FEBRUARY 1987 MONTHLY REPORT
SALT REPOSITORY PROJECT (SRP) REPRESENTATIVE
TO THE FEDERAL REPUBLIC OF GERMANY (FRG)

General

The GSF/IfT has a central role in the waste management research and development in the FRG. They operate the Asse salt mine which has been used for radioactive waste disposal and for development and testing of safe geological storage for high-level wastes (HLW) in salt. As indicated on the attached map, (Attachment 1) the Asse mine is situated just to the southeast of Braunschweig.

To the southwest of Braunschweig is the Konrad mine, a former iron ore mine for which mining was discontinued in 1976 due to economic reasons. The GSF/IfT has also carried out research and development at the Konrad mine to demonstrate its suitability for the final disposal of waste which has a negligible thermal effect on the surrounding rock. Detailed reports concerning activities at both the Asse and Konrad mines will be submitted at a later date.

The Physikalisch-Technische Bundesanstalt (PTB -- Federal Science/Engineering Laboratory) is also located in Braunschweig. Under the FRG Federal Ministry for Science and Technology (BMFT), the PTB has responsibility for developing and licensing radioactive waste repositories. Attachment 2, provides a brief description of the final disposal of radioactive waste in the FRG, was published by the PTB over a year ago, but should provide the reader with a general understanding of the developments at the Asse and Konrad mines, as well as the candidate salt repository site for HLW at Gorleben.The Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR -- Federal Institute for Geosciences and Natural Resources and the Deutsche Gesellschaft fur Wiederaufarbeitung von Kernbrennstaffen mbH (DWK -- German Reprocessing Company) are two important installations located in Hannover.

BMT at the Asse Mine

The Brine Migration Test (BMT) at the Asse Mine has been terminated and work is underway on the post-test analysis of this joint U.S.-FRG activity. The group at GSF/IfT, notably Dr. Kuhn, Professor Gies, and Drs. Rothfuchs and Jockwer, feels strongly that there should be a meeting of concerned parties at the Asse Mine to observe the visible effects of heat and radiation on the rock salt at the BMT site, and to finalize plans to conclude testing of this salt in both U.S. and FRG laboratories. The staff here believe that this would provide a useful forum for developing plans for joint U.S.-FRG work on salt irradiation effects at Brookhaven National Laboratory (BNL). With appropriate pre-planning and structuring, such a meeting could prove productive for bringing this matter to a close. This matter will be further discussed with the Germans and a recommendation will be made in a future report.

HLW Disposal Test at the Asse Mine

The planned HLW disposal test at the Asse Mine is beginning to be the focus of major attention at GSF/IfT. Tilman Rothfuchs is presenting a paper at the

Waste Management '87 meeting in Tucson on this subject (see Attachment 3), and will also be traveling to Richland, Washington for discussions with Pacific Northwest Laboratory (PNL) staff concerning the radioactive sources that will be supplied for this test by the U.S. More information on this subject will be provided at a later date.

Status Seminar on Radionuclide Studies

A status seminar on 1986 work on safety analysis of disposal (radionuclide behavior/migration in geologic media) was held in Braunschweig on February 18, 1987. The meeting was well attended (perhaps 60 persons) by representatives of various universities engaged in this program and of other FRG organizations (e.g., PTB, GSF/IfT, etc.). A copy of the agenda is contained in Attachment 4. The meeting consisted of presentations by the different university workers of their programs. Work in the area of colloids and their role in transport of radionuclides seems to be good.

The Kernforschungscentrum Karlsruhe (KfK -- Karlsruhe Nuclear Research Center) has the lead role in developing the direct disposal option, and Dr. K.-D. Closs is the leader of the Projektgruppe Andere Entsorgungstechnike (PAE) at the KfK. A copy of BMFT's semi-annual report for the last half of 1986 was obtained and will be translated and distribution will be made in a month or so. Future discussions with Dr. Closs will be held on the thermal simulation test in the Asse Mine.

GSF/IfT Management Meeting

The GSF/IfT Monthly Management Meeting was held on February 28, 1987. This meeting is for planning and review of all key activities in the GSF/IfT. A copy of the protocol and minutes for the January 1987 meeting are shown in Attachment 6. Discussions included operations at Asse, financial reporting, planned tests (backfill/sealing activities, PAE project on thermal simulation testing, etc.), submission of work plans for 1987, and other topics of current interest. The GSF/IfT is going to become involved in hazardous waste disposal as well, and a special group has been assigned responsibility for that in concert with other external organizations (the recent contamination of the Rhine River has aroused considerable controversy in Germany; the realization is that the chemical disposal problems are much less tractable than that of radioactive waste).

Although some of the attached items are in German, they do indicate how meetings are structured, the important parties, etc. Certain important materials will be translated. For example Attachment 5 will be made available in translation later.

