Note:
This is a translation of the statement entitled "Gemeinsame STELLUNGNAHME der ESK und der SSK zur Schachtanlage Asse II – Empfehlungen für Untersuchungen".
In case of discrepancies between the English translation and the German original, the original shall prevail.

ESK

SSK

Joint ESK and SSK STATEMENT on the Asse II mine – recommendations for investigations

CONTENTS

1 Reason for the consultations, background of the statement

In the Asse II mine, rock salt and potash mining took place from 1909 to 1963. Since 1965, the mine has been owned by the Gesellschaft für Umwelt und Gesundheit (GSF) – today Helmholtz Zentrum München – German Research Center for Environmental Health (HMGU). Within the framework of research and development work on the disposal of radioactive waste in salt formations, low- and medium-level radioactive waste with a total activity of 7.8 E+15 Bq were emplaced from 1967 to 1978. Since 1988, inflow of solutions has been observed which currently amounts to about 12 m³ per day. As a consequence, nearly all mining cavities in the southern flank were backfilled from 1995 to 2004.

So far, decommissioning of the Asse II mine within the framework of a plan approval procedure under mining law is planned. On 29.01.2007, the HMGU submitted the final operational plan required for the decommissioning of the Asse II mine to the competent licensing authority, i.e. the Landesamt für Bergbau, Geologie und Rohstoffe (LBEG) in Hanover.

In order to prevent an uncontrollable solution inflow and release of radionuclides, the Lower Saxony Ministry for the Environment (NMU), the Federal Ministry for Education and Research (BMBF), being responsible for the Asse research mine, and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) agreed in November 2007 to perform hazard prevention measures to enhance safety.

On 13.06.2008, it became publicly known that in the Asse II mine brines contaminated with Cs-137 are handled which exceed the exemption values according to the Radiation Protection Ordinance (StrlSchV). On 02.09.2008, the NMU presented a status report [9] to clarify this issue.

On 04.09.2008, BMBF, BMU and NMU agreed that in future the Asse mine is procedurally to be treated as a repository and operatorship shall be taken over by the Federal Office for Radiation Protection (BfS). The changeover is scheduled for the beginning of 2009.

For the decisions on the closure-related measures to be taken in future, a comprehensive understanding of the situation in the Asse will be required.

2 Request for advice

The BMU informed the Nuclear Waste Management Commission (ESK) at its first meeting on 30.06.2008 and the Commission on Radiological Protection (SSK) at its 224th meeting on 03.07.2008 about contaminated solutions in the Asse II mine. The BMU requested supporting advice as soon as possible and concretised its need for advice in letter RS III 3 - 17005/0 of 04.07.2008 [1] with the following questions:

1 Are the data and information of the Helmholtz Zentrum München German Research Center for Environmental Health (HMGU)

- on the radioactive inventory – including data on uncertainties,
- on the radiological measurement programme within and outside the mine, and
- on the possible causes of the contaminations occurred

complete and traceable?

2 Are additional measurements on contaminations in the mine required to be able to asses extent and origin of contaminations as well as resulting radiation exposures to workers and members of the general public?

3 Consultations

ESK and SSK established a joint ad hoc working group which dealt with the issue of contamination at its meetings on 07./08.07.2008 (with inspection of the Asse II mine), 25.08.2008 and 26.09.2008. The results regarding question 1 of the request for advice were adopted by the ESK at its 3rd meeting on 17.09.2008 and by the SSK at its 227th meeting on 25./26.09.2008 in form of a joint statement [2].

The present statement deals with the second question of the request for advice. Due to the current development regarding the Asse II mine, ESK and SSK assume that the investigations proposed in Chapters 6 and 7 are necessary for the overall understanding of the situation in the Asse. The radiation exposures to staff and members of the public can only be assessed and reduced in a targeted manner with an overall understanding.

In parallel to the dealing with question 1 of the request for advice [1], the ad hoc working group prepared the bases for answering of question 2 at its meetings. Preliminary results were presented and discussed at the 3rd ESK meeting on 17.09.2008 and the first meeting of the Committee on FINAL DISPOSAL (EL) on 18.09.2008. The results of the discussion were considered in the development of partial results which were put together to a draft statement at the meeting of the ad hoc working group on 26.09.2008.

The present statement was adopted by the SSK at its 228th meeting on 28.10.2008 and by the ESK at its 4th meeting on 06.11.2008. The last amendment was made by the SSK within the framework of the approval at its 229th meeting on 12.11.2008.

4 Statement bases

The present statement is based on the documents listed in Chapter 9 and supplementary explanations of the operator on the conditions in the Asse during on-site visits of the ad hoc working group as well as on measurements and analyses. These information are assessed on the basis of general knowledge of the

geological, rock mechanical and hydraulic condition of the rock. For the assessment of the radiological measurement programme, the requirements of the Radiation Protection Ordinance (StrlSchV) [3] and the Guideline concerning Emission and Immission Monitoring of Nuclear Installations (REI) [4] were used as criteria. Previous measurement programmes have not been systematically considered in the development of the proposals for necessary, future investigations. This statement does not serve the evaluation of previous measurement and investigation programmes..

