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REPORT ON OFFICIAL TRAVEL

SALT PROJECT TEAM

visit to

FEDERAL REPUBLIC OF GERMANY

and

BELGIUM

to discuss

NUCLEAR WASTE ACTIVITIES

April 23 - May 4, 1984

00585

TRIP REPORT

Visit to

FEDERAL REPUBLIC OF GERMANY AND BELGIUM

April 23 - May 4, 1984

A team of seven people associated with the U.S. DOE salt project visited facilities in the Federal Republic of Germany (FRG) and Belgium. The trip started on April 23 and was completed on May 4, 1984. The objectives of the team visit were to (1) tour the underground and surface facilities related to nuclear waste disposal in Germany and Belgium; (2) discuss possible cooperative activities with the Germans, Belgians, and the European community; and (3) establish the process for agreement at the German-U.S. bilateral meeting in late August on activities to be performed in support of salt. Nuclear waste disposal activities in these countries are very similar to many of the activities planned for the Salt Repository Program. The FRG waste disposal program includes disposal of HLW in salt. The Belgium program is of interest principally because of the freezing technique used to construct their shaft.

Members of the U.S. team are:

NAME	ORGANIZATION
Critz George Jefferson O. Neff	U.S. Department of Energy Headquarters Salt Repository Project Office
John Greeves	U.S. Nuclear Regulatory Commission
John W. Green	Mississippi Energy & Transportation Board, Nuclear Waste Division
William Klemt	Texas Department of Water Resources
Stanley Goldsmith	Battelle-Office of Nuclear Waste Isolation
Glen A. Stafford	Parsons-Redpath

Facilities and individuals visited during the trip are listed below.

Date	Agency/Facility	Principal Individual(s) Contacted*	Topic
4/25	GSF-IfT/Asse Mine	Klaus Kühn	German waste disposal program; R&D activities at Asse; Cooperative program
4/26	PTB/Konrad Mine	H. Röthemeyer	Nuclear waste storage and disposal
4/27	DBE/Gorleben DWK/Spent Fuel Storage	A. Jacobi W. Pitz B. Getzeina	Site characterization at the Gorleben site; spent fuel storage
4/30	BMFT	R. Randle	Bilateral agreement; Waste disposal program
5/3	CEN/SCK/Mol	P. DeJohnge Bahner	Belgium waste disposal program; Shaft construction
5/4	CEC	S. Orlowski	CEC sponsored waste disposal activities; Information exchange

* Copies of business cards of attendees at meeting are shown in Attachment 1.

The objectives of the meeting were achieved. The team members were able to visit the pertinent facilities and can now represent them to their respective organizations. All of the meetings led to informal agreements on exchange of reports and other information. Finally, a specific action has now been undertaken to provide for specific agreements at the German-U.S. bilateral meeting in late summer for cooperative activities in the evaluation of salt as the geologic host rock for nuclear waste disposal.

Details of these visits are presented below.

ATTACHMENT 1

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Date: Wednesday - April 25, 1984

Location: Asse Mine, Lower Saxony, Germany

Purpose: In situ Testing Program in the Asse Mine

Participants: J. Neff & C. George, DOE; J. Green, Miss.; W. Klemt, Tx.; G. Stafford, P-R; S. Goldsmith, Battelle-ONWI; J. Greeves, NRC; and K. Kühn, GSF/IfT

Discussion:

Klaus Kühn presented an overview of the German waste programs. The organizations involved in the program and their interrelationships are shown in Attachment 2. Research and development activities on waste disposal are the responsibility of GSF which is accountable programmatically to BMFT and financially to BMWi. Kühn is in charge of all Asse operations and R&D activities.

GSF is responsible for developing and demonstrating all technology to be used in waste disposal. Operations at Gorleben and Konrad will only employ proven technology. The Konrad mine, an iron mine no longer being mined for iron ore, is being developed for disposal of LLW and ILW. The Gorleben salt dome is the site selected in Lower Saxony for the disposal of HLW and possibly LLW and ILW. Adjacent to the Gorleben site are interim storage facilities for HLW (1500 MT) and LLW.