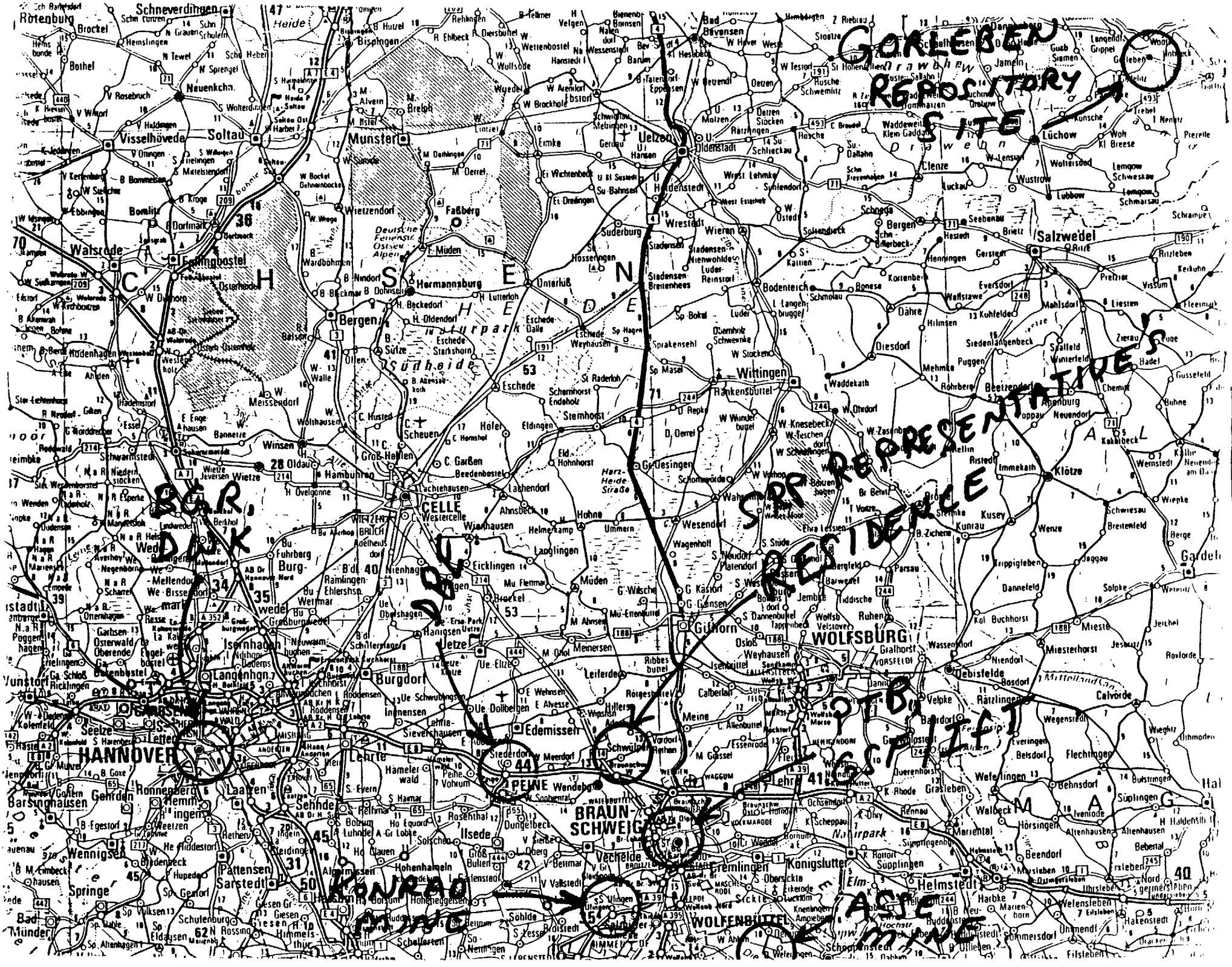
Planned Activities for March

Meetings will be scheduled with DBE, BMFT, KfK, and PTB and visits will be made to the Asse Mine and the Gorleben repository site.

Attachments

Six attachments, as follows:

(1) Map of local area.
(2) October 1985 Article by PTB on final disposal.
(3) Prepublication of paper by Rothfuchs and Stippler on HLW disposal test in Asse (for Waste Management '87 meeting).
(4) Agenda for status seminar on radionuclide behavior.
(5) KfK project PAE semiannual report, July-December 1986 (in German; translation will be available later).
(6) Protocol and minutes GSF/IfT January Management Meeting (in German, for information only).


GORLEBEN REPOSITORY SITE
BOR, DAK
SRP REPRESENTATIVES
RESIDENCE
ALT
MAB
KONRAD
ASSE MINE
Schneverdingen
Soltau
Munster
Uelzen
Bad Bevensen
Lüchow
Salzwedel
Walsrode
Fallingbostel
Bergen
Hermannsburg
Faßberg
Wittingen
Hankensbüttel
Gifhorn
WOLFSBURG
CELLE
Winsen
Hambühren
Burgdorf
Langenhagen
Isernhagen
Edemissen
Peine
HANNOVER
BRAUNSCHWEIG
Wolfenbüttel
Salzgitter
Vechelde
Ilsede
Sehnde
Lehrte
Laatzen
Pattensen
Sarstedt
Springe
Bad Münder
Hameln
Hohenhameln
Helmstedt
Königslutter
Gremlingen
Wolfenbüttel
Schöppenstedt
Lüneburger Heide
Naturpark Südheide
Deutsche Fernsehstraße Ostsee-Alpen
Harz-Heide-Straße

PTB aktuell

Information of the Physikalisch-Technische Bundesanstalt (PTB) on the disposal of radioactive waste