5 General objectives and basic recommendations

Based on question 2 of the BMU's request for advice regarding additional measurements required to be able to assess extent and origin of contaminations as well as resulting radiation exposures to workers and members of the general public, ESK and SSK present boundary conditions and requirements in this statement for investigations and measurements. These investigations and measurements refer to the determination of the geoscientific situation in the mine and the overburden (Chapter 6) and the radiological situation (Chapter 7). The geoscientific situation includes, in particular, the stability of the mine workings, origin and extent of the influent solutions as well as hydrology and pathways in the Asse. The radiological situation includes the kind of contaminant release from the inventories, their dispersion in the mine workings and, where relevant, their discharge and release into the environment. In this respect, attention is also paid to the question which measurements and investigations are of significance regarding the drawing of conclusions on the next steps concerning the Asse mine.

Against this background and in view of the time pressure, the geoscientific investigations proposed in Chapter 6 are oriented towards the following general objectives and associated sub-objectives:

- Understanding of the situation in the mine and its close vicinity regarding stability of the mine workings and the intrusion of solutions into the mine workings as well as the pathways in the mine workings

  - knowledge on the condition of the mine regarding existing excavation-disturbed zones (Chapter 6.1)
  - knowledge on pathways between galleries (Chapter 6.2),
  - localisation of the inflow from the overburden (Chapter 6.3),
  - clarification of the genesis of the inflow into the southern flank and distinction between Asse-internal solutions and those from the overburden (Chapter 6.4),
  - clarification of the relevant hydrogeological conditions in the adjoining overburden (Chapter 6.5),
  - knowledge on the origin and pathways of the solutions in the mine workings including the radioactive and chemical substances detected (Chapter 6.6), and
  - knowledge on the distribution of wet rock zones (Chapter 6.7)

The radiological investigations and measurements proposed in Chapter 7 refer to the following objectives:

- Determination of the situation regarding occupational radiation protection (Chapter 7.1)
- Determination of the situation regarding environmental radiation protection (Chapter 7.2)
- Determination of the situation regarding the clearance of materials (solutions) from the mine

(Chapter 7.3).

This statement was prepared with a view to the programme of all investigations that have to be performed. The statement identifies the essential bases for reaching the objectives mentioned. In this respect, it is not dealt with in particular whether parts of the proposed investigations are already included in the existing programme.

The statement concerns general aspects of proceeding and documentation as well as concrete measurements and investigations. The setting of priorities is oriented towards the question which measurements, investigations and measures seem to be particularly urgent or particularly effective for reaching these objectives.

For reaching the necessary system understanding, ESK and SSK are of the opinion that a comprehensive plan of investigations has to be developed and implemented. The generally accepted rules of sampling and measuring techniques shall be applied. The results of the individual investigations should be systematically summarised, quality assured and documented in a traceable manner (e.g. in annual reports, databases). They should be incorporated in an assessment comprising the overall system on the basis of which the next steps can be derived.

From the point of view of ESK and SSK, the current measurement programmes should first be reflected with respect to the current issues to be solved and the resulting need for information, and, if required, be optimised and supplemented by additional measurements. In general, purpose and objectives of the programme should be defined first for the establishment of a measurement programme; the need for information has to be specified adequately.

In any case, the measurements in the mine workings and in the overburden should give information about the situation in the mine regarding existing excavation-disturbed zones and their potential impact on the stability of the mine workings as well as about the location and extent of solution intrusion into the mine workings. The evaluation of the measurements should also allow for drawing conclusions about possible pathways for solutions in the mine workings.

The results of the radiological measurement programme should form a basis for the objective-based orientation of the measures for the operational radiation protection of the personnel and for the radiation protection in the environment as well as for decisions on the clearance of solutions from the mine.
Further, it should be possible to use the results of the measurement programme for the drawing of conclusions on the next steps and for the proof of long-term safety to be furnished on this basis.

The explanations on the measurements and investigations proposed in Chapters 6 and 7 differ from each other with regard to the level of detail and information depth. This is due the different informative value of the available documents and information that vary according to the issue to be solved.

6 Investigations on the geoscientific situation in the mine and the overburden

6.1 Knowledge on the condition of the mine regarding existing excavation-disturbed zones including observation of further development

Between the mine workings in the salt rock and the water-bearing layers of the overburden, a sufficiently thick saline protective layer consisting of impermeable salt rocks (e.g. rock salt but also massive anhydrite without water pathways along discontinuities) is to be provided which ensures sealing of the mine structures against the penetration of groundwater. This saline protective layer may also be supplemented by clay layers with no or low permeability. The required thickness of this/these sealing layer(s) is stipulated in the mining law (so-called water alarm level). It is specified empirically or determined site-specifically by rock-mechanical calculations.

In the case of the mine workings of the southern flank of Asse, this protective layer is geometric per se and at least in parts not sufficiently thick, in particular in combination with the mechanical configuration of the existing mine workings of the southern flank to be protected against solution inflow. Here, in the course of decades, deformations due to creep and deformations accompanied by strain softening of the pillars supporting the overlying flank rock also led to deformation with cracking and thus to a dilatant softening not only of non-saline but also of saline, actually sealing rock formations. As a consequence, brines from the overburden enter the mine workings via these secondary pathways. The formation of the pathways may here result from the load-bearing behaviour of the mine structure. Further, it cannot be excluded that – promoted by the secondary stress field with minimum stresses locally/zonally below the fluid pressure level – an infiltration of brines through the saline protective layer is caused or may be caused by the fluid pressure. Since rock stress as well as the rock deformation state change over time, changes of the pathways for solution inflow over time are to be assumed. In addition,

- the stress changes and the dilatant deformations further extend into the overlying overburden with increasing softening of the load-bearing elements in the mine workings so that, resulting from further opening and new formation of pathways, rock structures currently limiting solution inflow could increasingly lose this hydraulic property being central for future measures, and

- the dilatant deformations in the non-saline deformations concentrate in the so-called shear zones which then, in case of correspondingly reduced shear strength (also promoted by pore water pressures built up in these zones), fail and may lead to further load on the already weakened load-bearing elements in the mine workings of the southern flank. This failure process could also proceed discontinuously.