In 1965 GSF was assigned responsibility for R&D for waste disposal in salt. The Asse mine is being operated as a test and evaluation facility. It was used for LLW disposal starting in 1968. Disposal of LLW in Asse was discontinued in 1978. Disposal between 1968 and 1978 was done only under the mining laws. The Asse mine was "grandfathered" from conformation to the provisions in the 4th Amendment of the German Atomic Act of 1976. Current and planned activities in Asse do not require licensing--other than conformation to German mining law.

Asse Dome and Mine

Following are data on the Asse salt dome and mine:

- Dome is ~6 Km long and 1.5 Km wide
- Age ~220 million years (Folding ~70 m years)
- 40-50 meters of very dense, low moisture caprock over the dome
- Brine content - 0.04%
- No gas pockets found
- Several large carnolite seams present

- Brine pockets only infrequently found
- Salt mine started in 1906; used to mine salt and potash until 1924, then concentrated on salt mining only
- The mine contains a total of 130 rooms on 13 levels
- Salt mining stopped in 1964
- Room sizes 60 x 40 x 15 m high.

A total of 125,000 LLW drums (25,000 cu. m) have been disposed in Asse mine at the 725 m level.

Asse Test

Most tests in the Asse mine are located at the 750 m level. Salt temperature at this level is 37 C. Tests are to establish in situ thermal-mechanical properties of the salt. Several methods for measuring stress have been tried (including flat jacks and hydraulic fracturing). GSF has obtained test results with hydrofracture method. Kühn stated that reports of this work have been sent to ONWI.

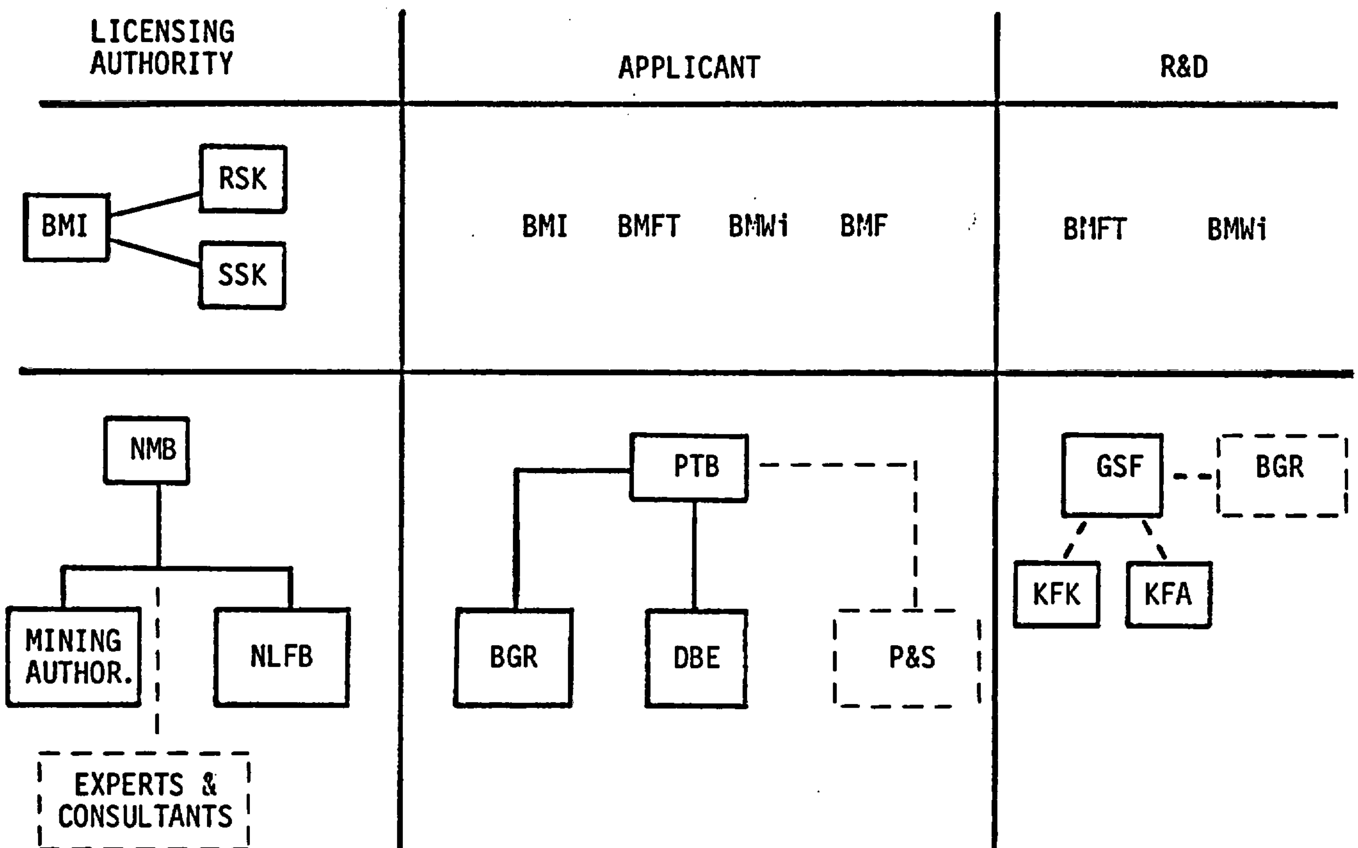
Heater tests currently under way use a 10 m test train with seven heater elements. Total heating capacity of test train is 720 kw. Test is designed to yield maximum salt temperature at borehole wall of 200 C.