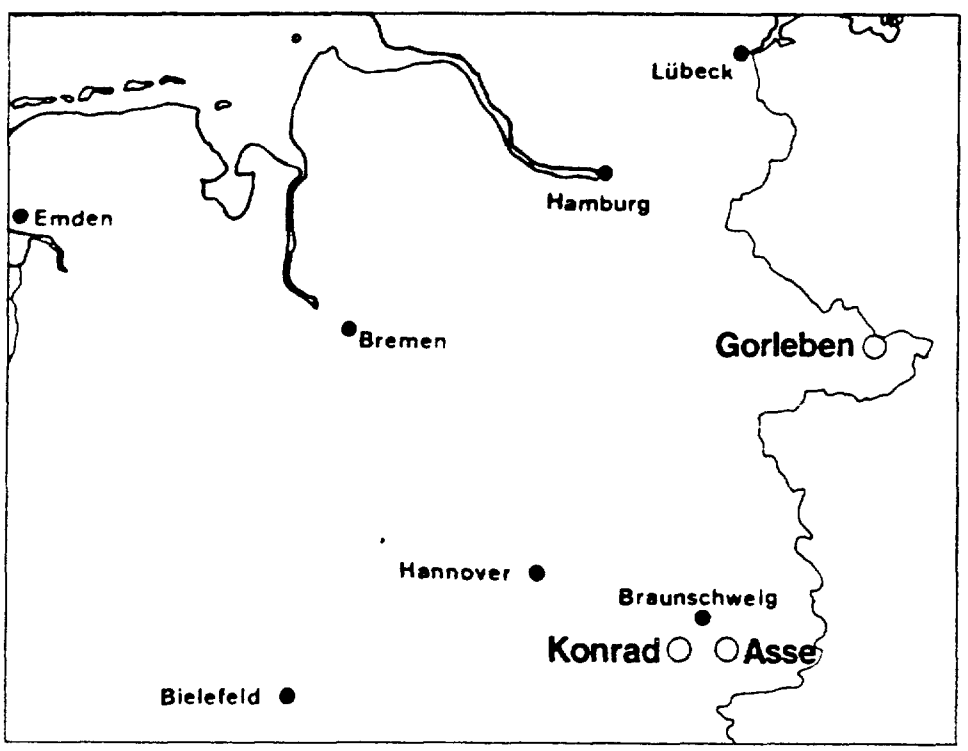
No. 9 / as of October 1985

Final disposal of radioactive waste

A survey of the planning and research work carried out in connection with the final disposal of radioactive waste in the Federal Republic of Germany

During the manufacture and consumption of goods, waste is produced which must be safely disposed of. This applies of course also to the utilization of nuclear energy for peaceful purposes and the use of radioactive materials in industry, research and medicine. In the Federal Republic of Germany, since the beginning of the development of nuclear technology, radioactive waste produced in these fields has been conditioned, stored and disposed of in such a way that man and his environment are protected against any risk arising from it.

In the Federal Republic of Germany, handling of radioactive waste is subject to the Atomic Energy Act. Here the primary objective is »...to protect life, health and material goods from damage due to nuclear energy and the detrimental effects of ionizing radiation...« (Section 1 Atomic Energy Act). As radioactive waste remains a hazard over a long period of time, the legislator has considered its safe disposal to be a task incumbent upon the state. The PTB, a higher federal authority, has been entrusted with the construction and operation of installations for the long-term storage and final disposal of radioactive waste. To perform its duties, the PTB may make use of »third parties«. For this purpose the »Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH« (DBE, German company for the construction and operation of waste repositories) was founded in 1979.



Today, experts all over the world consider the disposal in rock strata of the deep geological subsoil to be the safest method for the disposal of radioactive waste. In the Federal Republic, solid waste and waste which has been solidified to meet the disposal requirements, is intended to be finally disposed of in mines specially established for this purpose. The protection goal, i.e. no radionuclides at any time being able to reach the biosphere from the deep subsoil, in a concentration which is detrimental to organisms, is guaranteed here by a system of natural and technical barriers.

Since 1965, procedures and techniques for the safe disposal of radioactive waste have been developed and tested in the abandoned »Asse« salt mine near Wolfenbüttel.

Since 1979 investigations have been carried out by the PTB into the Gorleben salt dome's suitability for the final disposal of all kinds of solid waste and waste which has been solidified, i.e. heat generating waste.

Investigations into the suitability of the »Konrad« mine have been in progress since 1975. There, it is planned to dispose of that waste which has a negligible thermal effect upon the surrounding rock.

The rock in the immediate vicinity of the waste, i.e. the host rock in which the storage chambers are constructed, and the overlying strata are natural barriers. These geological barriers are carefully examined and made use of when the concept is elaborated and a repository mine driven.

Technical barriers, i.e. barriers set up by man, comprise for instance, the type of fixation of the radioactive waste, its packaging and the type of backfilling of the remaining cavities of the repository mine, including the galleries and shafts.

Already at the beginning of the sixties discussions on the selection of rocks suitable for the long-term safe disposal of all kinds of radioactive waste were started, and in the Federal Republic of Germany a decision was taken in favour of salt rock, in particular salt domes. More than 200 salt domes exist in the subsoil of Northern Germany, several of which could be considered for the final disposal of radioactive waste

Gorlebens site investigation program

In the mid seventies planning work was started for a federal repository to be constructed within the scope of the so-called "integrated nuclear waste management center". On February 22, 1977 the government of Lower Saxony designated the Gorleben salt dome as the provisional site. With a length of 14 km and a width of up to 4 km, its dimensions are above the average. Until the designation of the site, only a few drillings had been carried out which furnished information on the salt dome.

