistic transport capacities under consideration of the upgrading capabilities for the shaft hoisting installation. Only on this basis it can be clarified whether the capacities of transport to the surface will be the time-determining factor in the end.

For the estimations on the time periods for underground pretreatment of the waste and their transport to the surface, the report /1/ did not consider that restrictions such as dose rate limitations, additional radiation protection measures for some packages and thus also increased expenditures of time are to be expected. In addition, special measures are to be expected for the recovery of some wastes (e. g. special packaging). Moreover, the feasibility study /1/ does not contain information on a time requirement for an extended waste data collection at the place of emplacement (drum type, labelling, storage location, waste type, ...). In addition, an underground mass determination, which is already required for the transport of the waste to the surface (maximum loading of the recovery container, permissible load of the support cage), has not been provided for yet.

Furthermore, it is pointed out that, regardless of the fact that high-pressure compaction underground is not expedient, the throughputs and times indicated in the study are unrealistic in view of current operating experience made in above-ground conditioning facilities.

With regard to the time required for the implementation of the underground work for the pretreatment and conveyance of the waste packages to the surface, altogether, it can be stated that, on the one hand, the estimated times in the feasibility study /1/ in some cases are far too short and that, on the other hand, certain processing steps were not taken into account. More realistic time estimates, which will be possible only after more detailed planning, in any case will be well above those stated in the feasibility study /1/ and the correction factor of 1.25 stated in the comparison of options of the BfS /5/. Furthermore, it is to be noted that the issues still to be clarified regarding the condition of the emplacement chambers and the waste packages (see Chapter 5.1) lead to considerable uncertainties about the time required to recover the waste from the chambers.

- Above-ground storage and conditioning

The time required for the construction of surface facilities will depend, among other things, on the necessary size of the required area. The determining factors are, on the one hand, sufficient storage capacity for the retrieved waste and the surrounding crushed salt and, on the other hand, the space required for the conditioning methods and conditioning capacities.

For the prevention of retroactive effects of the available above-ground capacity on the waste removal process, the ESK assumes that storage capacities for the overall amount of 50,000 m³ of waste to be retrieved and the 50,000 m³ of contaminated crushed salt and the resulting waste packages with an estimated volume of 150,000 to 200,000 m³ will be required. The surface facilities for buffer storage, conditioning, packaging and interim storage of the waste until emplacement in a repository are to be sized accordingly.

The surface facilities outlined in the feasibility study /1/ are undersized for this purpose. The storage area will probably must have at least the same dimensions as the LLW/ILW storage area of the Interim Storage Facility North (ZLN); the conditioning area will in any case have to be much larger than designed there.

Regarding the required conditioning capacities, a postulated operating time for the conditioning of the Asse waste of 15 years would result in a required throughput of approximately 10,000 m³ per year. Currently, about 1,500 m³ of radioactive waste are conditioned throughout Germany per year to meet the waste acceptance requirements of the Konrad repository. For this purpose, conditioning facilities are available at different locations with a controlled area of around 20,000 m². As part of the preparatory work for the commissioning of the Konrad repository, it is planned to increase the capacity at decentralised sites that are available or that are still to be established for a repository container volume of 6,000 to 8,000 m³/y. In order to provide the required capacities for conditioning (even assuming doubling of the conditioning duration) and the required methods for conditioning, planning, there is a need for development, qualification and approval which is not covered by the information given in the feasibility study /1/.

The time required for the provision of the necessary storage and conditioning capacity is to be re-assessed on the basis of detailed plans. The work can be done in parallel with the preparatory activities for the underground work, checking what processes are time-determining, and what is the estimated time requirement resulting from it.

The time required for the entire period of operation of the storage and conditioning facilities depends, among other things, on the capacities for the characterisation and conditioning of the waste packages to meet the waste acceptance requirements for disposal (including product control and documentation), and on the boundary conditions for the removal of the packages for disposal in the Konrad mine. The feasibility study /1/ does not contain data and information on this issue. However, the operating time of the surface facilities is not decisive for the time-critical underground work if - as described - sufficient capacities are provided to accommodate all waste and the incurring amounts of contaminated crushed salt.

In summary, it can be stated that the periods of time specified in the feasibility study /1/ and also in the comparison of options of the BfS /5/ for planning, licensing, construction and operation of the required facilities for recovery, storage and conditioning are unrealistic; even in case of intact waste packages, significantly longer periods are to be assumed for the realisation of the individual steps that are to be determined when detailing the planning of underground and surface facilities and the required operating procedures and approaches.

5.4 Answer to Question 4

Question 4:

Have possible incidents during the retrieval operation adequately been taken into consideration, or are there open questions?