Tests with the four heater elements provided by ONWI as part of the bilateral project agreement are operating satisfactorily. All instruments and data collection equipment is operating as planned. Tests without Co^{60} sources started in May 1983. The two elements with Co^{60} sources started in December 1983. Results of tests to date are as expected, except a larger amount of hydrogen is being released in the heated-only tests than in the heated and irradiated tests. There was no good explanation for this. There is some concern as to how long the data recording system will last because it is operating very close to its design temperature (45 C).

The proposed high level waste test would be conducted at the 790 m level. Test rooms (chambers) are currently being mined. The test would involve using 30 glass logs produced by PNL. The logs would be doped with Strontium -90 and Cesium 137 to yield salt temperatures (at borehole surface) of 150 C, 200 C, and 250 C. Test time will be between 5 to 10 years with test schedule to start in 1987. Glass logs are about 30 cm in diameter by 100 cm long. Test would provide information on long-term irradiation effects, pillar deformation as function of heat loading, stress conditions, and underground handling methods for highly radioactive containers.

ATTACHMENT 2

PRINCIPAL ORGANIZATIONS IN GERMAN WASTE DISPOSAL PROGRAM



LEGEND:

- BMI - Federal Ministry of Interior
- BMFT - Federal Ministry of Science & Technology
- BMWi - Federal Ministry of Economics
- BMF - Federal Ministry of Finance
- NMB - State Licensing Agency
- PTB - Federal Science & Engineering Lab (roughly equivalent of U.S. NBS)
- BGR - Federal Institute for Geosciences and Natural Resources (corresponds to USGS)
- RSK - Reactor Safety Commission
- SSK - Radiation Protection Commission
- GSF - National Lab in charge of waste disposal R&D
- KFK & KFA - Other national labs involved in waste disposal R&D
- DBE - German company responsible for construction and operation of waste disposal facilities
- P&S - Owners of Konrad Mine

Date: Thursday, April 26, 1984

Location: Braunschweig, Lower Saxony, Federal Republic of Germany (FRG)

Purpose: Review of the Physikalisch-Technische Bundenstadt (PTB) Activities and Tour of the Konrad iron mine.

