Note:
This is a translation of the letter entitled "Zur Unterlage „Abschätzung potentieller Strahlenexpositionen in der Umgebung der Schachtanlage Asse II in Folge auslegungsüberschreitender Zutrittsraten der Deckgebirgslösung während der Betriebsphase"
Beratungsergebnisse und Empfehlungen der Ad-hoc-Arbeitsgruppe ASSE der ESK und der SSK".
In case of discrepancies between the English translation and the German original, the original shall prevail.

Ref. document "Estimate of potential radiation exposures in the environment of the Asse II mine due to beyond-design inflow rates of brine solutions from the overburden during the operating phase"

Consultation results and recommendations of the ASSE ad hoc working group of the Nuclear Waste Management Commission (Entsorgungskommission, ESK) and the Commission on Radiological Protection (Strahlenschutzkommission, SSK)

At the meeting of the ESK/SSK ad hoc working group ASSE on 21 09.2009, discussions were held on the GRS document "Abschätzung potenzieller Strahlenexpositionen in der Umgebung der Schachtanlage Asse II in Folge auslegungsüberschreitender Zutrittsraten der Deckgebirgslösung während der Betriebsphase" (*Estimate of potential radiation exposures in the environment of the Asse II mine due to beyond-design inflow rates of brine solutions from the overburden during the operating phase*).

Overall, the ad hoc working group ASSE arrives at the following conclusion:

The ad hoc working group ASSE considers the approach of (at least for some parts) overly conservative calculation of radiation exposures chosen in the document to be generally unsatisfactory in the context chosen here. This approach, however, was due to the task formulation. A realistic calculation of the potential radiation exposures is not possible on the basis of the current state of knowledge.

Although the ad hoc working group ASSE is of the opinion that the document is not suitable as a basis for decision-making in connection with a beyond-design- inflow of brine solution due to the overly conservative approach, the planning for dealing with beyond-design-basis inflow should be implemented as soon as possible.

The ad hoc working group ASSE stresses that the results of the GRS study are not to be regarded as "radiation exposures to be expected realistically" and that the document is not suitable for weighing up advantages and disadvantages of different options for further action with regard to potential radiation exposures of the population.

In particular, this is due to the following:

The closure of the Asse II mine also requires estimates of potential radiological consequences of a beyond-design inflow of brine solutions from the overburden into the mine workings. Such estimates are required to clarify whether the planning of measures for hazard control are necessary and justified. For this reason, the

Federal Office of Radiation Protection (BfS) had commissioned GRS to perform a review on this issue. The report submitted by GRS is based on the following considerations:

> Existing precautionary measures are sufficient for the technical control of brine inflow with volume flows up to about 200 m^3/d. In case of inflow rates of more than 200 m^3/d, brine solutions accumulate at the 750-m level and, possibly, at the 775-m level and in the area of deep exploration drilling. In these cases, planned decommissioning will no longer be possible. However, backfilling of the emplacement chambers and adjoining mine areas not fully backfilled and installation of shaft seals will still be realisable.

The report intended to investigate - by means of simple estimates as conservative as possible - "*which radiological consequences are to be expected if the inflow rates increases to beyond-design-basis values.*" However, these consequences are not analysed with detailed model calculations but by means of rough estimates. Here, only radionuclides in the brine solution are considered, distributions in the gaseous phase are excluded.

All considerations made by GRS are based on a model which, in particular, includes the following assumptions:

(1) Brine inflow takes place in the southern flank at a depth of 574 m to 500 m below ground level with a constant inflow rate.
(2) After or during the backfilling of the mine, which takes about 30 years, the radionuclide inventory will dissolve within a relatively short period of time. The waste inventories used in the model correspond to the status as at 01.01.2005 according to [2].
(3) Regarding chemical retention of the radionuclides due to solubility limitations and sorption, no retention is considered for the LAW areas. In the MAW chamber, retention is regarded to be possible for selected radionuclides under the assumption of complete backfilling with a suitable material.
(4) Gas formation in the emplacement areas is not taken into consideration.
(5) In case of inflow of NaCl saturated solution from the overburden, carnallitite dissolves and reprecipitates in the mine workings, leading to an increase of the total pore volume of the mine from 1.3 Mio. m^3 to 2.2 Mio. m^3.
(6) The escape of contaminated solutions from the mine workings takes place at the southern flank in the upper area of the brine solution inflow at a depth of 500 m.
(7) There is no escape of contaminated solutions from the mine workings above the shaft.
(8) Due to the convergence of the mine workings, extrusion rates of about 10,000 m^3/a are to be expected.
(9) Transport modelling for analysing the distribution of the solutions from the mine workings in the overburden is not being performed. It is assumed that the solution from the mine directly gets into the near-surface groundwater which passes over into the biosphere. In the calculations, the solution is diluted - while keeping the nuclide composition - such that the Cl concentration decreases to the level of the Drinking Water Ordinance (TrinkWV) and is thus accessible for direct consumption.
(10) For the calculation of the radiation exposure, only such radionuclides were selected for which a potentially radionuclide-specific radiation exposure of >1 mSv/a is to be expected in the base case "total inventory".