For stabilisation of the load-bearing structure southern flank, the mine workings were backfilled with crushed salt. However, the pneumatic backfill technique applied for this purpose, first led to a relatively soft backfill, thus having a low load-bearing capacity, which, in addition to a certain contour support function, will only reach its actual effectiveness with support pressure built up and deformation rate reduction after a major reduction of its pore volume thus leading to a corresponding compaction process. However, this compaction process is still associated with considerable further rock deformation.

For the qualitative and quantitative characterisation of the geomechanical/geohydraulic situation in the mine workings of the southern flank and the overlying overburden,

(1) knowledge of the location of the excavation-disturbed zones with their spatial-temporal development (progressive, regressive), and
(2) knowledge of the effectiveness of the backfill measures

are therefore of central significance.

This knowledge is required, in particular, for the formulation of statements regarding the current remaining load-bearing capacity (residual stability) and its expected development over time (e.g. restabilisation or increase of destabilisation).

This shows that the geomechanical situation with secondary stress field and excavation-disturbed zones/softening zones not only dominates the mine safety but also the hydraulic conditions.

Together with geomechanical calculations on the basic understanding of the complex current load-bearing behaviour und its expected further development, geotechnical measurements with high informative value that accompany and monitor the development process with determination/observation of the current situation and its further development are of central significance; they are necessary for the characterisation of the safety and softening level, in particular in the load-bearing/failing structure areas as well as for the quality assurance of the load-bearing structure analysis (validation and on-site confirmation) and the identification of the failure mechanisms and areas. The methodical basis for this approach is the monitoring method according to DIN 1054: 2005-01.

The aim of an updated measurement and monitoring programme has to be the provision of measurement and monitoring data

(1) for monitoring the stability of the mine workings and their load-bearing elements (characterisation of the time-dependent safety reduction in the area of residual strength with a mine structure already to be assessed as latently fragile) to be able to determine the spatial-temporal development of the excavation-disturbed zones and the movements of the load-bearing elements and the overburden,

(2) for establishment of an alarm system regarding an early identification of a transition – which cannot be excluded - from a currently rather monotonously degressive loss of load-bearing capacity to a future accelerated but possibly also spontaneous and large-scale brittle collapse-like failure process,

(3) for monitoring the current and future inflow situation under consideration of the possibility of inflow locations and pathways that also change over time as well as for the detection of currently not completely identified locations of solution inflow and quantities,

(4) for the determination and then also for monitoring of hazard zones in the mine workings to be specially

marked with different safety and hazard levels regarding the performance of mining activities, and finally

(5) for quality assurance of the calculation models with improvement of the prognostic reliability.

Thus, in a first step, the existing knowledge from geotechnical measurements (e.g. deformation measurements, microacoustic measurements, rock stress measurements, permeability measurements) is to be gathered and evaluated in a targeted manner, and the measurement locations to be presented with interpreted/assessed measurement data in the mine plans. On this basis, potential failure areas and weak points in the protective layer are to be identified. This analysis shall also include existing technical weakening of the protective layer (e.g. blind shafts).

In a second step, the generalised findings from these measurement data on the current situation of the load-bearing structure are to be reviewed – as far as possible by on-site inspections – with regard to the informative value of the measuring devices as indicators for the characterisation of the geomechanical-hydraulic situation.

Finally, in a third step, the existing measurement programme is to be evaluated regarding informative value, expediency and need for supplementation against the background of the rock mechanical analysis. In addition to a specification and systematisation of the underground measurement programme which, however, will probably reach the limits of feasibility at an early stage due to the limited access possibilities in particular to the geomechanically/geohydraulically relevant mine workings, drilling above ground with measuring devices (e.g. for observation of deformation in the overburden, of deep groundwater levels, groundwater pressures and seismic emissions) and an extension of the seismoacoustic monitoring from the near field of the mine to the overburden at a larger distance may also come into consideration.

6.2 Knowledge on pathways between galleries

The assessments on contaminations in the floor of the second southern driftway in front of chambers 4 and 8 of the 750-m level showed [2] that at least the major part of the radionuclides most likely originate from the mentioned emplacement chambers. Against this background and under consideration of the fact that at the 750-m level solutions are already collected which can be genetically assigned to the inflow from the overburden in the southern flank, the knowledge on possible pathways in the mine workings but also the assessment of long-time safety in dependence of the respective decommissioning concept are of importance for all further considerations regarding a potential radiation exposure of the Asse staff from contaminated solutions.

Appendix 11.2 of document [10] includes a survey of the pathways in the emplacement chambers. For the other areas of the floor at the 750-m level as well as the other floors, in a first step, all bores, slide holes, slopes and galleries and other connections between the floors should be identified by the mine surveyors on the basis of the mine plans. The completeness of the data is to be reviewed by the following measures:

- Comparison of the information from the mine plans with data from other sources (e.g. inspection reports, research reports)

- Inspection of the still accessible areas, if required.