Participants: Dr. H. Röthemeyer, Dr. E. Warnecke, Dr. H. P. Berg, W. Tebbe, PTB; Dr. Künz, GSF; J. Neff and C. George, DOE; J. Green, Miss.; W. Klemt, Tx; G. Stafford, P-R; J. Greeves, NRC; and S. Goldsmith, Battelle-ONWI.

Discussion:

The PTB is a national institute for science and technology. It is very comparable to the U.S. National Bureau of Standards. By an act of the Federal parliament, the PTB was assigned the responsibility for storage of nuclear fuels and radioactive waste. This includes the establishment and management of installations for storage and terminal disposal of radioactive waste.

There are 10 divisions in the PTB and it is the SE (Sicherstellung and Endlagerung) division that is responsible for nuclear waste. Dr. Röthemeyer is head of this office and he gave a brief discussion of overall PTB - SE responsibilities. An interestig aspect of their role is that for storage and transportation, PTB is the licensing authority, while for disposal they are the applicant and the states are the licensing authority (in the case of Konrad, Gorleben, and Asse they are all in the state of Lower Saxony). In those cases where PTB is the applicant (Konrad/Gorleben) then an application plan is submitted to both the state nuclear licensing authority and to the state mining authority. The plan is also submitted to a Federal authority that oversees the state authorities. And in both cases various administrative and civil processes work somewhat similarly to those in the U.S. The site investigation phase, however, at both Gorleben and Konrad are licensed only by the mining authority.

The FRG expects to have 30,000 MW(e) of nuclear power in 2000 and to eventually peak at 50,000 MW(e) in the next century. Two basic disposal facilities are now planned--Gorleben for all potential waste, LLW, TRU, HLW and the Konrad mine for all LLW and TRU wastes. Current emphasis in the FRG program is to develop and license the Konrad site by 1986 and to operate it in 1988. The license application was submitted on 8/31/82. Asse is now viewed by the FRG as an R&D facility where technology will be proven for Gorleben and Konrad. Apparently this decision was made by the Federal Government this year to define Asse basically as a test and evaluation facility.

The FRG has also made a decision to proceed with a small reprocessing facility of ~350 MT/year. The site of this would either be in Wackerdorf, Bavaria or in Dragahn, Lower Saxony. The Dragahn site is only 10 or so kilometers from Gorleben.

The PTB was particularly interested in the status of the salt, tuff, and basalt program. During our presentation of the U.S. program, they asked many questions on how the decision to choose three sites would be made. They asked about the EPA standard and the NRC rule and the DOE guidelines. Copies of the EPA standards (draft 3) and the NRC rule were left with them. Considerable questioning was raised over the NRC rule and it was apparent that the Germans are very concerned regarding the nature of criteria used in America as these criteria are used by their critics.

Several items of interest from the morning session include

a. The Germans do not desire retrieval capability in either Konrad or Gorleben

b. No human intrusion scenarios are assumed for the repositories

c. Konrad will be capable of accepting 800,000 m^3 of LLW and TRU

d. Any future leakage from the repository would be such as to limit doseage to less than 30 mR/yr.

In the afternoon we toured the Konrad mine. The Konrad mine is an abandoned iron ore mine near Salzgitter and is currently under investigation for the potential disposal of LLW in drums or concrete canisters.

Konrad was developed and operated between 1958 and 1976. It has 2 shafts (7 m I.D.) and can accommodate large cages and large weights (2.4 m x 2.4 m x 6 m, 20 MT). It has workings at the 1000 m, 1100 m, and 1200 m levels. Initially, mining for the iron ore was by room/pillar technique, in later stages it was by LHD (load, haul, dump). The iron ore seam sits in a sedimentary basin with clay and mudstone surrounding it. The central part of the mine ore seam is 12-15 m thick and dips to the West at angles as great as 20°. The mine still has large virgin areas which can be developed as a repository.