(11) The radiation exposure of members of the population resulting from this diluted water and its use as irrigation water is calculated with dose conversion factors (DCFs) derived according to the specifications of the draft general administrative provision (AVV) relating to § 47 of the Radiation Protection Ordinance (StrlSchV) (as at 13.05.2005) for the Morsleben repository (ERAM) site.

On the basis of these assumptions, radiation exposures for infants (< 1 a) of about 2 Sv/a are calculated for the base case for which complete dissolution of the total inventory is postulated. Main contributions to these exposures are provided by Th-232, Cs-137 and Am-241.

The ESK/SSK ad hoc working group ASSE is of the opinion that the consideration of beyond-design-basis inflow rates of brine solution from the overburden in the Asse II mine and an estimate of potential radiological consequences is an important basis for the planning of further action. The ad hoc working group intensively dealt with the GRS study but arrives at the conclusion that this work contains technical errors and some of the postulated assumptions cannot be substantiated scientifically. Against this background, the ESK/SSK ad hoc working group ASSE does not consider it appropriate to use this work in a licensing procedure. This recommendation is based on the following:

a) The radionuclide inventory used in [1] is incorrect. The errors already mentioned by the SSK in [2] regarding the consideration of daughter nuclides and the composition of natural thorium have not been taken into account.
b) In [1] Table 2, the radionuclides are presented in a form not complying with the notation of the Radiation Protection Ordinance. The presentation is not suitable for a licensing procedure. Daughter nuclides are summarised in the four decay series in a non-traceable way so that it is not possible to assess the completeness of the data and information or the dose relevance of the individual radionuclides.
c) A cut-off criterion for radionuclides on the basis of a potential dose of 1 mSv/a is not traceable in view of a limit of 0.3 mSv/a.
d) The dose values are calculated with dose coefficients developed for long-term safety considerations and which postulate, e.g., an irrigation duration with contaminated groundwater of 10,000 years. The application of the DCFs to the scenarios under consideration with relatively short time horizons of 40 to 130 years is not permissible for long-lived radionuclides such as thorium for which accumulation in the ground is assumed due to bad solubility.
e) Solubility limits have generally not been considered in the calculations. The concentrations of Th-232 postulated in [1] in the diluted water causing exposure are about 150 Bq/l (37 mg/l approx.). The Th concentrations in the saturated salt solutions would therefore have to be about 40 g/l. These concentrations are not plausible from a hydrogeochemical point of view. In addition, it is not taken into consideration that the solubilities of trace elements may dramatically change if highly saline solutions are diluted. Since thorium is one of the dose-relevant radionuclides in the model calculation, this formal consideration of the Th solution leads to an implausible result regarding the exposure.
f) In the model for determining the clearance values for removal of waste containing Th-232 on a landfill [3] it is assumed that the sealing of its base shows decreasing effectiveness after 100 years and offers no retention at all after 200 years. A limiting factor for Th-232 is the groundwater path whose modelling uses a well near the landfill in the groundwater flow for the extraction of drinking water, for irrigation, etc. If the whole Th-232 inventory contained in the Asse II mine were deposited on a near-surface landfill, this modelling would result in a dose in the order of 1 mSv per year. On the one hand, this comparison shows the very high level of conservatism of the dose calculation in [1].On the other hand, however, it demonstrates that the methods chosen in [1] differ considerably from the other

generic models that were used for the establishment of radiation protection requirements (here: clearance values).

Conclusion: The ESK/SSK ad hoc working group ASSE considers the approach of (at least for individual elements) overly conservative calculation of radiation exposure chosen in the GRS study to be generally unsatisfactory in this context. This approach, however, results from the task formulation. A realistic calculation of the potential radiation exposures is not possible on the basis of the current state of knowledge.

Although the ad hoc working group ASSE is of the opinion that the study is not suitable as basis for a decision in connection with a beyond-design inflow of brine solution due to the overly conservative approach, the planning for dealing with the beyond-design inflow should be implemented as soon as possible.

The ESK/SSK ad hoc working group ASSE stresses that the results of the GRS document are not to be regarded as “radiation exposure to be expected realistically” and that the study is not suitable for weighing up the advantages and disadvantages of different options for further action with regard to the potential radiation exposures of the population.

Literature

[1] GRS, Abschätzung potentieller Strahlenexpositionen in der Umgebung der Schachtanlage Asse II in Folge auslegungsüberschreitender Zutrittsraten der Deckgebirgslösung während der Betriebsphase, April 2009

[2] Bestimmung des nuklidspezifischen Aktivitätsinventars der Schachtanlage Asse, Abschlussbericht, Dr. U. Gerstmann (GSF, Institut für Strahlenschutz), H. Meyer (Forschungsbergwerk Asse), M. Tholen (Forschungsbergwerk Asse), August 2002

[3] Strahlenschutzkommission, Freigabe von Stoffen zur Beseitigung, Empfehlung der SSK, Berichte der SSK Heft 54 (2007)