Further, those mine areas have to be identified via which the solutions from the overburden can enter the emplacement chambers, taking into account the respective seal concept under consideration. For these areas, the connections identified have to be subjected to an assessment of their hydraulic effectiveness. As far as possible exit pathways for contaminated solutions are not identical with the intrusion pathways, the hydraulic effectiveness shall also be assessed for those pathways.

6.3 Localisation of the inflow from the overburden

An improved knowledge of position and formation of the location of solution inflow from the overburden is a prerequisite for substantiated statements on the connected groundwater reservoir in the overburden and the possible future development of the inflow rates. The latter, in turn, have a considerable influence on the stability of the mine workings, i.e., in particular (but not exclusively) if the amount of influent solutions increases drastically or even becomes uncontrollable.

Bores and other rock-disturbing methods for further investigation of the inflow location from underground would probably have to penetrate the contact surface between salt rock body and overburden in the critical area and would therefore be associated with the risk of uncontrollable inflow increase. ´Thus, for localising the inflow, non-disturbing and, above all, geophysical methods come into consideration. Different geophysical methods have already been tested or systematically applied in Asse II. However, a systematic cross-method evaluation of the results regarding the localisation of the inflow has obviously not been performed so far. Such an evaluation has to be the prerequisite for the planning of further investigations.

In recent years, different geophysical investigation methods have considerably been improved regarding applicability and informative value of the results. Therefore, it has to be checked which methods can be applied for clarifying the issues mentioned in a targeted manner (e.g. Georadar comes into consideration), and a corresponding geophysical investigation programme is to be developed and implemented.

6.4 Clarification of the genesis of the inflow into the southern flank and distinction between Asse-internal solutions and those from the overburden

For final clarification of the genesis of inflow from the overburden into the Asse II mine workings and distinction of solutions from the overburden and the mine-internal solutions, (in particular) geochemical analyses are to performed with regard to the relevant major, minor and trace elements as well as to individual parameters with high informative value. This applies to the distinction between contaminated and non-contaminated solutions within the mine workings accordingly. A programme has to be developed for

systematic and, where appropriate, hydrochemical analyses of the solutions.

The analyses and their traceability limits as well as the individual parameters to be analysed shall be adapted to the issue under consideration. The general principles of sampling shall be applied. In particular, existing sampling locations are to be modified or new ones to be established and sampling to be performed such that influences on the solution samples by mine air and contact with disturbing materials is prevented or, at least, minimised. Samples of the solutions from the overburden are to be taken at the primary inflow location or in the immediate vicinity.

Prerequisite for the final clarification of the origin of the inflow of solutions into the mine workings in the southern flank of the Asse mine is the distinction between material and nuclide concentrations and compositions in solutions and the groundwater outside the Asse, Asse-specific uncontaminated concentrations and compositions or being influenced by the emplaced wastes. For the characterisation of the solutions from the overburden, the informative value of radioactive and stable isotopes (e.g. H-2, H-3, C-14, O-18, S-34) as indicators is to be checked. For clarifying the origin, such parameters are particularly suitable which (may) indicate a formation-specific signature of the groundwater (the influent solution) and residence times in the groundwater or specific genetic conditions. In the case of Asse II, statements on the formation of origin (Röt) are to be expected in particular via the isotope S-34.

The results from the hydrochemical and isotope physical investigations in the mine workings are to be compared to corresponding results for the groundwater in the immediately adjoining overburden of the southern flank. These indicate the reference composition of the groundwater which is found in the mine as solution inflow.

6.5 Clarification of the relevant hydrogeological conditions in the adjoining overburden

At present, only model assumptions exist on the ways in the overburden by which the solution entering the mine reaches the location of inflow for lack of concrete investigations. The “available groundwater” for solution inflow can therefore only be estimated insufficiently and it is not possible to make reliable statements on the development of solution inflow in terms of quantity and hydrochemistry. Alternatively, safety analyses are based on the possibility of an uncontrollable increase of the entering solution and critical hydrochemical changes in the foreseeable future. Under consideration of already available data and information and under consideration of the risk associated with investigations in the border area between salt rock body and overburden, concepts are to be developed for investigations whose results contribute to narrow the scope of interpretation and to improve the basis for the planning of further measures. In this respect, the following may be considered in particular:

- Targeted deep drilling into the overburden of the southern flank of the Asse to improve the state of knowledge regarding the structure and the structural and mechanical condition of the overburden in the southern flank of the Asse structure near to the mine and regarding groundwater hydraulics and chemism. Main objects of investigations are the basal Röt anhydrite and the overlying pelitic series of the Röt as

well as their hydraulic and hydrochemical relation to the neighbouring rocks of the Lower Muschelkalk and the dumped overburden. The largest gain in information seem to yield directed boreholes. They allow aligning the bore axis according to the spatial position of the probable discontinuities, including the "shear bands" caused by the overburden displacement into the mine workings and thus may give information for the planning of tests for determining the direction-dependent rock permeability of the Röt series

- It is to be checked to which extent high resolution geophysical exploration methods can contribute to bore planning and planning verification. It also has to be checked whether relevant information on thickness and spatial position of the basal Röt anhydrite and on its spatial relation to the mine workings and adjacent rock bodies in the surroundings of the inflow location can be obtained from non-disturbing exploration of the border area between salt rock body and overburden or the immediately adjoining overburden units from underground.

- Systematic hydraulic tests in the bore holes in order to obtain a clearer picture of the Röt series. When determining the test sections, the petrographic and structural results of the drillings are to be considered.