On July 28, 1977, the PTB filed an application for the initiation of a plan-approval procedure for final disposal in the Gorleben salt dome. Since April 1979, at the PTB's request, the salt dome has been investigated from above ground within the scope of a comprehensive site investigation program. It comprises the hydrogeological examination of the overlying strata and drillings into the salt dome to gain a first impression of the salt dome's internal structure and the stratigraphic sequence of the salt rock.

The hydrogeological investigation program covered an area of about 300 km²; it was carried out mainly within the period from April 1979 to July 1981. Within its scope the type and thickness of the unconsolidated rock covering the salt dome and the ground-water horizon above the salt dome and in its vicinity were explored.

Four deep drillings (up to a depth of 2 000 m) into the salt dome flanks furnished an almost complete survey of the salt rock existing in the salt dome. In addition, important information on the structure of the salt dome was obtained from these deep drillings.

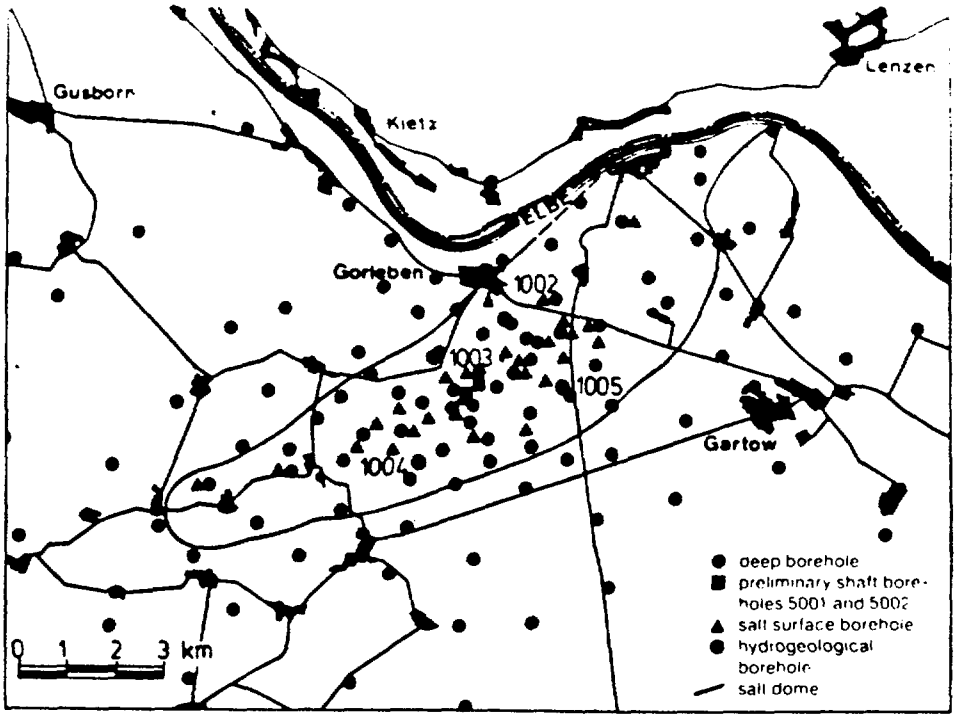
The next step required will be the underground investigation of the salt dome in order to determine the geological structure and the usable volume and to draw up a detailed concept for the future repository mine.

Only on this basis can statements be made as to what quantities of which type of waste can be where emplaced in the salt dome. These statements must be examined in a licensing procedure under the Atomic Energy Act, in which the public also participates (plan approval procedure).

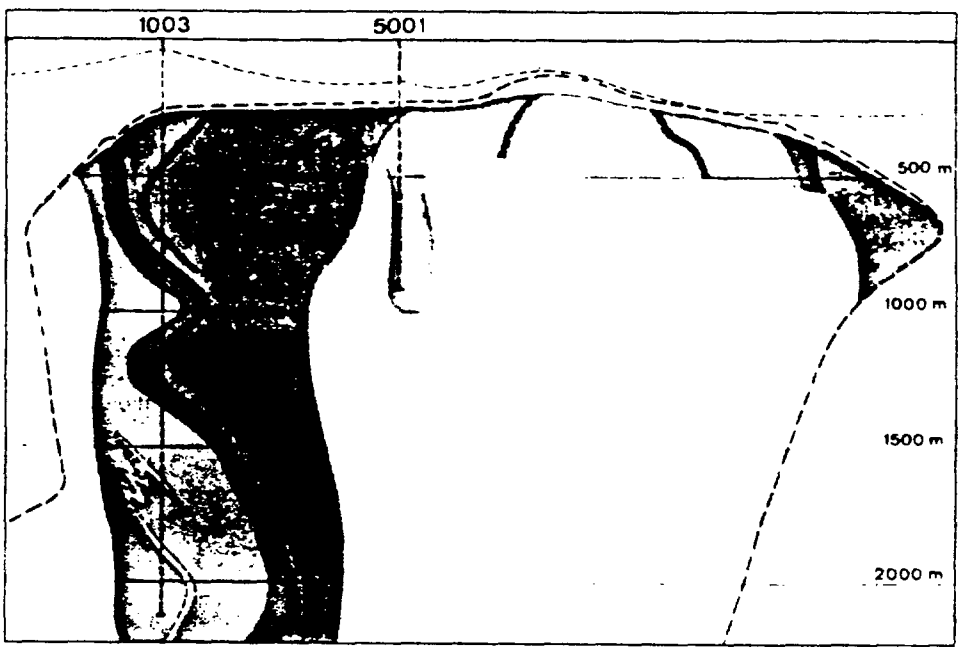
According to the frozen aquifer emplacement technique two shafts with an inside diameter of 7,50 m will be sunk for the underground investigation. Starting from these shafts, at a depth of about 840 m, it has been planned to investigate an area of about 18 km² by galleries and further drillings. Downward drillings are also planned in order to obtain information on the bedrock below the level being explored.

