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MEMORANDUM FOR: Robert E. Browning, Director
Division of Waste Management

FROM: Tilak R. Verma
Senior On-Site
Licensing Representative
Salt Repository Project

SUBJECT: REPORT ON FOREIGN TRAVEL

Attached is the trip report on my travel to FRG. The trip was very useful and provided me with an opportunity to review and discuss the FRG Waste Program.

If you have any questions, please give me a call.

Tilak R. Verma

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Senior On-Site
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REPORT ON FOREIGN TRAVEL

by

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G. Holtz, DBE - Konrad Mine
Hr. Scholer, DBE - Konrad Mine
E. Warnecke, PTB - Branschweig, FRG
H. Schneider, PTB - Braunschweig, FRG
I. Rothemeyer, PTB - Braunschweig, FRG
G. Grubler, DBE - Gorleben, FRG
H. Engeleman, DBE - Gorleben, FRG

U.S. PARTICIPANTS

Robert C. Wunderlich - U.S. DOE, SRPO
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Tilak R. Verma - U.S. NRC

Foreign Trip Report
December 7-14, 1985

ITINERARY

December 8 - Team Meeting, Bonn, FRG
December 9 - BMFT, Bonn, FRG
December 10 - GSF/IFT, Asse Mine, FRG
December 11 - DBE, Konrad Mine, FRG
December 12 - PTB, Branschweig, FRG
December 13 - DBE, Gorleben, FRG

SUMMARY

The travel was undertaken under the auspices of the current U.S./FRG Bilateral Agreement regarding waste management and disposal technology transfer. Specific achievements were:

- The status of U.S. and FRG waste programs was exchanged. Present schedules, priorities, recent progress, and future plans were discussed at length.
- A further understanding of the FRG's planning and rationale for offsite testing being implemented at the Asse, FRG mine was achieved.
- Observation was made of the progress made at Gorleben, FRG on both the repository project and the surface storage facilities.

Monday, December 9, 1985 - Bonn, FRG

The morning was spent with the BMFT who explained the organization and progress of the German Waste Disposal Programs. Individuals contacted:

Dr. Rolf-Peter Randl - BMFT (Federal Ministry for Science and Technology)
Hr. Reinhold Ollig - BMFT
Ms. Maria Van Hess - BMFT

General Information - The FRG has made impressive progress this year. Intermediate storage operations have begun at Gorleben. There is an apparent thawing of the people's attitude on starting new nuclear plants although the emotionalism around Plutonium continues. In November, they started enriching uranium by the centrifuge process. This has reduced the price of enriched uranium and reduced their reliance on other Governments including the USA. The FRG is continuing to plan and design for 500 MTHM/year reprocessing in Southern Bavaria.

Konrad - A license application has been made to use the abandoned Konrad iron ore mine for radioactive waste disposal. The public hearing process will start in March 1986. This facility will be used to dispose of low level radioactive waste (non-heat producing), LAW. These wastes will be placed between 1,100 - 1,300 meters underground as opposed to the U.S. where this type of waste is taken to shallow land burial. A license for disposal of 500,000 cubic meters has been requested.

Asse - The FRG has dropped plans, at least for the foreseeable future, for seeking renewal of the license to dispose of radioactive waste at Asse. Approximately 120,000 drums of waste were disposed of prior to the shutdown in 1978. They intend to use this facility for high level radioactive waste (HAW) research and development.

Gorleben - Two 7.5 meter finished diameter shafts are under construction. They are separated by 150 meters and will be used to explore and perform tests at a depth of 1,100 to 1,500 meters in the salt dome. If the tests prove successful, then the test drifts will be used for repository ventilation which will be constructed approximately 60 meters below the test facility. Gorleben will be used to dispose of reprocessing wastes and some spent fuel elements. Generally, the FRG does not support the direct disposal of spent fuel with the exception of HTGR fuels which are impractical to reprocess. The FRG is also concerned with the future safeguarding of spent fuel because they believe that you cannot guarantee against clandestine removal.

Bob Wunderlich presented a brief overview of the U.S. program and explained the status of the Salt Repository Project.

The late afternoon and early evening were spent traveling from Bonn to Braunschweig, FRG.

Tuesday, December 10, 1985 - Braunschweig, FRG

The morning was spent reviewing and touring the Asse research and development area. Personnel contacted were:

Dr. Tilman Rothfuchs - GSF/IFT
Dr. Hermann Gies - GSF/IFT

Background - Since the cessation of storage at Asse in 1978, this facility has been used to perform research and development on disposal of nuclear wastes in domal salt. A number of major test programs has been conducted to date, including a number of heater tests, brine migration tests with and without radioactivity, a flooded mine experiment, stress meter development programs, etc. In the future, they plan full scale dispoal experiments on doped waste logs used to simulate reprocessing wastes and direct disposal of shielded spent fuel. The FRG is confident that the Asse test results will be directly applicable to Gorleben and plan to do very little confirmation testing at Gorleben itself.