Presentation of the facts in the report /1/

The operations and processes for the retrieval of the LLW described in the feasibility study /1/ and the areas of operation involved are analysed for possible incidents with release of activity (see Chapter 6.3). In order to verify the completeness and to derive preventive measures, analyses of incidents of the current operation of the Asse II mine and other facilities for the storage of radioactive waste (Konrad, Morsleben) have also been referred to. The following events that could result in releases of radioactive substances into the environment of the Asse II mine during the retrieval of the LLW were identified:

Underground:

- Filter failure (filtering of the waste air from the area of retrieval),
- failure of the ventilation isolation (maintenance of negative pressure in the area of retrieval),
- drop of heavy loads on waste packages (roof fall),
- drop of waste packages during transport processes and at transfer locations,
- deflagration/explosion during the handling of waste packages (due to gas formation in the package/release of solvents, etc.),
- leakage of liquids,
- underground fires (vehicle fire, filter fire, deflagration with fire),
- drop of loads in the hoisting shaft (during loading of the cage or drop of the cage), and
- earthquake.

Above ground:

- Incident during transport between shaft and transport preparation hall and in the transport preparation hall (repackaged packages or packages meeting the requirements for disposal),
- handling errors (waste package drop) in the transport preparation hall,
- fires in transport preparation hall, including filter fire, and
- earthquake (drop of parts of the shaft hall onto packages that are temporarily located in the shaft hall or in the transport preparation hall).

On this basis, the radiologically relevant events are defined. Here, separate ventilation of the retrieval area is mentioned as the most important measure to reduce the discharges of radioactive substances into the environment of the Asse II mine. Its task is to keep the retrieval area under negative pressure and to filter the waste air. Various precautionary measures for maintenance of negative pressure and waste air filtering are specified. From this, it is concluded that all incidents that take place at negative pressure in the retrieval area will have no significant radiological impacts on the environment of the Asse II mine.

According to the feasibility study /1/, all incidents are to be regarded as radiologically relevant events which may occur during transport or handling of packages underground outside of the area where filtering of the exhaust air takes place, as well as transport and handling incidents above ground:

1. Drop of waste packages during transport processes and at transfer locations outside the retrieval area,
2. incident during transport between shaft and transport preparation hall and in the transport preparation hall (repackaged packages and packages meeting the requirements for disposal),
3. handling errors (drop of repackaged packages and packages meeting the requirements for disposal) in the transport preparation hall.

Assessment

To ensure the completeness of the accident scenarios, the corresponding studies for the same or comparable facilities (Asse, Konrad, Morsleben) are referred to. The scope of the events taken into consideration is complete if postulated events like aircraft crash or explosion pressure wave can be assigned to the beyond-design-basis events. This must be demonstrated for the respective site. The beyond-design-basis events are to be investigated as to their impact they may involve.

The possibility of damages from mining activities and their impact on the surface facilities has neither been considered in the feasibility study /1/ nor in the comparison of options of the BfS. From the point of view of the ESK, this aspect could be an important site feature that may have to be considered in the concept of surface facilities.

Incidents are usually divided into events

- where appropriate precautions have been taken in accordance with the state of the art in science and technology to prevent accidental releases of radioactive substances into the environment (Class 2), and
- where in case of a release of radioactive substances the doses remain below the accident planning levels of the Radiation Protection Ordinance (StrlSchV) under consideration of § 6 (2) StrlSchV (Class 1).

For events of Class 2, an assessment of the required precautions and design measures is somewhat problematic, since the technical design is not presented here but they are assessed deterministically. This applies, in particular, to the following events for which relevant activity releases have to be expected:

- Roof fall: The condition of the Asse is not comparable, e. g., with the Konrad repository where another mine design is envisaged.

- Vehicle fire: If vehicles with diesel engines will be used, the prevention of vehicle fire appears to be impossible in spite of all fire protection measures (see plan approval procedure for the Konrad repository). A fire where waste packages are affected involves significantly higher activity release rates than in the case of mechanical loads of waste packages.

- Drop of loads in the hoisting shaft: Without knowledge of the individual measures (upgrading measures – no new facility), the feasibility of precautionary measures cannot be assessed.

- Fire in the transport preparation hall: At least in cases where conditioning measures are automated, e. g. as it is common practice in the case of drying measures for waste packages, the limitation of fire events to the early stage is problematic.

The determination of the source terms of incidents for the radiologically relevant events identified in the study to be considered is based on the current knowledge available. However, the analysed events do not include fire scenarios and releases due to filter failures, which would result in greater impacts.

A detailed assessment of the results of the incident analyses is not possible, since the ESK did not review the incidents investigated. However, it can be stated that the incidents investigated do not cover the entire spectrum for nuclear installations.

5.5 Answer to Question 5

Question 5:

Have the radiation exposures of personnel and the population affected occurring during a retrieval of the radioactive waste and measures to be derived been adequately considered in the above-mentioned report, or are there open questions?