Preliminary investigations of the geological set-up of areas earmarked for the shafts were carried out by shaft pilot drillings (Gorleben 5001 and 5002). After preparation of the site, the freezing shaft sinking and the construction of a frost jacket, work on the sinking of the first shaft can begin early in 1986. Work on the second exploratory shaft is scheduled to begin shortly after this. The results of the underground investigation will presumably be available in 1992.

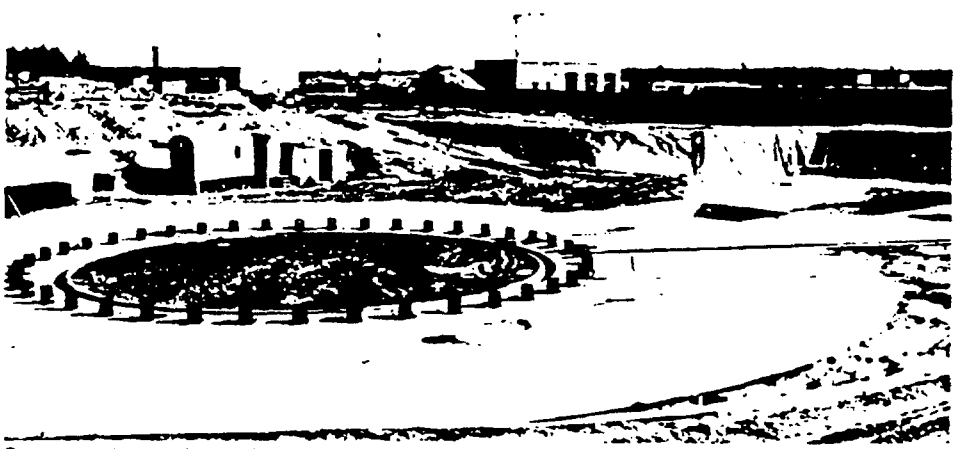
If the underground investigation yields positive results and if the plans have been approved at the beginning of 1995, the construction of the repository mine and the driving of storage chambers could then be started. First emplacements of radioactive waste will be possible by the end of the nineties.



At 110 locations, exploratory drill holes were drilled into the overburden and ground-water measuring stations installed from which water samples from the ground-water horizons encountered can be taken for the preservation of evidence.



Cross section through the Gorleben salt dome in the area of the preliminary shaft borehole 5001. The areas of the salt dome left white have not yet been investigated.
(blue: rock salt, red: potash salt, deep-green: anhydrite)



Concrete plate at the shaft 1 drilling site (preliminary shaft borehole 5001)

The »Konrad« mine

The »Konrad« mine is situated near Salzgitter-Bleckenstedt between Braunschweig and Salzgitter-Lebenstedt. It is the youngest of all former iron ore mines in the Peine/Salzgitter area. The iron ore horizon, opened up in its southern part by two shafts, was deposited about 150 million years ago during the Upper Jurassic (Malm) and was discovered only at the beginning of the thirties in connection with oil drillings.

In 1958 the »Konrad 1« shaft was sunk to a depth of 1 232,5 m. Then the »Konrad 2« shaft was sunk as an upcast ventilation shaft with a depth of 997,5 m. Iron ore mining was started in 1965 but then discontinued in autumn 1976 for economic reasons.

The »Konrad« mine is exceptionally dry for an iron ore mine. In view of this characteristic feature an investigation into its suitability for the disposal of waste material suggested itself. Preliminary investigations carried out in 1975 showed that this mine could be considered for the final disposal of radioactive waste. Important criteria for this are, among other things, the position of the iron ore body at a great depth (800–1 300 m) and the good impermeability to ground waters due to the predominantly clayish overlying strata. This forms the geological barrier for a safe reposition of radioactive waste.

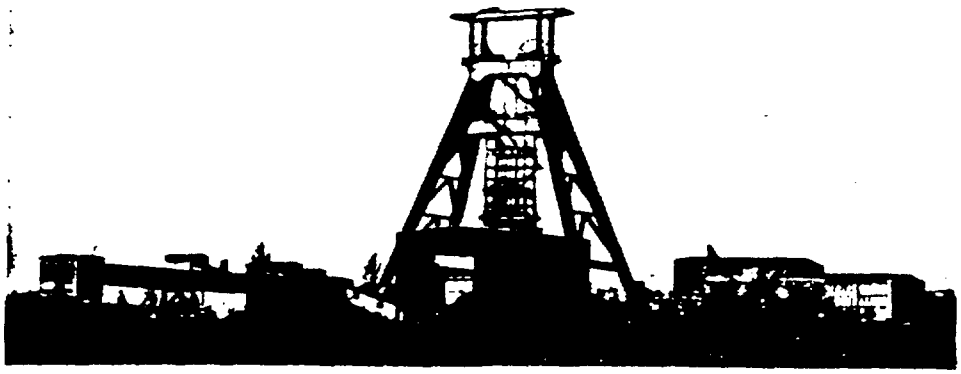
Within the framework of a research and development program carried out from 1976 to 1982 at the request of the Federal Government, the »Gesellschaft für Strahlen- und Umweltforschung« (GSF, Company for radiation and environmental research) being the responsible party, it was proved that from the point of view of mining and geosciences, the »Konrad« mine is suitable for the final disposal of waste which has a negligible thermal effect upon the surrounding rock. Consequently, on August 31, 1982, the PTB filed an application for the initiation of a plan-approval procedure for the final disposal. At the same time, underground work and supplementary work above-ground within the scope of the site investigation program was carried out, the results of which are expected to demonstrate the suitability of the mine in the plan-approval procedure.

