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KERNTECHNIK
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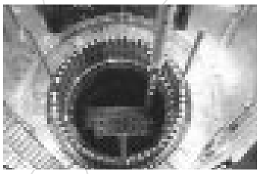
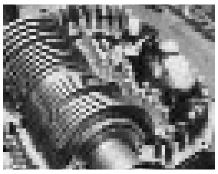
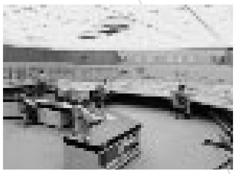
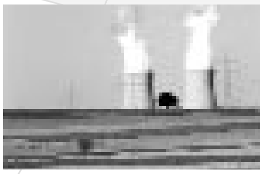

ILK Statement

on the Final Storage of Radioactive Waste

Für deutsche Fassung bitte umdrehen!

July 2000
Nr.: ILK-02 E

Content

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Executive Summary

Against the background of the statements made by the Federal Government /14, 15/ and the pronouncements of the coalition agreement between the Social Democrats and the Green Party /5/ on the final storage of radioactive waste, the International Nuclear Technology Commission (Internationale Länderkommission Kerntechnik, ILK) has studied the national and international approach to the final storage of radioactive waste and reaches the following conclusions:

- The concept thus far pursued for the final storage of radioactive waste in deep geological formations should be maintained.
- According to this disposal concept, the final storage of radioactive waste should be handled separately, as is customary on an international level, in two distinct final repositories depending on the heat generating properties of the waste.
- Since the suitability of the site Konrad as a final repository for waste with negligible heat generation has already been confirmed within the framework of a comprehensive land use planning inquiry that also dealt with considerable objections, we recommend to grant the planning resolution and to enable a begin of operations without further delay.
- An examination of the amount of radioactive waste produced in Germany shows that if the site Konrad is put into operation soon, then the reversal of the emplacement freeze for the final repository Morsleben can be relinquished and its post-closure phase can be initiated.
- The underground exploratory activities for the salt deposit Gorleben should be brought to completion on the same scale as originally envisaged because a final decision on the suitability of the salt deposit Gorleben as a final repository for heat generating waste cannot be made before then. An interruption (moratorium) or termination of the exploration is not justified on the basis of existing findings on the aboveground and underground explorations.

The Chairman

Prof. Dr.-Ing. Josef Eibl
9th July 2000

1 Introduction

The disposal of radioactive waste in Germany is regulated by the statutory guidelines of the Atomic Energy Act /1/ and the Radiation Protection Ordinance /2/ as well as by the disposal concept on radioactive waste /3/ negotiated between the Federal Government and the individual federal states. With regard to final storage, this disposal concept stipulates that the final storage of all radioactive waste in Germany should take place in deep geological formations. Furthermore, the concept prescribes that the site Gorleben should be examined in terms of its suitability as a final repository for all kinds of radioactive wastes on the basis of the site selection conducted by the Federal Government dating from June 1977. The concept expressly relinquishes the need for retrievability of radioactive waste to ensure reduced access of the transport medium water to the emplaced waste and the associated possible release of radionuclides by premature filling and closure of excavated and backfilled cavities. Next to the final repository project Gorleben, the Physical-Technical Federal Institute (PTB, Physikalisch-Technische Bundesanstalt), on the basis of corresponding pilot studies conducted by the Society for Radiological and Environmental Research (Gesellschaft für Strahlen- und Umweltforschung, GSF) /13/, as it was then known, applied in 1982 for the opening of the land use planning inquiry for the shaft Konrad as a final repository site for radioactive waste with negligible heat generation /4/.

The current government has repeatedly stated (in the coalition agreement between the Social Democrats and the Greens /5/, in a lecture held by a representative of the Federal Environmental Ministry (Bundesumweltministerium, BMU) on the occasion of the fourth colloquium on the Atomic Energy Act in September 1999 /14/ as well as in a Statement of the BMU on current issues regarding disposal from May 2000 /15/) that the above-mentioned disposal concept has failed and is no longer supported by a factual base /3/. Regarding the final storage of radioactive waste, specific points made in the coalition agreement include:

- one single final repository in deep geological formations is sufficient for the final storage of all kinds of radioactive wastes,
- the emplacement in the final repository Morsleben is stopped and this final repository is decommissioned,
- one final repository for all radioactive wastes should be made available as of around 2030 and

- the suitability of the salt mine Gorleben is questionable, that consequently its exploration is interrupted and further sites in different host rocks should be examined for their suitability.