Current Status - The post test plan for the brine migration experiments done jointly between the U.S. and FRG has been approved and the dismantling is underway. Core was observed which had been taken from the test field within the last hour. It takes roughly an hour to package the core with a plastic wrapper. Limited studies are being done on the effects of packaging. Some core was wrapped in an additional layer of aluminum foil to ensure that the properties of the core, such as moisture content, are maintained. No core property differences between the two preparation techniques have been detected to date. Core taken under heated conditions has been shown to be extremely brittle and samples with useful integrity were hard to come by. The Germans feel that salt which has undergone a gradual heat load reduction provides better samples and suffers no change in properties.

There were four heater arrays in the brine migration test. Arrays 3 and 4 had Co^{60} sources to simulate the effects of waste radiation.

The central heaters from arrays 1 and 2 have been pulled and coupons of material have been taken to study corrosion effects. The imprint of aluminum beads could be plainly seen showing that considerable stress was placed on the heaters.

The failed seal area of the heater was observed. This test was a partial failure because these seals malfunctioned during the test. Neither O-rings or urethane plastic worked and the pressurization was lost. The heaters from arrays 3 and 4 are stuck and unable to be extracted. The FRG feels this is due to structural end effects of the test room and gallery entrance and not radiation. The FRG plans to ramp down and excavate the heaters out.

The flooded mine experiment was observed. The brine has been removed in order to replace instruments and take salt samples.

Problem Areas - There are numerous examples of partial or complete test failure due to lack of instrument survivability. The FRG is seriously concerned with this, particularly in the very elaborate test fields planned for the HAW waste tests.

The flat cell pressure (stress) meters apparently failed due to corrosion. The SGS stressmeters, designed by Sandia National Laboratories, either cannot be calibrated or the calibration cannot be maintained. Extensometers have failed due to excessive corrosion of the rods. In many cases, gas generation of H_2S is the culprit. The FRG is concerned with corrosion studies to date because they have always centered around saturated brine conditions and not the normal situation encountered. This is also affecting their deep hole waste test plans because they must trade off retrievability against adversely affecting the tests from excessively thick emplacement tubes (e.g., shielding effects).

In the afternoon we visited the Braunschweig Laboratories of the PTB to discuss with Hr. Staupendahl their experiments on gas generation.

We toured the GSF Laboratory Facilities at Braunschweig. They are conducting a number of experiments in geochemistry and corrosion. These studies include the measurement of trace elements, gas generation, and brine composition of salt under conditions of radiation and increased temperature. Some of the GSF activities are similar to work being performed in the U.S., under the commercial program, by PNL and BNL.

GSF has had some instrument corrosion problems in their experimental program. In particular, the stressmeters corroded, leading to failure of the instruments. The stressmeters were constructed of stainless steel and corroded from the presence of H_2S and humidity.

Approximately 100-200 ppm of H_2S and 10 ppm of HCl have been measured in rock salt prior to being subjected to radiolysis or elevated temperatures. At 200°C decomposition of MgCl, a salt impurity, occurs to produce methane and other hydrocarbons. The level of impurities within the salt is a very important factor in the geochemical reactions within the salt.

Measurement of H_2S, CO_2, hydrocarbons, and HCl is conducted as part of the experiments. H_2S and CO_2 are detected as they are liberated by boreholes and drifts. As much as 1,000 ppm of H_2S can be produced if the salt is heated to 100°C. The results of the experiments are used as input to waste package corrosion studies.

Radiolysis work examines the production of H, O, hydrocarbons, HCl, and Cl. There appears to be some small amounts of HCl produced from radiolysis, but most results from the elevated temperatures. The production of Cl seems to be minor. Using FRG samples of salt and temperatures of 150°C or lower, colloidal sodium has not been a problem. The German experimentors believe that the production of colloidal Na will not be a significant problem in salt because the impurities in the salt will tie up the colloidal Na produced from radiolysis.

Wednesday, December 11, 1985 - Braunschweig, FRG

In the morning we visited the Konrad mine and were briefed by Hr. Scholer, DBE. This is an abandoned iron ore mine which ceased to function in the mid-seventies because of the ore quality. The FRG is planning to buy the mine to dispose of non-heat producing waste (LAW). We toured the underground facilities and were generally impressed with the extremely dry conditions. The mine conditions were dusty. The ore deposit is overlain by several hundred feet of clay making it very dry. One test of interest now underway is a chamber test where dry unsaturated air is pumped in and the increase in moisture content is used to calculate permeability. A new drift is also being constructed for ventilation purposes.

In the afternoon we visited Hr. Warnecke of the PTB and discussed waste acceptance criteria and general items of interest.

Hr. Warnecke stated, when asked, that the PTB as an orgaization is involved in quality assurance and safety. They do relatively little or no design construction work themselves so they feel they have adequate independence to perform qualtiy assurance without establishing additional independent organizations.

With respect to licensing, the PTB should be considered as the applicant to the Government of Lower Saxony which is the licensing authority. The BMFT sets general program requirements and assures uniformity in the licensing process. Also, the BMFT acts as an expert advisor to the states.

Other interesting facts from their studies:

- Dome growth now estimated at 0.0002 mm/year is expected to increase because of heat to 8 mm/year peaking at roughly 50 years. The effect then begins to diminish and at 150 years shrinkage begins due to cooling.