If a repository were operated, the »Konrad 1« shaft should be used for the transport of the iron ore extracted during the construction of the storage galleries, and for the transport of material and manriding (transport of persons). The »Konrad 2« upcast ventilating shaft should be used for the transport of the radioactive waste in the mine. Storage operations and the excavation of cavities underground are to be kept separate in space and also in time.

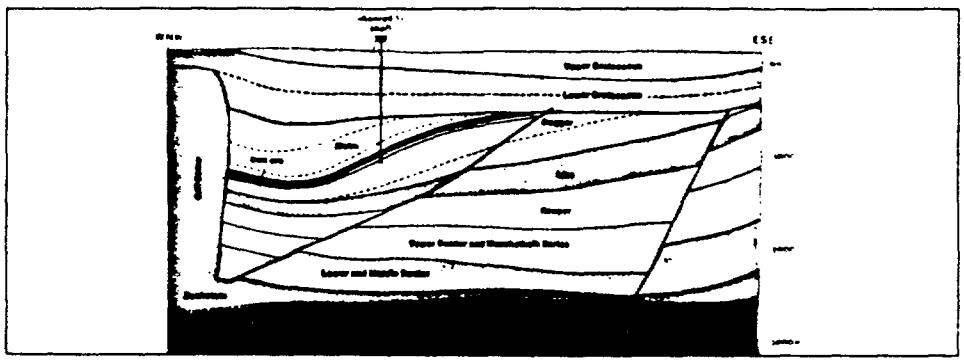
For storage operations, storage galleries with a cross section of about 40 m² must be driven. In these galleries the radioactive waste is to be stacked. The remaining cavities will be backfilled with rock from the excavation of the galleries.

The underground mine area at present under consideration allows storage cavities of about 650 000 m³ volume to be driven. Depending on the waste package volume to be disposed of annually (assumed volume 40 000 m³ at first, and about 20 000 m³ after approximately 5 years of operation) a period of operation of more than twenty years is calculated. This would mean that during its period of operation, the »Konrad« mine could be used for the final disposal of about 95 % of all the radioactive waste produced in the Federal Republic.

Providing there is a positive outcome of the plan-approval procedure, the emplacement of radioactive waste could be started by about 1989.



»Konrad 1« shaft of the »Konrad« mine (near Salzgitter-Bleckenstedt)



The iron ore deposit (red) is 12 to 18 m thick. At the top it is delimited by thick mudstone of the Lower Cretaceous

Stable galleries for the reposition of radioactive wastes can be established in the iron ore horizon.

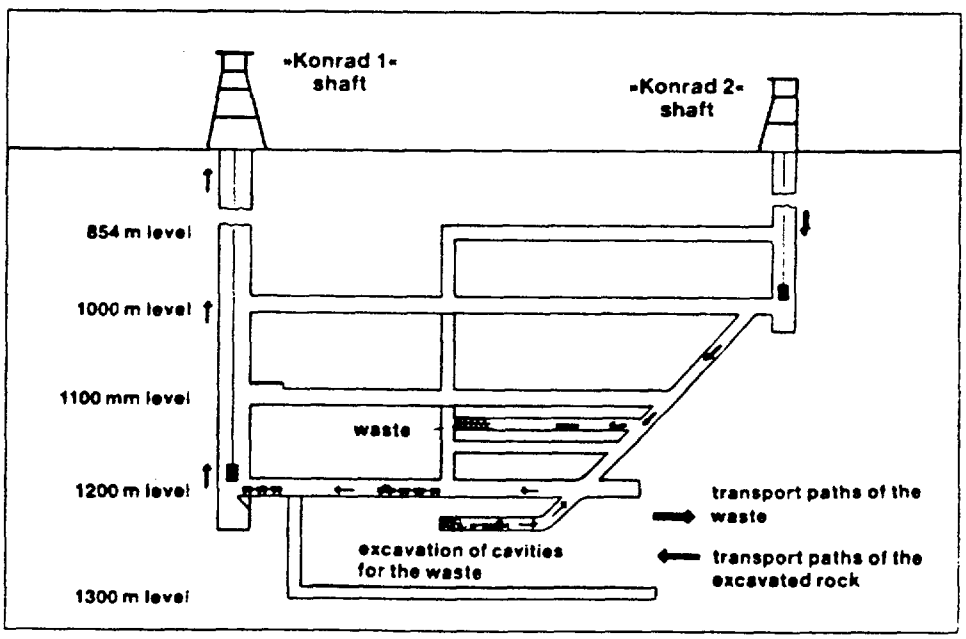


Diagram of the planned storage operations.