Work to date in Konrad has concentrated on geomechanical factors, deformation measurements, in-situ stress measurements, and seismic measurements. On the basis of this information, designs have proceeded to the point that a reference concept for disposal is defined. This design calls for a system of parallel orientated galleries to be positioned horizontally between main levels in the strike of the ore. Sections between main levels will have ventilation raises. The annual acceptance rate of the mine will be ~25,000 two hundred liter drums or 10,000 four hundred liter drums with concrete shielding on the basis of single shift operation.

A considerable amount of testing of mechanical properties and mine behavior is going on at Konrad. It was not possible to get a feel for the type of performance assessment that was being done in parallel. This apparently is the responsibility of the Federal Geologic survey and we did not visit their offices.

Date: Friday, April 27, 1984

Location: DBE offices in Peine during the morning and Gorleben repository project site in the afternoon (see map, Attachment 3)

Purpose: Discussion on the Gorleben repository project by DBE and site visit to Gorleben.

Participants: A. Jacobi, Managing Director, Surface Facilities, DBE; W. Pitz, Managing Director, Underground Facilities, DBE; Dr. Wolfgang Schorr, Information Officer for Nuclear Disposal; J. Neff and C. George, DOE; J. Greeves, NRC; J. Green, Miss; W. Klemt, Tx; S. Goldsmith, Battelle-ONWI; and G. Stafford, P-R.

Discussion:

Messrs. Arno Jacobi and Wolfgang Pitz, mining engineers with Deutsche Gesellschoft Zum Bau Und Betrieb Von Endlagerm Für Abfallstoffe MBH (DBE), provided an overview of the Gorleben project to date. Mr. Jacobi is responsible for all surface facilities and Mr. Pitz is responsible for subsurface facilities.

The site is located on the eastern border of West Germany, near the town of Gorleben. The Elbe River borders the site on the east and is the border with East Germany. The Gorleben salt dome underlies the site and is approximately 15 km long and 3 km wide. Part of the dome runs under the Elbe River and into East Germany.

The overburden material is mostly sands and gravels with groundwater at a depth of about 4 meters. The site characterization activities have identified up to five separate aquifers within the overlying deposits. The sands and gravels are glacial deposits and form an irregular boundary with the caprock and dome. The average depth of the overburden material is 250 meters.

The caprock is generally 20-40 meters thick, however, it is absent in some areas. This absence has been attributed to glacial erosion. The salt dome extends down below 2000 meters. Four deep holes (2000 m) have been drilled on the flanks of the dome, and additional shallow boreholes at 120 separate locations (with three piezometer holes at each location), have been used to characterize the site. The shallow holes were drilled 80 meters into the salt. Two additional deep holes were drilled as pilot holes for the exploratory shafts. The groundwater flow is towards the east and it is estimated (conservatively) to take 600-1170 years to reach the surface east of the dome.

The exploratory shafts will be constructed full production size (7.5 m I.D.) and ground freezing will be performed prior to shaft sinking to stabilize the saturated overburden soils. Additional details on shaft construction are given in Attachment 4. The freeze holes (42) will be drilled 10 m into the salt dome at a diameter of 17.5 meters. Freeze holes will be 8.5 inches in diameter and the liquid used will be at -40 C. The pilot hole drilled in the center of the shaft will serve as a stress relief hole and three additional holes will be drilled to monitor the temperature. The first freeze hole is to be started on May 15, 1984. Once all freeze holes are in and operating it takes 12 weeks to freeze the overburden material and conventional drill and blast construction will begin at the end of this period. The second shaft will be started 6 months after the first shaft with the same technique and equipment.