Presentation of the facts in the report /1/

The examinations in the report /1/ with regard to radiation protection, in a first part give an answer to the question of whether the requirements for radiation protection measures for staff specified in the Radiation Protection Ordinance (StrlSchV) can be fulfilled with the activities carried out during the retrieval of radioactive waste. These include the following issues:

§ 6 Avoidance of unnecessary radiation exposure and dose reduction
§ 36 Radiation protection areas
§ 43 (1) Protection arrangements
§ 44 Contamination and decontamination
§ 54 Categories of occupationally exposed persons
§ 55 Protection with occupational radiation exposure.

Furthermore, the exposure of the population to be postulated from specified LLW retrieval operation was determined. This is followed by the check for compliance with the dose limits of § 47 (1) StrlSchV for discharges of radioactive substances with air from the Asse II mine that consider the discharges from current operation as a preload.

For the operating personnel, a collective dose of about 400 mSv over the entire period of waste removal is obtained. Workers in the emplacement chambers were identified to belong to the group of persons with the highest individual doses to be expected. As stated in /1/, there will be, averaged over a period of three years, personal doses of 9.9 mSv/a for the 13 members of this collective, which corresponds to approximately 50 % of the maximum permissible annual dose for occupationally exposed persons of Category A.

The calculation of the radiation exposure of the population was based on the general administrative provision (AVV) (draft) regarding § 47 of the Radiation Protection Ordinance (StrlSchV). It was also investigated whether the effective dose limit of 1 mSv/a for members of the public pursuant to § 46 (1) StrlSchV is complied with. According to § 46 (3) StrlSchV, this limit applies outside the operating site for the sum of the radiation exposure from direct radiation and radiation exposure from discharges. The contribution to direct radiation comes from the packages with the retrieved radioactive material stored in the transport preparation hall.

For the assessment of the potential radiation exposure of the public from incidents, the incidents that may

occur during the retrieval were identified and their radiological impacts determined. It was investigated whether the potential exposure of the population from incidents during retrieval is below the accident planning values stipulated in § 49 (1) StrlSchV. According to § 49 (2) StrlSchV, these accident planning levels also apply to federal facilities for the safeguarding and disposal of radioactive material. The calculation of the radiation exposure in the environment of the Asse II mine was carried out on the basis of the Incident Calculation Bases (SBG) with the revised version of Chapter 4 of the Incident Calculation Bases according to § 49 StrlSchV.

Assessment

Question 5 regarding the radiation exposures of personnel and the population occurring during retrieval of the waste and measures to be derived cannot be answered before clarification of the open issues relating to Questions 1 to 4, and therefore has to be answered later in consultation with the Commission on Radiological Protection (SSK).

Although it is currently not possible to make substantiated estimates of the radiation exposures of personnel and the population occurring during retrieval of the waste from the Asse II mine, the ESK points out that for the prevention of conservatively calculated hypothetical doses in the future in the case that the waste remains in the Asse II mine, significant real exposures for the operating personnel would have to be accepted in the next decades in the case of retrieval of the waste. There would also be an additional real radiation exposure for persons in the vicinity of the plant from direct radiation and higher emissions.

6 Summary

Given the fact that an examination of the technical feasibility and concrete planning of the conditioning of retrieved Asse waste should take place as early as possible, if retrieval of all radioactive waste from the Asse II mine will be pursued, the BMU commissioned the Nuclear Waste Management Commission (ESK) to prepare an “Assessment of the possibility of retrieving the LLW from the Asse mine”. This request for advice covers five questions.

The ESK concludes that the requirements for the safe transfer of the waste to the surface can only be specified and finally evaluated if there are reliable information on the condition of chambers and packages.

According to the present knowledge it is to be assumed that in individual chambers areas with contaminated brine will be found. The feasibility study /1/ does not consider this case to the extent required and is not applicable if there are larger amounts of brine in the chambers.

For a large number of the steel drums, a loss of integrity is to be assumed due to internal corrosion and loss of the sealing effect. For lost concrete shielding (*Verlorene Betonabschirmung – VBA*) in the LLW chambers, integrity of the shielding is not ensured. Therefore, some of the waste to be recovered can only be transferred to the surface in containers with additional shielding

Overall, handling of unsealed radioactive substances and any other pollutants (e. g. asbestos) is to be expected.

The waste and the potentially contaminated surrounding salt must be safely enclosed in special still to be designed containers for recovery before they can be transferred to the surface. For part of the waste, these containers must have an additional shielding. For the handling of this part, special shielding measures are to be taken for the staff, especially underground.