Against the backdrop of these planned deviations from the existing disposal concept, the International Nuclear Technology Commission - Internationale Länderkommission Kerntechnik ILK - states its position in this report on the final storage of radioactive waste.

2 Final Storage of Radioactive Waste in Germany

2.1 Site Konrad

The site Konrad is the most recent of the former iron ore mines in the area of Salzgitter. The iron ore horizon mined by the shaft was deposited during the early Jurassic period around 150 million years ago in the rock formation coral oolite. The ore deposit does not reach the earth's surface at any point and is mined in the shaft at a depth of between 800 m and 1300 m. After completing preliminary investigations by the GSF that lasted several years, the Physical Technical Federal Institute (PTB, Physikalisch Technische Bundesanstalt) applied in 1982 for the initiation of a planning inquiry. Within the framework of this planning inquiry, the suitability of shaft Konrad as a final repository for radioactive wastes with negligible heat generation was thoroughly examined on the basis of "Safety criteria for the final disposal of radioactive waste in a mine" /7/. An important component of these criteria that were set up in 1983 by the Federal Government on the basis of recommendations of the Reactor Safety Commission (Reaktorsicherheitskommission, RSK), is that the sealing of radioactive waste from the biosphere through a system of natural and technical barriers is ensured and that thus an inadmissible strain on the environment is thus excluded in the long term. Focus of the above-ground and underground exploration were questions pertaining to

- the extension of the storage site as well as its hanging and foot wall layers,
- the general geological structure,
- the hydrogeological conditions given by Quaternary, Cretaceous and Jurassic eras as well as the hydrochemical conditions of the ground water conductors,
- the characteristics of the geological formations as barriers against the dispersion of radionuclides (permeability and sorption behavior),
- the mountain conditions in the vicinity of cavities, between stations and the entire mine,
- the long-term seismic stability of the site and
- the dispersion behavior of radionuclides in the operating and post-operating phase during specified normal operation and during malfunctions (safety analysis).

The technical-scientific investigations on the planning inquiry procedure have been concluded after sixteen years' duration. Following a thorough investigation of all issues, the planning inquiry concluded that the site Konrad is suited as a final repository for radioactive wastes with negligible heat generation. The investigations on hydrogeology, for instance, showed that the site Konrad is exceptionally dry. Furthermore, it was established that the water paths emanating from the pit would reach the biosphere within the course of approx. 300,000 years at the earliest. Considering the radionuclide inventory to be emplaced and its half-life value, the long-term safety analyses that are based on the very low dispersion speed of the transport medium water indicate that the potential radiation exposure of the population, also in the long-term, lies far below the fluctuation range of natural background radiation, i.e. is less than 0,3 mSv/a.

Once the planning confirmation resolution has been issued, excavation of the disposal areas at a depth of approx. 800 m can begin. The disposal areas are planned to consist of several disposal rooms with an area of 40 m^2, a floor width of around 7 m and a height of approx. 6 m. A maximum of 10 disposal areas are planned which will have an emplacement cavity of 1,1 million m^3 after excavation with a capacity for approx. 650,000 m^3 of radioactive waste /4/. The estimated time period for the construction of the final repository is estimated to take a further 3 to 4 years.

In the Environmental Expert Opinion 2000 (Umweltgutachten 2000) /10/, the influence of gas development in radioactive waste on long term safety is once again intensively introduced into the discussion. At issue is the development of non-radioactive gases (especially hydrogen) that arise from corrosion reactions, decomposition and fermentation processes as well as radiolysis. Due to the mechanical mountain properties, the site Konrad is sufficiently permeable to gases and thus a buildup of gas pressure in the emplacement fields can be excluded. Furthermore, gas development in radioactive waste was measured and an average for the permissible gas development rate for waste to be emplaced under final storage conditions was laid down /11/.

2.2 Salt mine Gorleben

More than 200 salt mines and other salt structures with varying spatial extension are known to exist in Northern Germany. The development of these salt deposits in the North German lowlands can be traced back to the period more than 250 million years ago when, during an extended period of warm climate, huge quantities of salt minerals were deposited by the evaporation of salt water. In this way, a stone formation with a characteristic sequence of layers was created during the geological Permian era. In the further course of the earth's history, the formation of Permian stone was superimposed with deposits of the Triassic (unit 205 million years ago), Cretaceous (65 million years ago) and also by the layers of the Tertiary (until around 1.6 million years ago) and the Quaternary periods. The salt deposits were formed over the course of the accompanying geological development. The formation of the salt deposit Gorleben was basically complete at the end of the Cretaceous / start of Tertiary era.