- Quality Control on LAW is part of the contract with waste producers. The PTB retains the right to enter and inspect waste generators. They are in the process of developing a mobile testing station. Random destructive testing may also be used.

Thursday, December 12, 1985 - Braunschweig, FRG

In the morning we returned to PTB headquarters to discuss the Gorleben Program with Hr. Schneider. The surface drilling program has extended over 30 square kilometers:

321 ground water test wells
140 still open for monitoring
44 holes were drilled into the caprock overburned contact area
17 were for surface water monitoring
4 deep drill holes
2 shaft centerline holes
1 deep near-dome hole to investigate hydrogeology (git brine)

In addition, 156 km of seismic profiles have been run.

They feel that salt domes are harder to characterize because of their complicated shape and hydrogeology. The top of the Gorleben dome has actually folded over and moved downward again. There are also different ages of salt within the dome. They still feel that Asse is representative because it is from the same age and has the same facies. The chemistry is also similar although some microstructural differences have been noted. They plan to compare additional drill samples and some limited in situ testing.

In Gorleben, the old and new salts appear to be separated by an anhydrite and carnalite seam which should be avoided because of the water generation when subjected to repository heat loading. They feel a setback from this seam by a few hundred meters is required. This may drive them to a multilevel repository. They have positioned their shafts to avoid the seam and will leave them unlined in salt. Note that, according to PTB, their surface geophysical program has been of little value in characterizing the interior of the dome itself.

Both methane and H_2S gasses have been encountered and continuous gas monitoring is planned. They are using two parallel drifts with crosscuts at 200 to 300 meters.

An existing erosion feature through the caprock is actively undergoing dissolutioning. They have made calculations to determine the extent of dissolution.

In May, 1984 they started freeze hole drilling of the shafts. Shaft Number 1 is now being frozen with Shaft Number 2 approaching the start of freezing as soon as the freeze gallery is completed.

February or March is the expected start date for shaft sinking (completion of freezing). Shaft Number 2 is lagging behind because of drilling difficulties when they encountered clays which prevented casing the holes.

Freezing will extend 60 meters into the top of salt. They have some concern with microfractures in salt but construction experience has shown freezing into the salt is necessary. Mapping of shafts and drifts is planned.

Licensing documentation will be worked in parallel with the exploratory work. It is intended to use the exploratory drifts as ventilation drifts for the repository which will be located 30 to 40 meters deeper.

They expect 1-1/2 to 2 years will be required from the final license application to receipt of the license. During this time they will do confirmatory testing between Asse and Gorleben. Under FRG law, additional data can be supplied up to the time a license is granted. This would not include basic changes to the framework of the program particularly on nuclear or mining safety related items.

The field work is being performed by the DBE which is a company formed at the request of the FRG government. The principal partners are Thyssen and Diamond. The work was not completed as we know it in the U.S. The DBE will do third party quality assurance in the field as well as other work related responsibilities. Shaft sinking is done by ASG as a joint venture under contract to DBE.

In the afternoon we drove to Gorleben via Gartow, where we briefly visited one of their public information offices. We were briefed by Hr. Meyer, DBE, on the history of public interactions surrounding Gorleben. The Luchow/Dannenberg region of the FRG has 48,000 inhabitants on 1,4000 km^2. There are 27 people per km^2 versus 250/km^2 for Germany as a whole. The unemployed in the area is roughly 25% and agriculture employs 30%.

In 1977 Gorleben was named as the repository site. The population is divided in its support of the project and they have had no large demonstrations by the local citizens. Public interaction is important in their effort to educate the public and the DBE, PTB, State, and Federal Governments all maintain information centers. In addition, they concentrate on hiring locally as much as possible.

We received a tour of the Gartow information center and were impressed with the quality of the exhibits.

Friday, December 13, 1985 - Gorleben, FRG

Our last day was spent touring both the surface storage facility and the repository construction at Gorleben.

We were met in the morning by Hrs. Grubler and Engleman of the DBE who made a presentation followed by a tour of the Gorleben Repository work.

Attachment 1 shows the detailed schedule for Gorleben construction. Attachment 2 shows the surface facilities plan.

The exploratory shafts are being conventionally sunk (drill and blast) using a freeze wall to control water. Their design is similar to the one proposed for use at the Deaf Smith site. They have a unique operation involving cutting a slot to protect the shaft walls from blast damage, see Attachment 3 for details.

The shaft liner and seal design shown on Attachment 4 are very similar to that proposed for Deaf Smith. A wedge shaped block with compressible wood strips is placed through the frozen zone for temporary protection only. No credit is taken for strength of the block in final liner design. The liner is a sandwich of un-reinforced concrete and steel plate. The void between the liner and rock or block walls is filled with hot bitumen at roughly 150°C. When this cools it has a consistency of honey and slowly fills the voids. Additional bitumen can be added from the top. The entire liner is designed to be supported from the liner foundation or key. The design bearing load in salt is 350 kg/cm^2. The foundation is below the projected salt fracture zone which may result from the freezing effort; freezing causes a temperature gradient from 25°C at the freeze pipes to +40°C natural salt temperature. This fracture zone is calculated to be 10m to 20m thick. See Attachment 5 for the grouting method being planned for the fracture area.