On the basis of adequate radiological and material characterisation, above-ground reconditioning of the Asse waste into waste that meets the waste acceptance requirements for the Konrad repository is principally possible. However, the relevant statements in the feasibility study /1/ are incomplete, partly unfounded, and are not consistent with the waste acceptance requirements and the specifications of the product control for the Konrad repository. The ESK holds the view that reconditioning of recovered waste with contaminated crushed salt can only be carried out in specially equipped, surface facilities. A waste container (Container V designed as DBA-resistant packaging) is currently not available, and for individual waste streams (such as fixed ion exchange resins), proved conditioning methods have not been established yet.

Furthermore, it can be stated that the periods of time specified in the feasibility study /1/ and also in the comparison of options of the BfS /5/ for planning, licensing, construction and operation of the required facilities for recovery, storage and conditioning are unrealistic; even in case of intact waste packages, significantly longer periods are to be assumed for the realisation of the individual steps that are to be determined when detailing the planning of underground and surface facilities and the necessary operating procedures and approaches.

A detailed assessment of the results of the incident analyses is not possible, since the ESK did not review the incidents investigated. However, it can be stated that the incidents investigated do not cover the entire spectrum for nuclear installations.

Although it is currently not possible to make substantiated estimates of the radiation exposures of personnel and the population occurring during retrieval of the waste from the Asse II mine, the ESK points out that for the prevention of conservatively calculated hypothetical doses in the future in the case that the waste remains in the Asse II mine, significant real exposures for the operating personnel would have to be accepted in the next decades in the case of retrieval of the waste. There would also be an additional real radiation exposure for persons in the vicinity of the plant from direct radiation and higher emissions.

7 List of reference documents

/1/ DMT GmbH & Co. KG, TÜV NORD SysTec GmbH & Co. KG
Beurteilung der Möglichkeit einer Rückholung der LAW-Abfälle aus der Schachtanlage Asse
Evaluation of the option of retrieving the LLW from the Asse mine
As of 25.09.2009

/2/ AF-Colenco AG, Baden, Switzerland, 1764/01; Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, Braunschweig, GRS-A-3494; IfG Institut für Gebirgsmechanik GmbH, Leipzig, 8681-9
Schachtanlage Asse II, Beschreibung und Bewertung der Stilllegungsoption Vollverfüllung
Asse II mine, description and evaluation of the decommissioning option complete backfilling
As of 01.10.2009

/3/ ERCOSPLAN Ingenieurgesellschaft Geotechnik und Bergbau mbH,
TÜV NORD SysTec GmbH & Co. KG, EGB 07-036.01
Beurteilung der Machbarkeit einer Umlagerung aller oder Teile der radioaktiven Abfälle in der Schachtanlage Asse II
Evaluation of the feasibility to relocate all or part of the radioactive waste in the Asse II mine
Erfurt, 30.09.2009

/4/ BMU Website; Asse II mine; as of January 2010;
http://www.bmu.de/atomenergie_ ver_ und_ entsorgung/endlagerung/asse/doc/40319.php

/5/ BfS
Optionenvergleich Asse
Fachliche Bewertung der Stilllegungsoptionen für die Schachtanlage ASSE II
Expert report on comparison of options for decommissioning Asse
9A/21400000/MZA/RB/0001/00

/6/ ESK/SSK ad hoc working group Asse
Letter to the BMU dated 05.1.2010

/7/ Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Assessment of the possibility of retrieving the LLW from the Asse mine
Statement on the underground and above-ground treatment of retrieved radioactive waste, letter to the ESK
RS III 3 – 17 005/0, 25.11.2009

/8/ Radiation Protection Ordinance of 20 July 2001 (Federal Law Gazette (BGBl.) I p.1714, (2002, 1459)), last amendment by the Act of 29. August 2008 (Federal Law Gazette (BGBl.) I p. 1793)

/9/ BfS
Anforderungen an endzulagernde radioaktive Abfälle
(Endlagerungsbedingungen, Stand: Dezember 1995) - Schachtanlage Konrad –
Requirements on Radioactive Waste for Disposal
(Waste Acceptance Requirements as of December 1995) - Konrad Repository–
ET-IB-79

/10/ BfS
Produktkontrolle radioaktiver Abfälle - Schachtanlage Konrad -
Stand: Dezember 1995
Product Control for Radioactive Waste - Konrad Repository -
as of December 1995,
ET-IB-45-REV-3

/11/ Niedersächsisches Umweltministerium
Planfeststellungsbeschluss Konrad
Plan approval decision for the Konrad repository,
Hannover 2002, Annex 4

/12/ RSK
Recommendation: Safety requirements on the interim storage of low and intermediate level waste in the longer term
RSK357, as amended on 05.12.2002 with new wording in Section 2.7.1 of 16.10.2003

/13/ ESK/SSK ad hoc working group Asse
Letter to the BMU dated 02.11.2009