The salt mine Gorleben has been investigated for its suitability as a final repository especially for high level wastes since 1977 following the suggestion by the Lower Saxon federal state government and corresponding examination by the relevant authorities /6/. These investigations are based on the "Safety criteria for the final storage of radioactive waste in a mine" /7/ that came into effect in 1983.

In agreement with these safety criteria, a comprehensive program for the above-ground and underground exploration of the salt mine was drawn up. The above-ground explorations have meanwhile been concluded and have led to a more in-depth knowledge on the salt mine, the layers of overlying rock as well as the prevailing hydrogeological conditions. The results of the above-ground explorations show that the salt mine Gorleben can be described as suitable as a final repository for radioactive waste based on the conducted drilling probes and geophysical measurements /6/.

Despite all currently available positive interim results /6, 13/, including those derived from underground exploration, no conclusive statement on suitability can yet be made. The confirmation of the suitability will only follow once the underground exploration is complete. The aim of the underground geoscientific exploration is to gain comprehensive information about the inner structure of the salt mine, its mineral composition and thermomechanical resilience. The underground exploration has meanwhile reached an advanced stage, as the following list shows:

- penetration of the connecting stretch at the exploratory level at 840 m depth,
- final depth in shaft 1 reached at 933 m,
- exploratory area 1 (EB 1) circumscribed except for 500 m (for a complete circumference of approx. 5 km) and
- completion of haulage systems in shaft 1.

The final planning and design of the repository, for instance in terms of technical facilities or available final storage volume as well as the extensive safety analyses, can only be conducted once the exploratory activities have been completed in about 4 to 5 years time and can be determined within the framework of the licensing procedure when found to be correspondingly suitable.

The gas development that was introduced into the discussion in the Environmental Expert Opinion 2000 /10/ is of subordinate importance in the emplacement of highly radioactive waste in the salt mine Gorleben due to the properties of the waste product (glass blocks and/or spent fuel elements without moisture residues). Additionally, cracks that might arise in the salt mine would be counteracted by the plasticity of the host rock and thus not be eligible as a possible dispersion path for groundwater streams.

2.3 Final Repository Morsleben

Low- and intermediate-level waste with low concentrations of alpha-emitters were stored in the final repository Morsleben (ERAM) in Lower Saxony until September 1998. This final repository is a former salt mine (disposal chambers located at a depth of approx. 500 m) that has been used since 1978 for the disposal of approx. 14,300 m^3 of radioactive waste in the former GDR. In the course of German reunification, the ERAM attained the status of a federal final repository in 1990. The operation license granted to the final repository in 1986 is limited to the 30th of June 2005 by the Atomic Energy Act /1/. Following a suspension of operation in 1991 due to court orders and safety-related examinations, operations only recommenced in January of 1994. In September 1998, the emplacement was temporarily frozen following a decree by the Superior Administrative Court of Magdeburg. The court decision for the main proceeding is still pending. About 22,300 m^3 of radioactive waste were emplaced using stacking- and dumping techniques during the resumption of disposal from 1994 to the freeze on emplacement in 1998 (planned capacity: 40,000 m^3). At the moment, work is being conducted for the land use planning inquiry on the decommissioning of the ERAM.

2.4 Waste Volume in Germany

The Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS) annually conducts a survey on the amount of radioactive residual materials in the FRG /8/. The stock of untreated residual materials (reusable residual materials and raw wastes), interim products and the accrual and supply of conditioned radioactive waste are determined. Furthermore, /8/ gives a comprehensive overview on the origin and composition of radioactive waste. On the 31st of December 1998, 33,845 m^3 of untreated residual materials as well as 2,550 m^3 of interim products were recorded in Germany according to the waste survey of the BfS /8/. The quantity of conditioned wastes amounted to 60,895 m^3. Additionally, 454 m^3 of heat-generating radioactive raw wastes and 1,428 m^3 heat-generating conditioned wastes were recorded.

The BfS uses the results of the annual survey for calculating the future quantity of conditioned radioactive wastes. Different scenarios of nuclear power use are considered for this purpose. The predicted (cumulated) quantities of conditioned radioactive wastes according to /8/ thus reaches a value of approx. between 324,000 m^3 to 392,000 m^3, depending on the operating period of the nuclear power plants, for the year 2080 including decommissioning wastes. Of these, around 27,000 m^3 to 48,000 m^3 are due to heat-generating wastes. The capacities of the planned final repositories Konrad and Gorleben were originally based on greater waste volumes. In the preparation of the disposal areas, the current waste volumes are being considered and the volume required for final disposal is correspondingly adjusted.