Exploratory drifting is planned as shown in Attachment 6.

H. Engleman explained the FRG program planning effort for deep injection of tritium wastes and for design of a repository for spent fuel.

After the extensive site tour, conducted by H. Grubler and H. Engleman, a brief tour was provided of the dry surface storage facility which is located immediately across the road from the planned repository. This facility is in the last stages of licensing for HAW using the Castor Cask, which is used for both waste shipment and storage. In addition, the facility also stores LAW in drums, an operation which is already underway.

The tour at Gorleben concluded our tour of the FRG waste operations.

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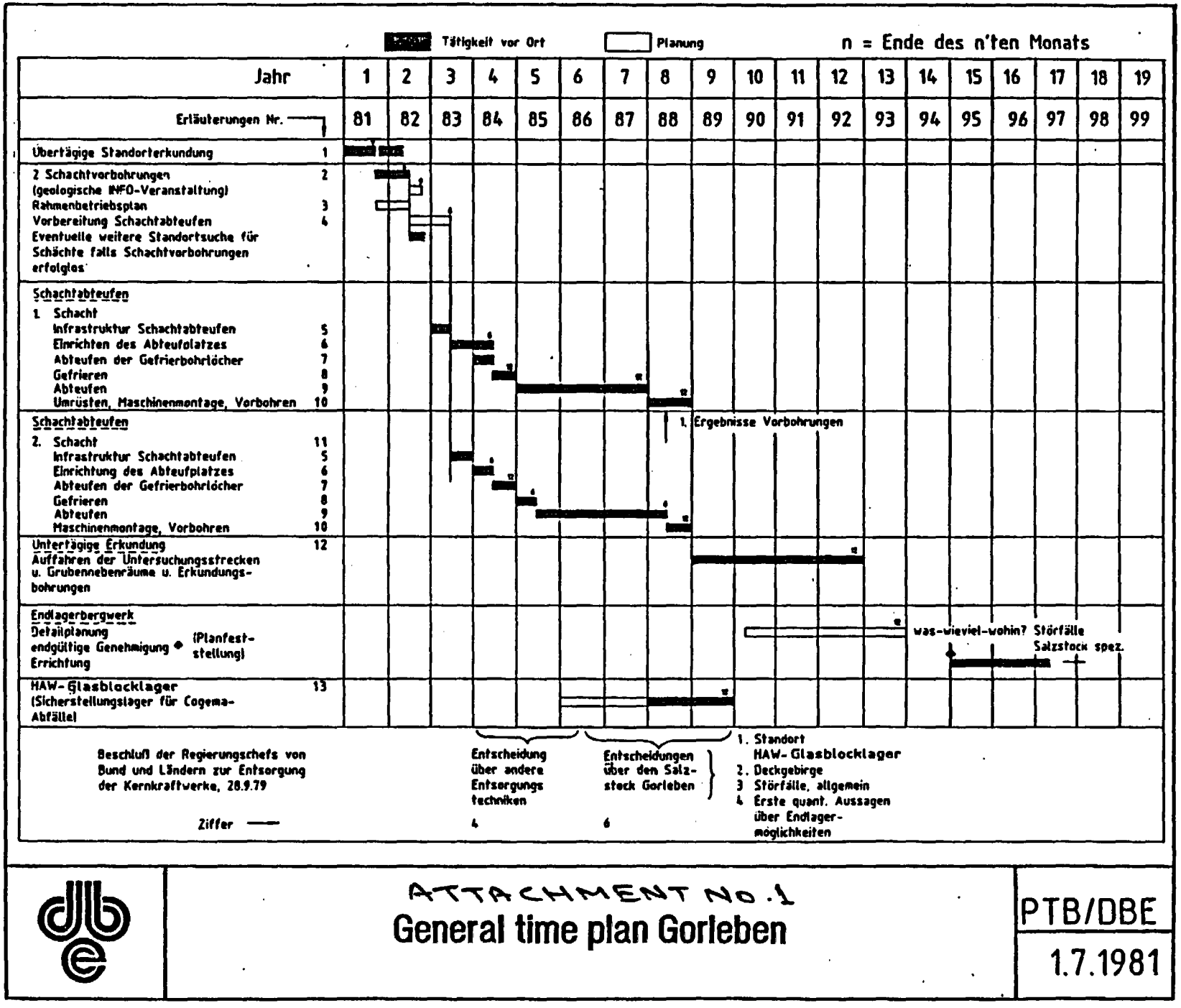