- On the basis of the exploration results, a depth-specific network of hydraulic and hydrochemical measurement points is to be designed that enables the registration and monitoring of the groundwater movement and the hydrochemical structure of the groundwater and that allows assessment of the maximum "groundwater availability" for solution inflow into the mine workings.

For the investigations described, it is also to be checked to which extent information can be gained for matters related to radiation protection, e.g. regarding the contamination of the groundwater with radionuclides.

6.6 Knowledge on the origin and pathways of the solutions in the mine workings including the radioactive and chemical substances detected

An important basis for the determination of pathway for solutions within the mine workings is the geological model of the salt dome to be derived from the geological mapping of the different floors and the rock reactions showing the stress condition of the rock. In addition, there is the monitoring of the migration paths of contaminated solutions in the mine workings. This requires the differentiation from non-contaminated solutions on the basis of systematic analyses of the solutions.

The characterisation of the solutions and identification of their migration paths enables to draw conclusions on the existing pathways and the potentials for future solution inflow into the mine workings. Further, it is of significance for the question to which extent radionuclides from the emplacement chambers are already mobilised and for assessment of the mobilisation potential still existing.

For characterisation and differentiation between contaminated and non-contaminated solutions in the mine

workings, a systematic and gradual investigation programme is to be developed. At all locations where solutions occur, sampling points are to be installed and samples taken at regular intervals, also at locations not having been noticeable from a hydrochemical and radiological point of view. For documentation of the results, an appropriate database is to be established. The investigation programme has to ensure that the analysis results are compared and checked to determine to which extent information on flow paths and origin of the solutions and their composition can be gained from the results.

Regarding establishment and organisation of sampling points, sampling and samples stored for reference as well as their treatment and analysis, the general descriptions in Chapter 6.4 apply accordingly. On the basis of the investigation results, the programme can later be reduced to selected informative sampling points or be extended.

The analysis programme should be structured in a stepwise manner. The parameter sets to be used in the different analysis steps are to be derived under consideration of the waste inventory and plausible indicator parameters for wastes. Due to the general knowledge about the waste inventory, it is currently assumed that the stepwise analysis will be proposed for the following parameters which also enable the consideration of interests related to radiation protection and the clearance of solutions:

1. Tritium, radionuclides measurable by gamma-spectrometry,

2. total organic carbon (TOC), nitrate, boron,

3. in dependence of the results from 1. and 2.: selected uranium isotopes, beta-emitters (e.g. Tc-99, C-14), and,

4. in dependence of the results from 1. to 3.: selected alpha-emitters, volatile radionuclides, soluble organic matter, trace elements of the drum corrosion, stable isotopes, and other parameters, where required.

6.7 Knowledge on the distribution of wet rock zones

From mapping of rock zones penetrated by moisture, conclusions can be drawn on pathways for solutions. It may also be possible to derive statements on the extent of existing solution quantities and solution reservoirs. Findings on moisture penetration of the waste emplacement chambers may lead to statements on destabilisation processes that might already take place and on the mobilisation of radionuclides. In which way and how fast backfill measures will contribute to stabilisation may also depend on the moisture penetration since it leads, for example, to a change of the friction coefficient of the backfill material.

Information on moisture-penetrated zones can be gained by the use of geophysical measuring methods. For the Asse II mine, the use of Georadar and geoelectric methods is conceivable. It is therefore recommended to review the corresponding possibilities and to perform a measurement programme, if appropriate. Depending on the resolution capacity of the method chosen, information on the condition of the mine could also be

gained in addition to the information on moisture penetration.

With regard to solutions present in areas not being accessible for direct monitoring, different questions arise which might further be handled with these methods of investigation:

- Where are the solutions located that entered the mine workings from outside but still not having left the rock from accessible areas?
- Did they lead to moisture penetrations in larger areas?
- Where are moisture penetrations in backfilled areas of the southern flank?
- Where are moisture penetrations in the backfilled area of the former carnallitite minings?

7 Investigations on the radiological situation

7.1 Measurements and investigations on occupational radiation protection

For operational radiation protection, measurements are necessary

- to determine the occupational radiation exposure,
- to protect against contamination and uncontrolled spread of contamination, and
- to determine actual radiological conditions,

to create the prerequisites for compliance with the dose limits and with the requirements of §§ 5 and 6 StrlSchV (principle of dose reduction).

With regard to these objectives, supplements and modifications are proposed – where required – in the following for the current investigations.

For the determination of the occupational external radiation exposure, official dosimeters and dosimeters of the operator are used. The measurements are to be continued to the current extent.

The contamination of the mine air in areas frequently accessed is to be monitored regularly with an existing mobile suspended particle sampler. The filters loaded with air are to be subjected to gamma-spectrometric analyses and analysed for alpha emitters. The filters are to be kept for any possible remeasurements. For work involving large amounts of suspended particles that might be contaminated with radioactive material, mobile suspended particle samplers are to be used, too, and the loaded filters to be evaluated and kept as described above. In addition, an incorporation measurement is carried out in a whole-body counter every year which is to be continued. In dependence of the results, measures to reduce the radiation exposure of the personnel are to be taken, if required. The provisions of the guideline for physical radiation protection control for ascertaining body doses – Part 2: determination of the body dose in case of internal radiation

exposure (incorporation monitoring) (§§ 40, 41 and 42 StrlSchV) [11] are to be observed.

Monitoring of the mine air for radon is to be continued in the present manner. On this basis, the occupation exposure to radon is to be determined in accordance with the respective licensing situation.