3 International Final Storage Concepts

Short-lived low- and intermediate-level wastes are disposed of in surface-based repositories in very many countries (e.g. France, Japan, Spain, UK, USA) /9, 13, 16/. In near-surface final disposal, the radioactive waste is simply stored in simple trenches or, as is common practice today, in engineered constructions which are covered after being filled. Corresponding final repositories have partly been in operation for substantial timer periods (see Table 1). When compared to final repositories in deep geological formations, surface-based final repositories are usually cheaper to construct and operate. However, surface-based final repositories should to be institutionally controlled for a period of up to 300 years following end of operation /9/. The final storage of short-lived low- and intermediate-level waste in 50 - 60 m depth as is practiced in Sweden and Finland represents an intermediate form of disposal between surface-based and deep geological final disposal. The concept pursued by Germany, in contrast, is to dispose of all radioactive wastes in deep geological formations. A similar disposal concept is adopted by Switzerland, which is planning two separate geological final repositories for short-lived low and intermediate level waste on the one hand and for long-lived intermediate and high-level waste on the other.

The aim for disposing of long-lived intermediate- and high-level waste (including spent fuel elements) on a world-wide basis is the final storage in deep geological formations /13/. Apart from one final repository for low- and intermediate level waste with a high proportion of long-lived alpha-emitters from the production of nuclear weapons in the USA (Waste Isolation Pilot Plant, WIPP) that began operations in 1999 /17/, currently there is no corresponding operational final repository anywhere in the world. With regard to the long-term safety of the final repository, these wastes are comparable with highly radioactive wastes such as spent fuel elements. The final storage projects in the individual countries are in different stages of development. A comprehensive overview on the principal approach adopted on an international level is given in Table 1 for the final storage of radioactive waste with negligible heat generation as well as Table 2 for radioactive waste with heat generation /9, 13, 16/.

Country	Surface-based Final Storage	Final Storage in Geological Formations
Germany[1)]		in planning
France	in operation since 1969	
UK	in operation since 1959	
Finnland		in operation since 1992
Canada	in planning	
Netherlands		in planning
Sweden		in operation since 1988
Switzerland		in planning
Spain	in operation since 1993	
Japan	in operation since 1992	
USA		in operation[2] since 1999
USA	in operation since 1963	

1) Emplacement in the experimental final repository Asse has been completed, emplacement in final repository Morsleben has currently been frozen

2 In contrast to the final depositories in other countries, WIPP also stores waste with a high proportion of long-lived alpha-emitters

Table 1: Overview of the international approach towards final storage of radioactive wastes with negligible heat generation /9, 13, 16/

Country	Final Storage in Geological Formations	Rock Formation
Germany	in planning	Rock salt
Finland	in planning	Granite
France	in planning	Opalinus-Clay or Granite
Japan	in planning	Granite
Sweden	in planning	Granite
Switzerland	in planning	Clay or Granite-Opalinus
USA	in planning	Tufa

Table 2: Overview of the international approach towards the final storage of radioactive wastes with heat generation /9, 13/

While in some countries (e.g. Germany, USA), exploratory activities at a selected site have already been conducted, other countries (e.g. Sweden, France) have not yet completed their search for an appropriate site. Different countries are examining different rock formations (e.g. salt, granite, clay, tufa) for their suitability as final repositories. This variation is due mainly to the different geological conditions prevailing in each country.

Thus far, the concept pursued world-wide in the disposal of radioactive waste has been to permanently remove these from the biosphere and also to prevent any kind of future access (final storage). This is met today in some countries by requests for reversible emplacement with possibilities of supervising, controlling and retrieving wastes. However, irreconcilable contradictions are inherent in the request for safety according to /12/ for a period of more than 100,000 years and the simultaneous demand for constant supervision and institutional control. Additionally, accessible disposal rooms that are kept open for institutional control purposes increase the safety risk both in the short term by enabling undesired access of third parties as well as in the long term by weakening the natural and technical barriers /12/.

In order to nevertheless enable reversibility and to overcome acceptance problems by the population with regard to long-term safety, a Swiss expert commission recommends a controlled long-term storage consisting of the three components test depot, main depot and pilot depot /12/. The components test depot and main depot are already being implemented by the underground exploration program and the emplacement in deep geological formations, so far without intended retrievability in the planned final repository Gorleben. The Swiss Commission pinpoints a pilot depot as the third component. The pilot depot should receive a small but representative part of the HAW for emplacement under conditions comparable to those of the main depot (host rock, packaging, technical barriers, etc.). Yet in contrast to the main depot, the storage in the pilot depot would be accessible in the long term also. This approach would enable periodic examinations of whether the safety engineering considerations and geological models are confirmed by operational experience. The time period for accessibility and ability to institutionally control the emplaced waste still needs to be determined.