ATTACHMENT NO.1

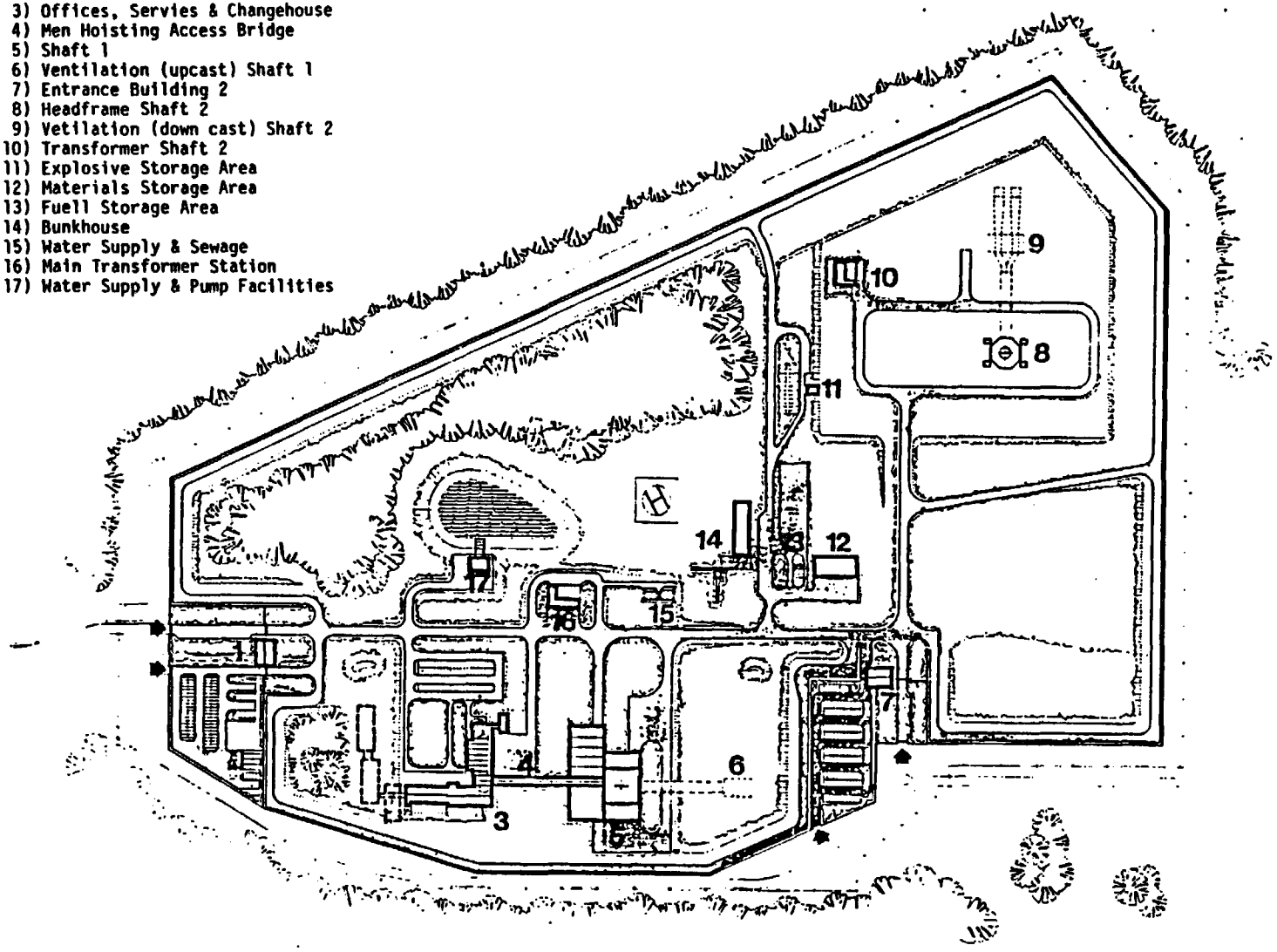
General time plan Gorleben

PTB/DBE

1.7.1981

Legend
1) Entrance Building 1

3) Offices, Servies & Changehouse
4) Men Hoisting Access Bridge
5) Shaft 1
6) Ventilation (upcast) Shaft 1
7) Entrance Building 2
8) Headframe Shaft 2
9) Vetilation (down cast) Shaft 2
10) Transformer Shaft 2
11) Explosive Storage Area
12) Materials Storage Area
13) Fuell Storage Area
14) Bunkhouse
15) Water Supply & Sewage
16) Main Transformer Station
17) Water Supply & Pump Facilities