Mobile and stationary measuring devices for determining the surface contaminations of persons and objects are provided. Their use after performance of activities that may lead to surface contaminations as well as for the control of objects to be moved out of controlled areas is to be ensured. The suitability of the measuring devices for the measurement of alpha-emitters still has to be demonstrated (see also [9]).

Prior to and during material-removing work in the mine workings, intensive exploration of the material to be removed and of the adjoining material is necessary for forecast and determination of potential suspended loads. This is to include material which might be located, e.g., in the area underneath the runway. For the explorations, a detailed procedure has to be defined which covers the evaluation of documents, gamma-spectrometric measurements on the material as well as sampling (bores) with evaluation in the laboratory. The procedure may comprise different steps by defining criteria whose compliance make further in-depth analyses unnecessary.

In addition to the measurements described above for occupational radiation protection, the basis for a better assessment of the radiological situation is to be created by suitable measurements and, where appropriate, indicator data are to be included for an analysis of longer-term changes of radionuclide concentrations in the mine. According to the commissions, priority should be given to the investigation of the following:

- Release behaviour of the tritium from the emplaced waste to clarify the discrepancy identified between tritium inventory and annual release, on the one hand, and to determine the chemical compound in which tritium occurs in the mine air, on the other hand.

- For C-14, it is to be clarified whether, in addition to CO_2, there are also other gaseous carbon compounds that are relevant as carrier compounds.

- For sample tests regarding persons who have been working in the plant for a longer period of time, urine analyses for tritium and, where required, for other radionuclides are recommended.

7.2 Measurements and investigations on environmental radiation protection

Regarding emission monitoring, there is no necessity of measures going beyond the programme which has already begun. The following only deals with immission monitoring. From the point of view of the commissions, this immission monitoring only serves the purpose of preservation of evidence. They emphasise that, apart from the radionuclides released with the mine waste air to a permissible extent, there are no releases from the mine into the surrounding area of the Asse.

The Asse environmental monitoring programme of the operator includes measurements of air, soil and vegetations as well as water. As an independent measuring agency, the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN) conducts measurements. The existing measurement programmes include position plans for measuring and sampling sites.
At present, the measurement programme of the operator for immission monitoring comprises:

- measurements of the total beta activity in water samples (ground and surface water, 26 measurement points),
- analysis of drinking water for Sr-90, Cs-137, Pu-239 (2 measurement points),
- measurement of the short- and long-lived aerosol activity in the air (10 measurement points, 2 of them continuously),
  (The detection limit for Co-60 at the two measurement sites with continuous sampling is stated with a value below 10 µBq/m³. As measured radionuclides, the gamma-emitters Be-7 and Pb-210 are documented in the environmental reports.)
- determination of the activity of gamma-emitters in grass samples (four measurement points),
- determination of the activity of gamma-emitters in soil samples (four measurement points),
- measurement of the activity distribution over the soil (four measurement points),
- monitoring of external radiation exposure at 39 measurement points.

The operator issues annual summary reports on the results of the environmental monitoring.

The environmental monitoring programme summarised above had been developed for the Asse II research facility. It does not fully comply with the provisions of the current Guideline concerning Emission and Immission Monitoring of Nuclear Installations (REI) [4] with regard to the monitoring of repositories (REI, Appendix C2). Thus, the continuation and definition of the measurement programme has to be reviewed and specified under consideration of the measured data with a view to the current requirements.

Independent of issues related to radiation protection and the requirements of the REI, Appendix 10 [4] to be fulfilled in any case, ESK and SSK deem it necessary to conduct measurements of selected indicator nuclides in the environment of the Asse, also with detection limits at the natural concentration levels, in order to better understand radioecological aspects of environmental monitoring and to develop basic data for a long-term monitoring of the site. The general appropriateness of the current immission monitoring programme is not put into question by this. The measurements of specific radionuclides proposed in the following are to be understood as first indications for a systematic further development of the measurement programme.

Under the current circumstances, where there are no discharges of radioactively contaminated waters and release of radionuclides from the mine into the groundwater is not possible, measurements of the total beta activity in water samples are only suitable for the preservation of evidence. They are, however, not required according to the REI. It is rather required to perform gamma-spectrometric analyses and to determine tritium concentrations. Independent of the radiological monitoring tasks, measurements of H-3 and C-14 in water samples with detection limits at the natural concentration levels are to be recommended since these radionuclides also give information about the age structure of the groundwater and thus the natural

groundwater dynamics at the site. In addition, the local background level of Cl-36 and I-129 should be determined. The necessity of measurements of further long-lived radionuclides in the groundwater should be determined systematically. The objective of these measurements should be to document reference values also for the assessment of measurement results in the more distant future.
The analysis of drinking water should be supplemented at regular intervals (which may also be more than one year) by the determination of the reference dose (indicator parameters according to Appendix 3 No. 20 of the Drinking Water Ordinance (TrinkWV)) and of tritium (indicator parameters according to Appendix 3 No. 19 of the Drinking Water Ordinance (TrinkWV)). Moreover, uranium should be analysed and assessed with regard to the limit or reference values currently being discussed for chemical-toxic reasons.

The aerosol-bound discharge of radionuclides into the ambient air, monitored by gamma-spectrometric analyses of filter samples, should be checked whether – at least at larger intervals – further, and in particular, long-lived radionuclides can be measured by more sensitive measuring devices or additional measuring methods, such as mass spectrometry. Mainly for reasons of preserving evidence, measurements of the current status regarding Cl-36 and, above all, I-129 are to be recommended.