The »Asse« mine

The former »Asse« salt mine is situated 1.5 km north of the municipality of Remlingen in the county of Wolfenbüttel. The »Asse« is a ridge, about 8 km long, formed by the anticlinal uparching of salt rock. Above the back of the salt saddle, the overlying strata are about 250 m thick.

The driving of the »Asse 2« shaft was commenced as early as 1906, and on March 1, 1909 exploitation was started. First carnallitite, a salt rock for the production of potash fertilizer, and later on rock salt were extracted. A total of about 10 million tons of crude salt was mined. In 1964 salt extraction was discontinued for economic reasons. As exploitation progressed the chambers in the carnallitite were backfilled. More than 100 chambers in the rock salt, each of a volume of about 35 000 m³, are still accessible.

The experience gained in German salt mining over more than a century has shown that in salt rock, large cavities can be established and kept accessible without support. Corresponding to the state of technology in German salt mining, storage chambers with volumes of, for instance, 30 000 m³ to 50 000 m³ as envisaged in the radioactive waste repository can be constructed without any difficulty.

In order to be in a position to carry out research work in the field of the long-term safe disposal of radioactive waste in salt, in spring 1965 the »Asse« mine was purchased by GSF on behalf of the Federal Government, thus enabling research work to be carried out there. An intensive research and development program was started, aiming at clarifying on the one hand scientific questions arising in connection with the construction and operation of a repository mine to be established later on for all solid waste produced, and on the other hand, at testing on a large scale, methods for the final disposal of radioactive waste.

Within the framework of these test programs, up to the expiry of the storage licences at the end of 1978, approximately 124 500 drums of low-active waste and 1 300 drums of medium-active waste were disposed of. Since January 1979 the research and development projects have been continued without any further storage activities taking place.

Present activities are centered above all around problems and questions arising in connection with the final disposal of heat-generating, highly radioactive waste. Already in 1968, the first testing ground for temperature tests with electric heaters was put into operation. Further experiments followed, until in 1983, Co-60 sources were used for the first time to investigate the combination of radiation and the release of heat. A large-scale test using highly radioactive vitrified blocks is planned. The radioactive packages will be removed from the mine on completion of the tests.

In the course of 1987 the decision will presumably be taken as to whether the »Asse« mine will additionally serve as a repository. For this purpose the cavities still existing in the mine would make enough space available to take up some 100 000 containers with radioactive waste.

Imprint

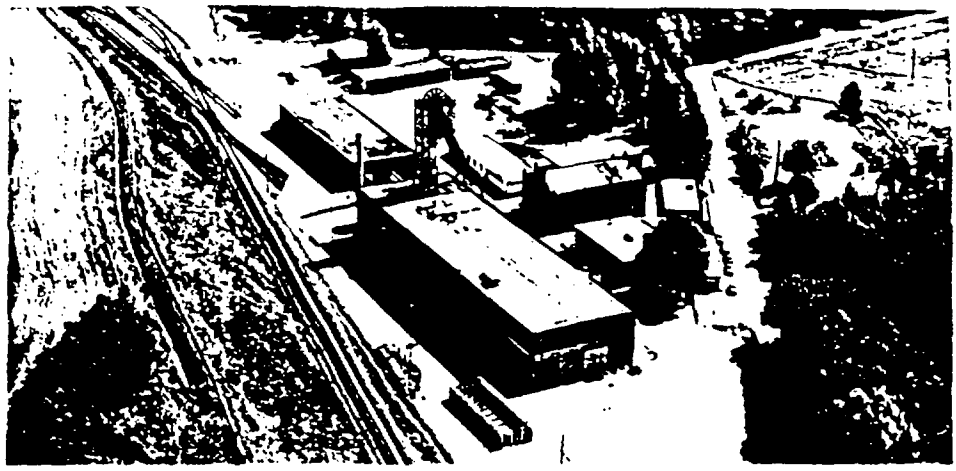
This leaflet was drawn up in cooperation with the Gesellschaft für Strahlen- und Umweltforschung (GSF) and the Bundesanstalt für Geowissenschaften (BGR).

Illustrations made available by GSF, BGR and PTB. Air photographs of the Asse: Stuttgarter Luftbild Elsäßer GmbH. (By courtesy of Reg. Präs. Stuttgart 26.8.1980 No. 9/56527)

Published by

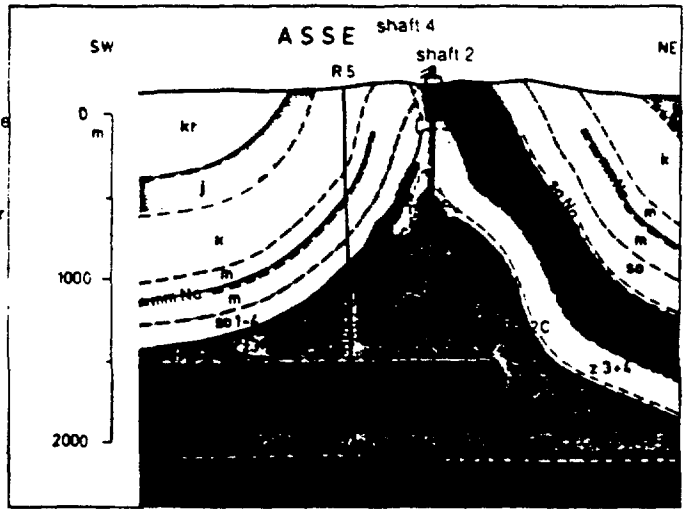
Physikalisch-Technische Bundesanstalt (PTB)
Bundesallee 100, D 3300 Braunschweig
Press and Public Relations of Division SE, Dr. Eckart Viehl