The shaft will be constructed by Thyssen/Schachtbau and Deilmann-Haniel GmbH. As the shaft is excavated prefabricated concrete blocks (about 40 lb.) will be used to line the shaft on the way down. These blocks will be wedged into place with thin sheets of pressurized wood which swells when saturated. This method will be extended 50 meters into the salt. At this depth a thick seal will be constructed.

After completion of the shaft into the salt with the concrete blocks the permanent liner will be installed. Construction will start from the bottom and proceed up. The liner includes a welded steel section with concrete on the inside face (thickness varies from 50 cm at the top to 120 cm at the bottom) and a bituminous seal (20 cm) between the prefabricated blocks and the steel section.

Additional points made during the presentation include the following:

- A safety zone of 50 meters will be maintained on the sides of the dome during construction.
- The surface area required for construction is 30 hc.
- Site characterization included extensive geophysical testing.
- The Gorleben site investigation is licensed under the state Mining Authority; a later application will have to be made for repository operation after the in situ investigation.
- The Mining Authority requires two shafts for safety reasons and the repository design is limited to two shafts to minimize the number of penetrations to the repository level.
- Gorleben is being designed to receive up to 1400 to T/yr of radioactive waste (all types of radioactive waste will be placed at Gorleben).
- HLW holes will be drilled in the floor of repository drifts at the 800 m level. These holes will be 300 meters deep and will be loaded with several canisters. There are no requirements for retrieval. Holes will be 57 meters apart.
- The maximum temperatue will be 200 C at the borehole wall.
- Site investigation includes 25 km of drifting and 50 km of horizontal boreholes.