4 Conclusion

The final storage of radioactive waste in deep geological formations is currently viewed as the safest method for keeping the waste away from the biosphere on a safe and long-term basis. For heat generating waste, the concept of final storage is pursued all over the world. Different countries are examining different rock formations for their suitability as final storage sites. This is due to the prevailing geological conditions found in the individual countries. In Germany, tribute is paid to the "Safety criteria for the final storage of radioactive waste in a mine" /7/ so that final storage is based on a barrier concept involving independent technical and natural barriers.

Rock salt is frequently preferred as a host rock for heat-generating waste due to its physical characteristics. It is sufficiently available in the salt mine Gorleben and is characterized by its very good thermal conductance and high plasticity. Due to these properties, the excavated cavities are rapidly resealed by the mountain pressure, the entrance of water is prevented and thermal tensions are reduced. The experiences gained to date with the experimental final repository Asse /6/ and in the USA with the WIPP /17/, a final repository in rock salt for wastes derived from nuclear weapons production with a large proportion of long-lived alpha-emitters, confirm these safety-related benefits.

Many countries are investigating the suitability of granite as a host rock for heat-generating waste. However, in contrast to rock salt, granite always has finely branched gaps that may act as paths for water entry. This is why additional technical barriers must be considered when planning final storage sites in granite formations.

The international comparison shows that rock salt is well suited in principle for heat-generating waste /17/. The exploratory activities conducted thus far both above-ground and underground have led to the expectation of suitability of the salt mine Gorleben as a final repository for heat-generating waste /13/. A final decision with regard to suitability of the salt mine Gorleben can, however, only be provided upon completion of the extensive underground exploration in approx. 4 to 5 years' time. An interruption (moratorium) or termination of exploratory activity is scientifically unjustified given the existing geological and hydrogeological findings.

The international comparison shows that radioactive waste with negligible heat generation is stored in geological formations or in near-surface final repositories. In contrast to final repositories for heat-generating wastes, most countries already operate final repositories for waste with negligible heat generation. Due to the varying technical safety requirements (usually shorter half-life of the radionuclide

inventory) and the different waste volume (quantity of highly radioactive waste substantially lower than low- or medium radioactive waste), the international approach to the final disposal of radioactive wastes is usually handled separately for waste with negligible heat generation versus waste with heat generation.

With regard to these arguments, Germany has also examined the site Konrad next to the planned final repository Gorleben in a comprehensive land use planning inquiry in terms of their suitability as final repositories for radioactive waste with negligible heat generation. The extensive investigations performed in the framework of this proceeding on the geology, hydrogeology, mountain dynamics and long-term safety confirm the suitability of the site Konrad as a final repository for these wastes.

The comparison of the existing quantities of conditioned radioactive wastes with the quantities of waste expected to accrue in the coming years confirms the demand for speedy begin of operations of site Konrad. A renunciation of the site Konrad would, by default, lead to a development of the interim storage capacities for low and intermediate level waste and an above-ground interim storage for approx. 30 to 50 years. Additionally, this would also necessitate post-conditioning measures for existing radioactive waste since its present conditioning was not devised for such long interim storage periods. At the same time, the comparison of radioactive waste quantities shows that if the site Konrad is put into operation soon, the capacity for the final storage of all kinds of radioactive waste with negligible heat generation is sufficient. Against this background, the reversal of the emplacement freeze for the final repository Morsleben can be relinquished and its post-closure phase can be initiated.

Statement

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Objectives of the International Nuclear Technology Commission established by the States Baden-Württemberg, Hesse and Bavaria [Internationale Länderkommission Kerntechnik] - ILK -

Mission

Independently and objectively advising the states Baden-Württemberg, Hesse and Bavaria at the highest, internationally acknowledged scientific level on questions relating to the safety of nuclear installations, the regulated disposal of radioactive waste and the peaceful utilization of nuclear energy against the background of a sustainable energy supply.

Goals

1. Maintenance and improvement of the high safety standard of the German nuclear power plants and further development of the waste management concept for radioactive waste according to the internationally recognized state-of-the-art in science and technology.

2. Application of an holistic system approach to man-technology-organization.

3. Timely detection of safety defects against the background of competition in the liberalized European electricity market and development of countermeasures.

4. Inclusion of internationally acknowledged practice into the German safety philosophy and safety concept for improving state supervision and for increasing the safety standard of installations.

5. Treatment and evaluation of selected safety issues with regard to new scientific insights and development of recommendations on the harmonization of nuclear engineering standards on a European level.