Printed by Fischer Druck-Verlag, Wolfenbüttel
Federal Republic of Germany



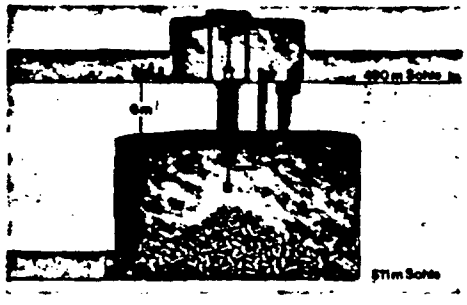
General view of the »Asse« mine (county of Wolfenbüttel)

kr	– Cretaceous
j	– Jurassic
k	– Keuper
m	– Muschelkalk Series
mmNa	– Rock salt in the Middle Muschelkalk Series
so	– Upper Bunter (Roethian)
soNa	– Rock salt in the Upper Bunter (Roethian)
sm	– Middle Bunter
su	– Lower Bunter
K2C	– carnallitite
z2-4	– Zechstein salt
z1-2	– Zechstein – basic strata
r	– Rothliegendes
R5	– Remlingen 5 deep borehole



Geological cross section through the »Asse« anticline in the area of the »Asse« mine.

Tumble down technique for low-active waste



Storage chamber for medium-active waste (»Top loading technique«)

»Stacking technique« for low-active waste in »lost concrete shieldings« in the »Asse« salt mine.

+++++++++ physikalisch-technische bundesanstalt ++ 3300 braunschweig ++ bundesallee 100 ++++++++
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The situation

of the radioactive waste disposal in the Federal Republic of Germany

By the year 2000, a nuclear power station capacity of 30 GW_{el} and a cumulated amount of approx. 300 000 m^3 of conditioned waste from the peaceful use of nuclear power must be expected.

- 30 % of the waste will originate from the reprocessing of spent fuel elements (waste taken back from France; Wackersdorf reprocessing plant, prospective date of commencement of operation 1992),
- 43 % from the operation of nuclear power stations,
- 22 % from research centres and the Karlsruhe reprocessing plant,
- 2 % from industry, research and medicine,
- 1 % from factories of the nuclear fuel cycle (among other things, fuel element production),
- 2 % from the decommissioning of nuclear plants (among others, the Niederaichbach nuclear power station)

About 3 % of this total amount of waste and 10 % of the waste from the planned German reprocessing plant is heat-generating waste. Even with a nuclear power station capacity of 50 GW_{el}, this portion of approx. 3 % would increase to approx. 5 % only.

The Federal Government follows a differentiated programme for the disposal of radioactive waste:

Since 1965, procedures and techniques for the safe disposal of radioactive waste have been developed and tested in the closed-down Asse salt mine near Wolfenbüttel.

Since 1979, the PTB has investigated the Gorleben salt dome with regard to its suitability for the disposal of all kinds of radioactive waste, i.e. the disposal of heat-generating waste has also been included.

Since 1975, investigations into the suitability have been carried out in the Konrad mine; waste with a negligibly thermal influence on the surrounding rock is to be disposed of there.

It is planned to dispose of tritium-containing water originating from reprocessing by sinking it under pressure into deeper geological formations.

The decision as to whether the Asse 2 mine will be used as a repository for radioactive waste will be taken by the Federal Government in 1987. At the moment, research and development work, in particular with regard to the Gorleben plan approval procedure, constitute the focal points here.

A final statement on the suitability of the Gorleben salt dome will only be possible after the underground investigation has been completed (according to the actual state of the plannings, in 1992 at the latest). The evaluation of all investigation results obtained up to now, taking also international and above all American requirements into account, confirms its suitability.

Should, however, the site prove to be unsuitable, a new site could be investigated completely within about 10 years, when the experience gained at the Gorleben site was taken into account and the above ground and underground investigations were carried out to a large extent at the same time. In case suitability was established a repository mine would consequently be available after a construction time of 6 years, i.e. in the year 2008.

The investigation work for the Konrad mine and the drawing up of the plan approval documents have reached an advanced state and will probably be finished by the end of the year with the completion of the whole plan.

The predominant part of the documents, including the specification of the waste which can be disposed of and the proof of safety for the operational phase were submitted on March 29th, 1985 and are already being examined by the plan approval authority and its experts. The PTB expects that a decision on the approval of the plans will be taken in the second half of 1987.

The PTB's safety analyses with regard to the running of repositories have shown that approx. 95 % of the waste volume produced will be suitable for disposal in the Konrad mine. Two different geological formations (salt: Gorleben, Asse; clastic sediments: Konrad) are therefore investigated with regard to their suitability for disposal.

The underground mine area of the Konrad mine at present under consideration allows storage cavities for a waste package volume of approx. 650 000 m^3 to be driven. Depending on the waste package volume to be disposed of every year (approx. 40 000 m^3 have been assumed for the time being and approx. 20 000 m^3 about 5 years after the start of the operation), a running period of more than 20 years results. In the case of a positive decision on the plan approval procedure, the disposal of radioactive waste could be started from 1989.