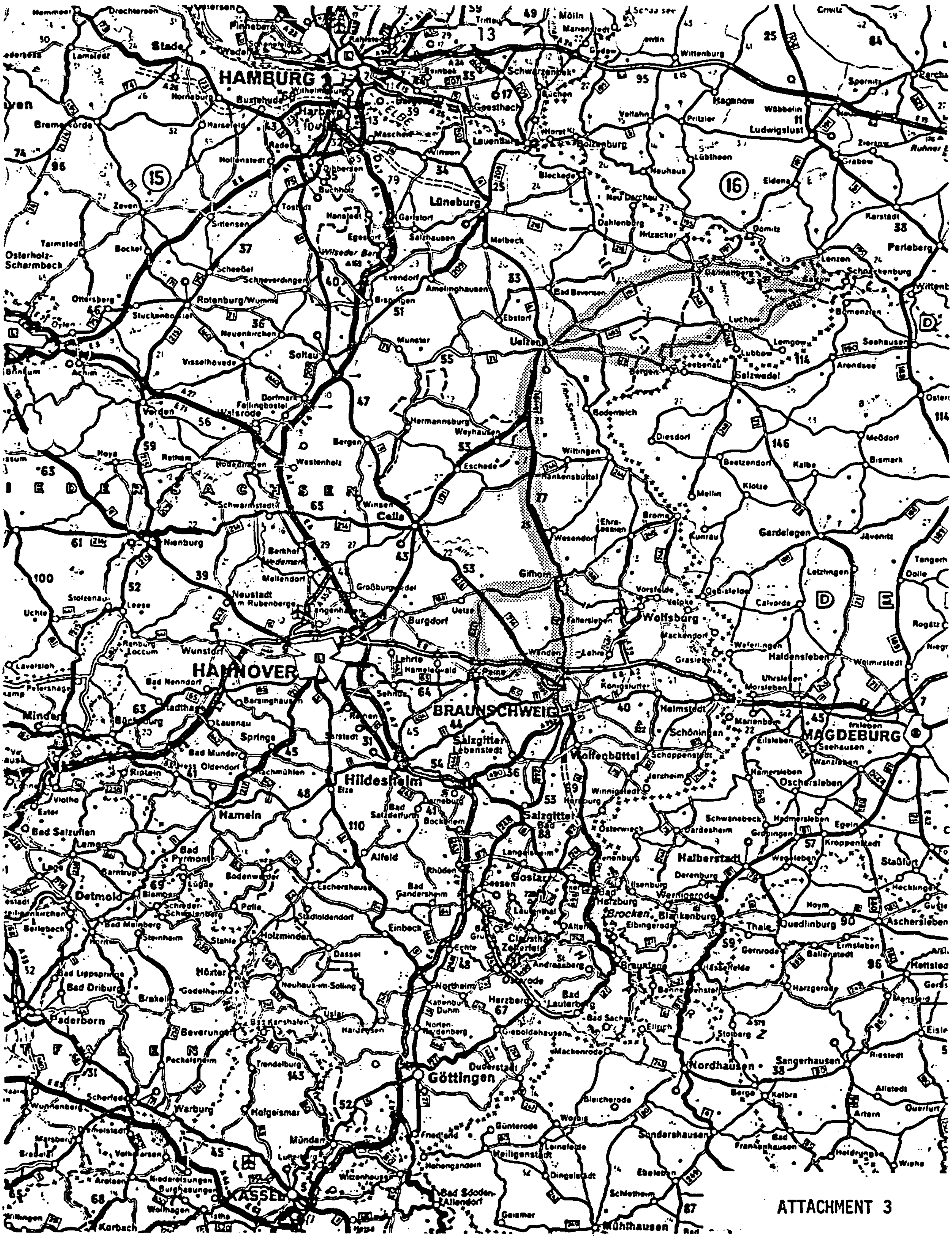
Gorleben Site Visit

During the afternoon of April 27 we visited the Gorleben site and vicinity. The site visit included stops at the Elbe River (where a water sample was being taken from a well) and a visit to the exploratory shaft construction site. The following points were made at these locations.

- It is common practice in FRG to drill separate wells for sampling different hydrologic units.
- Well covers are welded shut between readings to protect against vandalism.
- The exploratory shaft site is surrounded by construction of a high (~15 feet) concrete wall. Fortification requirements will cost about 17 million marks (~$6.8 M).
- The first exploratory shaft location has been graded and utility construction is under way. Utilities will be placed in a large concrete duct which can be entered from the top for repairs, etc.
- A large housing facility for 100 policemen is under construction.
- The site construction crew will be about 100 people.
- A water pond (approx. 1-2 acres) is in the center of the construction site.

At the end of the Gorleben site visit we toured the adjacent AFR facility which is due to begin operation next month. This is a large concrete walled facility which will store both spent fuel and low level waste drums. The spent fuel facility is an enclosed building (180 m x 40 m x 20 m) designed to allow natural ventilation through vents in the side of the buildings. The concrete walls are about 12 in. thick. The cost of this facility was approximately 50 mil. DM ($20 M).

The low level waste facility consists of six enclosed concrete bays. Each bay is approximately 15 ft. high, 30 ft. wide, and 200 ft. long. Low level waste drums will be stacked in these bays. Drums will contain low level waste solidified in concrete. The cost of this facility was approximately 30 mil DM ($12 M).



ATTACHMENT 3

SINKING OF THE SHAFTS AT GORLEBEN, WEST GERMANY

Geologic investigations of the Gorleben site showed that above the salt dome there are about 40 metres (130 feet) of caprock and 250 meters (820 feet) of unstable and unconsolidated formations extending all the way to the surface. These hazardous ground conditions dictate that a special technique has to be applied to temporarily secure and stabilize the geology during the shaft sinking and lining operations.

1. Securing and stabilization of the unstable ground

The ground freezing method will be used to stabilize the unstable water-bearing formations to a depth of about 290 metres (950 feet) during shaft sinking and installation of the permanent lining. Ground freezing uses refrigeration to convert in-situ pore water to ice. This ice fuses the soil particles together, increasing their combined strength and making them impervious. A cylindrical ice wall is formed around the periphery of each shaft. This allows safe shaft sinking by providing a stable support and ground water control system. The ground freezing method of shaft sinking has been successfully utilized over several decades and the extensive experience available and the reliability of this method enables detailed planning of time and economic factors.