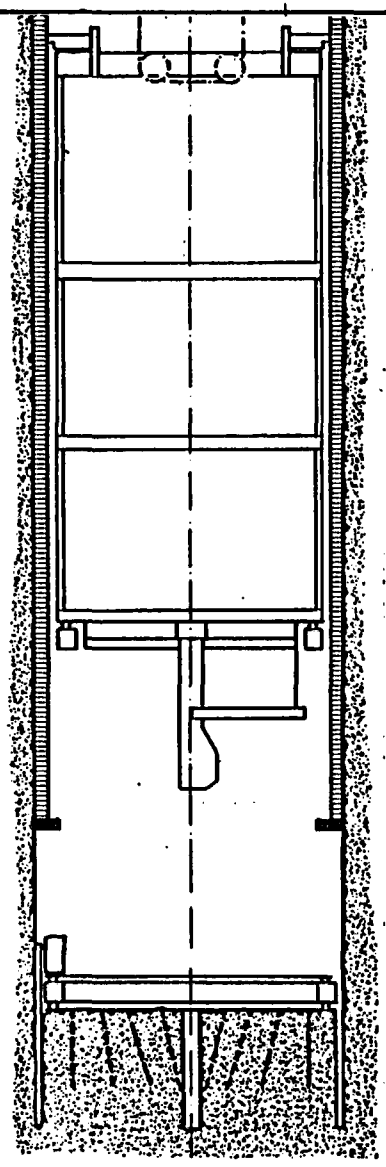


ATTACHMENT No. 2

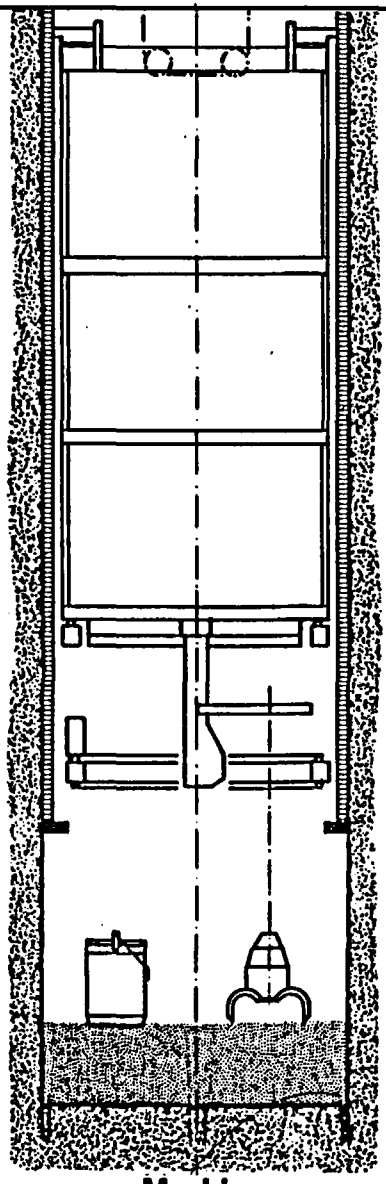
Surface Facilities - Gorleben

1985

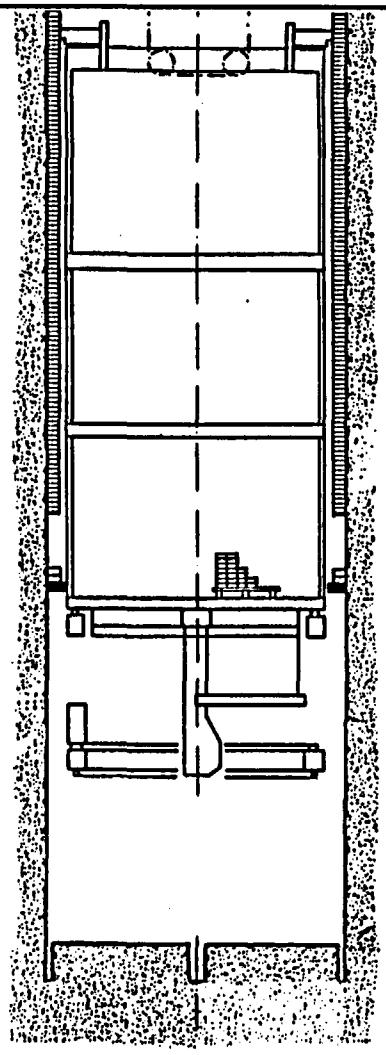
P - G



Cutting and drilling