The measurements of radionuclides in gas samples should be supplemented by the determination of C-14 and, where appropriate, also of H-3. These radionuclides represent the most significant activity discharges with the mine air and are stored in organic material.

For the preservation of evidence, the analysis of soil samples should be supplemented, at least on a spot check basis, by radionuclides such as C-14 and I-129 that also may serve as indicators for discharges in the past.

During specified normal operation, measurements of the surface-related beta activity of the soil with a contamination monitor are not very suitable for monitoring due to their low sensitivity. They can therefore be reduced, discontinued or replaced by other suitable methods, as the case may be.

From today’s point of view, the measurement programme for monitoring of the local dose rate in the environment of the Asse can be continued without changes.

Regarding the monitoring network, ESK and SSK point out that due to its location in a mountain range, the Asse II mine has particular features compared to other sites above all with regard to monitoring of the water. The interrelations between hydrological and hydrogeological system and the measurement points and results should therefore be clarified and described such that an interpretation of observation data is possible both with regard to the radiological monitoring task and to a radioecological indicator function.

7.3 Measurements and investigations on the clearance of solutions from the mine

The current calculational derivation of the activity concentrations of solutions for determining whether an effective dose in the area of some 10 µSv per year is not exceeded during their discharge to another mine comprises the radionuclides H-3 and Cs-137. According to the molecular formula of the Radiation Protection Ordinance (StrlSchV), other radionuclides (e.g. Co-60, Sr-90, Ra-226, Ra-228, Am-241) may also have to be taken into consideration. This is only possible by determining a clearance value related to the planned way of disposal for all long-lived radionuclides of the Asse inventory.

For the different types of solutions occurring, a nuclide vector is to be determined at regular intervals, e.g. quarterly, having to cover all radionuclides for which a clearance value has to be defined. The routine measurements may then be limited to a reference nuclide of the vector (e.g. Cs-137). The sensitivity of the measurements has to be such that the detection limit is about 10 % of the respective clearance value.

According to § 29 (2) Sentence 4 StrlSchV, the requirements for clearance may not be brought about, caused or facilitated in a targeted manner by mixing or diluting. Mixing of radioactive substances with an activity above the clearance values with clearable substances after having determined their different radiological condition by measurements or other methods, is deemed an impermissible mixing in terms of § 29 (2) Sentence 4 StrlSchV by the commissions. Therefore, samples have to be taken separately from solutions collected at different locations. If homogenisation is conducted for representative sampling from one charge before determination of the activity, this does not present an impermissible mixing.

From the cleared charges, reference samples are to be taken and stored for days. Random controls of the measurements of the operator should be initiated by the regulatory authority.

8 Summary

Based on the question of the BMU regarding additional measurements required to be able to assess extent and origin of contaminations in the ASSE II mine workings as well as resulting radiation exposures to workers and members of the general public, ESK and SSK present boundary conditions and requirements in this statement for investigations and measurements. The investigations and measurements refer to the geoscientific situation in the mine and the overburden, on the one hand, and the radiological situation, on the other hand.

For reaching the necessary understanding of the system of the Asse II mine, ESK and SSK are of the opinion that a comprehensive plan of investigations and measurements has to be developed and implemented. The current measurement programmes should first be reflected with respect to the respective issues to be solved and the resulting need for information, and, if required, be optimised and supplemented by additional measurements. The results of the individual investigations should be systematically summarised, quality assured and documented in a traceable manner and be incorporated in an assessment comprising the overall system on the basis of which the next steps can be derived.

For the qualitative and quantitative characterisation of the geomechanical and geohydraulic situation in the mine workings of the southern flank and the overlying overburden, knowledge of the location of the excavation-disturbed zones with their spatial-temporal development and knowledge of the effectiveness of the backfill measures are therefore of central significance. This knowledge is required, in particular, for the formulation of statements regarding the current remaining load-bearing capacity (residual stability), its expected development over time and thus regarding the mine safety. On the basis of the geotechnical measurements, potential failure areas and weak points in the protective layer are to be identified. The findings from these measurement data should be reviewed as far as possible by on-site inspections and finally be incorporated in the revision of the measurement and investigation programme.

The knowledge on possible pathways for solutions in the mine workings but also the assessment of long-time safety in dependence of the respective decommissioning concept are of importance for all further considerations regarding a potential radiation exposure of the Asse staff from contaminated solutions. For all bores, slide holes, slopes and galleries and other connections between the floors should be identified by the mine surveyors on the basis of the mine plans. Conclusions on existing pathways could also be drawn from mapping of rock zones penetrated by moisture. Those mine areas have to be identified via which the solutions from the overburden can enter the emplacement chambers, taking into account the respective seal concept under consideration.

Further information and data on possible pathways for solutions seem to yield the characterisation and the systematic and regular analysis of contaminated and non-contaminated solutions in the mine workings. To this end, an analysis programme structured in a stepwise manner is proposed.

An improved knowledge of position and formation of the location of solution inflow from the overburden and the connected groundwater reservoir in the overburden is a prerequisite for substantiated statements on the stability of the mine workings and the future development of the inflow rates. Rock-disturbing investigation methods would be associated with the risk of uncontrollable inflow increase. ´Thus, for localising the inflow, non-disturbing and, above all, geophysical methods come into consideration.

The geoscientific properties of the Röt and adjacent units relevant for the assessment of the future development of solution inflow from the overburden are to be determined by (targeted) bores in the overburden of the southern flank of the Asse near to the mine. This applies in particular to the structural-mechanical condition and the permeability of the rock bodies involved as well as to the movement and hydrochemical structuring of the groundwater. A depth-specific network of measurement points for hydraulic and hydrochemical monitoring of the groundwater is to be established. By hydrochemical and isotope physical investigations of groundwater and solutions in the mine workings (likely) originating from the overburden, this origin is to be verified.

For the different types of solutions occurring, in the mine workings a nuclide vector is to be determined at regular intervals, e.g. quarterly, having to cover all radionuclides for which a clearance value has to be defined. The sensitivity of the measurements has to be such that the detection limit is about 10% of the

respective clearance value.

The requirements for clearance may not be brought about, caused or facilitated in a targeted manner by mixing or diluting. Mixing of radioactive substances with an activity above the clearance values with clearable substances after having determined their different radiological condition by measurements or other methods, is deemed an impermissible mixing in terms of § 29 (2) Sentence 4 StrlSchV by the commissions. Therefore, samples have to be taken separately from solutions collected at different locations.

For operational radiation protection, measurements are necessary to determine the occupational radiation exposure, to protect against contamination and uncontrolled spread of contamination and to determine actual radiological conditions, to create the prerequisites for compliance with the dose limits and with the principle of dose reduction. With regard to these objectives, supplements and modifications are proposed in Chapter 7.1 for the current investigations in the Asse II mine.

Prior to and during material-removing work in the mine workings, intensive exploration of the material to be removed and of the adjoining material is necessary for forecast and determination of potential suspended loads. This is to include material which might be located, e.g., in the area underneath the runway. For the explorations, ESK and SSK propose a detailed stepwise procedure which covers the evaluation of documents, gamma-spectrometric measurements on the material as well as sampling (bores) with evaluation in the laboratory.

The environmental monitoring programme of the operator had been developed as programme for a research facility. It does not fully comply with the provisions of the current Guideline concerning Emission and Immission Monitoring of Nuclear Installations (REI) with regard to the monitoring of repository sites. Consequently, the commissions are of the opinion that the continuation and definition of the measurement programme has to be reviewed and specified under consideration of the measured data with a view to the current requirements.

ESK and SSK deem it necessary to conduct measurements of selected indicator nuclides in the environment of the Asse, also with detection limits at the natural concentration levels, in order to better understand radioecological aspects of environmental monitoring and to develop basic data for a long-term monitoring of the site. The measurements of specific radionuclides proposed in Chapter 7.2 are to be understood as first indications for a systematic further development of the measurement programme.

9 List of reference documents

[1] Schreiben des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit (BMU) (Az.: RS III 2 – 17005/0) vom 04.07.2008 an den Vorsitzenden der Entsorgungskommission (ESK), Herrn Dipl.-Ing. Michael Sailer, und den Vorsitzenden der Strahlenschutzkommission, Herrn Prof. Dr. Rolf Michel, betr.: Sicherheit der Asse, Einrichtung einer Ad-hoc-Arbeitgruppe „Asse“

[2] STELLUNGNAHME der ESK und der SSK zur Schachtanlage Asse II – Plausibilitätsprüfungen der Angaben des Betreibers, Anlage zum Ergebnisprotokoll der 3. ESK-Sitzung am 17.09.2008

[3] Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung – StrlSchV) vom 20.07.2001 (BGBl. I, S. 1714) zuletzt geändert durch Artikel 2 §3 Abs. 31 des Gesetzes vom 1. September 2005 (BGBl. I, S. 2618)

[4] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen, Rundschreiben des BMU vom 07.12.2005 -RS II 5 – 15603/5 (GMBl. 2006, Nr. 14-17)

[5] G. Kappei: Kontaminierte Salzlösungen in der Schachtanlage Asse. Vortragsunterlagen anlässlich der Befahrung am 08.07.2008

[6] Information von Umweltstaatssekretär Dr. Stefan Birkner, Landtags-Ausschuss für Umwelt und Klimaschutz am 20. Juni 2008, http://www.umwelt.niedersachsen.de/master/C47943068_N11622631_L20_D0_I598.html

[7] Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz: Ergebnisbericht, Untersuchungen im Forschungsbergwerk Asse II, Juli 2008

[8] Schachtanlage Asse, Gutachtliche Stellungnahme zum Ist-Zustand des Betriebes hinsichtlich der strahlenschutzrelevanten Aspekte und zum vorhandenen radioaktiven Inventar, erstellt im Auftrag des Niedersächsischen Ministeriums für Umwelt und Klimaschutz und des Bundesministeriums für Forschung und Technologie von der TÜV NORD EnSys Hannover GmbH Co. KG, August 2008

[9] Niedersächsisches Ministerium für Umwelt und Klimaschutz Statusbericht des Niedersächsischen Ministeriums für Umwelt und Klimaschutz über die Schachtanlage Asse II Hannover, 01.09.2008

[10] M. Heydorn, Dr. G. Hensel, Dr. G. Bracke (GSF): Beschreibung der Lagerbereiche der Abfälle Projekt Langzeitsicherheit Asse, Lagerbereiche (14/77756/RHV/RB/BW/001/02) Stand: 20.06.2005

[11] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): Anlage zum Rundschreiben vom 12.01.2007 – RS II 3 – 15530/1, Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen – Teil 2: Ermittlung der Körperdosis bei innerer Strahlenexposition (Inkorporationsüberwachung) (§§ 40, 41, 42 StrlSchV)