Mucking



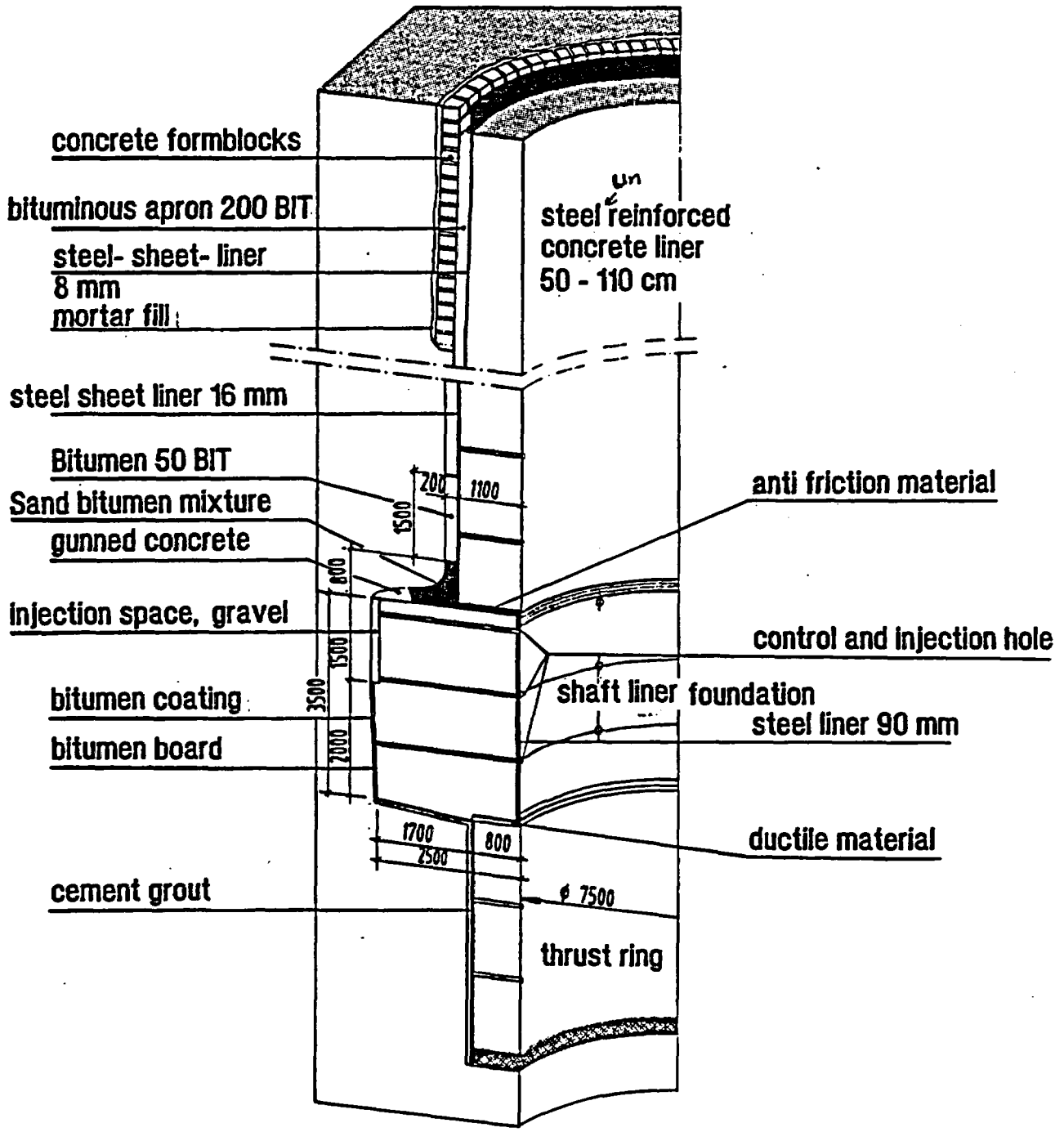
Preliminary Lining

ATTACHMENT NO. 3

Shaft Sinking Procedure

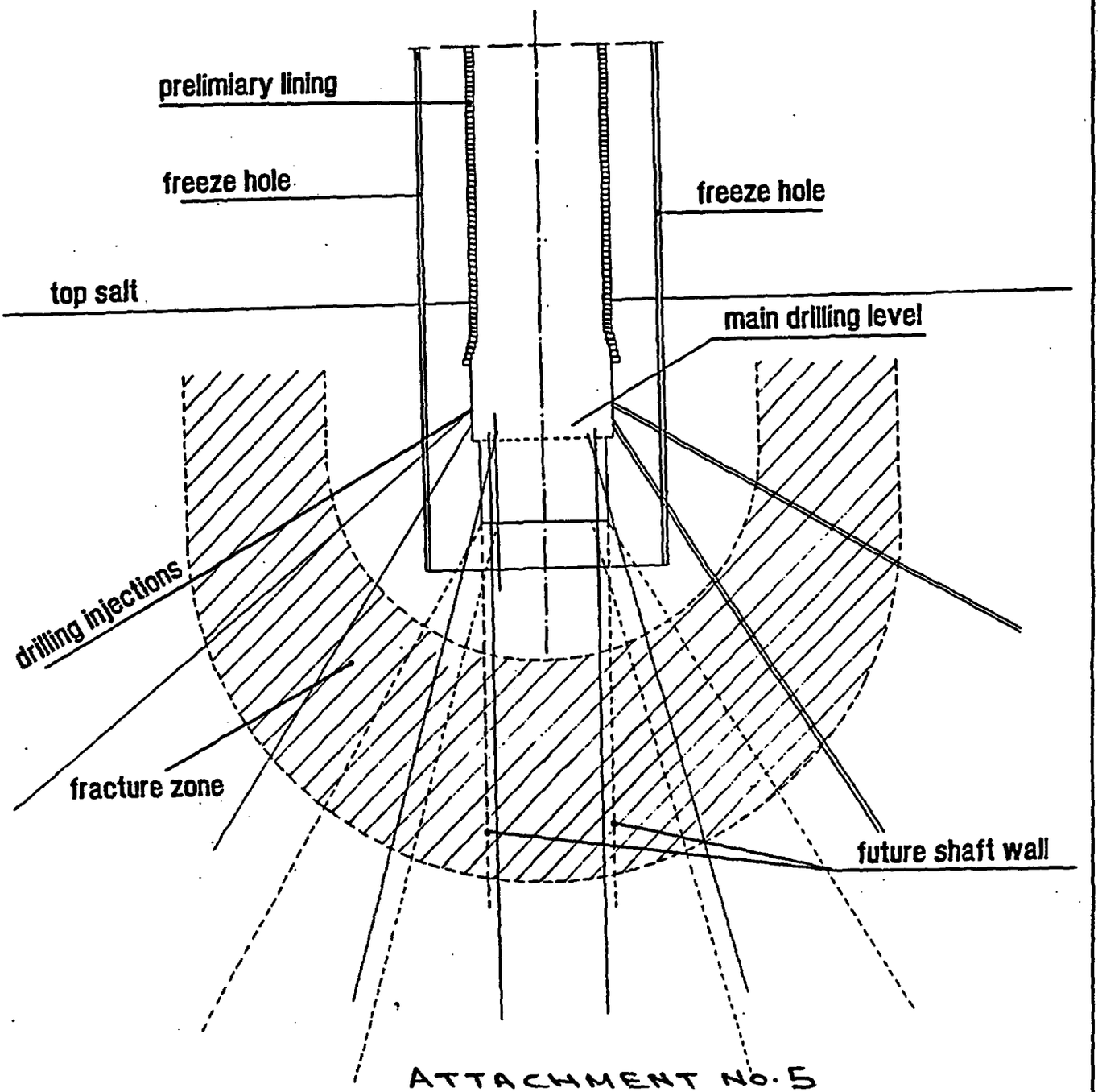
P - G

1985



ATTACHMENT NO. 4

	Final lining of freeze shaft	1985 P - G



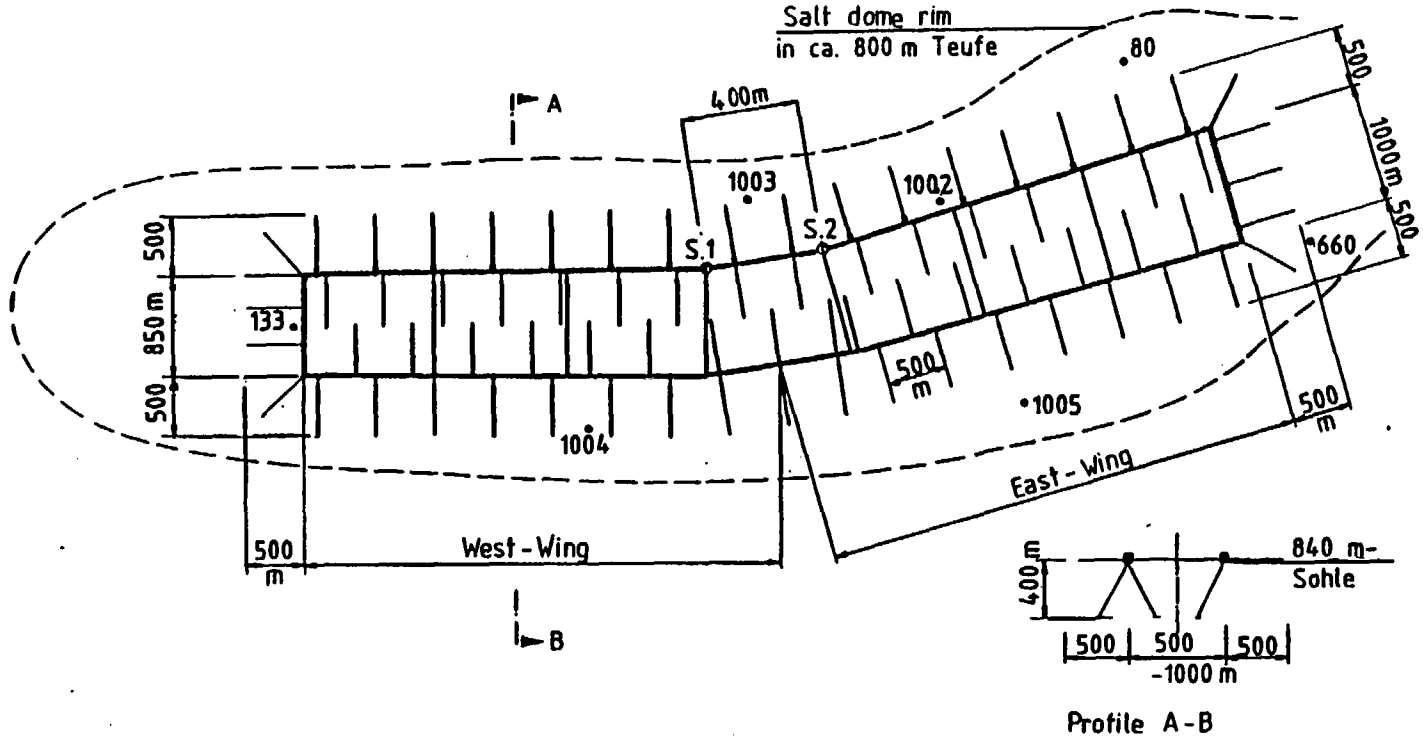
ATTACHMENT No. 5

Freeze shaft in rock salt

(from: Kali und Steinsalz)

1985

P - G



Profile A-B

ATTACHMENT NO. 6

Exploratory Drilling - Drifts

1985

P - G