At Gorleben, the finished diameter of the two shafts will be 7.5 metres (24.6 feet) and the final depths will be approximately 850 metres (2,800 feet) and 900 metres (2,950 feet). To create the freeze wall at each shaft, 42 freeze pipe holes will be drilled from the surface, through the cap rock and about 10 metres (33 feet) into the salt. The hole diameter will be 8.5 inches and holes will be equally spaced around the planned shafts on a diameter of 17.5 metres (57 feet). This means the distance between holes will be about 1.3 metres (4.3 feet). Also, three temperature monitoring holes will be drilled near the freeze ring and one relief hole will be drilled on the shaft center. To ensure positive and uniform closure of the freeze wall, accurate drilling is vital and continuous monitoring and correction will be required during drilling of the freeze pipe hole. Refrigeration pipes of about 7 inches diameter will installed in the holes to a depth of about 290 metres (950 feet). 2.5 inch diameter down pipes will be lowered into these and the refrigeration pipes connected to the main manifold lines, and coolant - usually calcium chloride brine - at approximately -40 deg. C (-40 deg. F) will be pumped through the circuit. Circulation of the cold brine causes a continuous extraction of heat from the ground. Figure 1 shows the brine circulation system.

Initially, a cylinder of frozen ground forms around each pipe and as circulation continues, the frozen cylinders grow and when they merge a continuous freeze wall is formed. The freeze wall will then have to thicken further until the desired thickness is attained to allow excavation to begin. Figure 2 show the freeze wall formation process.

Special measurement techniques will be used to monitor the freezing process at all stages. The brine flow and ground temperature are continuously monitored and ultrasonic measurements are used to check the progress, extent and continuity of the freeze wall.

2. Sinking and lining in the unstable strata

The initial starter shaft or foreshaft will be sunk as an open excavation. This allows the installation of the normal shaft sinking equipment, i.e. sinking headframe, sinking stage, hoist ropes, etc. Above the water table a watertight lining is not necessary and a concrete lining to withstand earth pressure will suffice. Below the water table the freeze wall will provide adequate support to allow installation of a preliminary lining.

Excavation in the frozen shaft section must be carried out carefully by loosening of the ground with jackhammers and controlled blasting techniques to avoid damage to the pipes or the freeze wall . Muck is removed with a grab and muck bucket.

The preliminary lining will be reinforced concrete or prefabricated concrete blocks. The prefabricated blocks will be used in the frozen shaft section and by placing chip boards between the blocks, in the horizontal and vertical joints, a "flexible" lining is produced. This will minimize damage of the final lining due to ground movement since the chip boards compress and allow a certain degree of movement of the ground. A thin mortar backfill provides intimate contact between the blocks and the frozen ground. Figure 3 shows the installation of the preliminary concrete block lining.

The expected strata movements due to the mining activities around the shaft required that the frozen shaft section be lined with a lining which, despite all the deformations which may occur, will not leak or loose its bearing strength. Therefore, the final lining will be constructed so as to tolerate considerable deformation without damage or loss in watertightness. Between the preliminary and final lining an annulus is left which will be filled with asphalt having the properties of a viscous fluid. The asphalt layer separates the final lining from the surrounding strata allowing relative movement between the two. It also serves as a protection layer as lateral ground movements will only influence the final lining once they exceed the width of the asphalt layer.

The final lining will be supported by a reinforced concrete foundation keyed about 50 metres (160 feet) into the salt formation. The lining will consist of a welded steel liner (backfilled with asphalt) and reinforced, cast-in-place concrete. The steel liner, which will be welded in the shaft and welds ultrasonically tested for quality, and the reinforced concrete together will provide the necessary strength and watertightness.

Figures 4 and 5 show the various components of the frozen section liner.

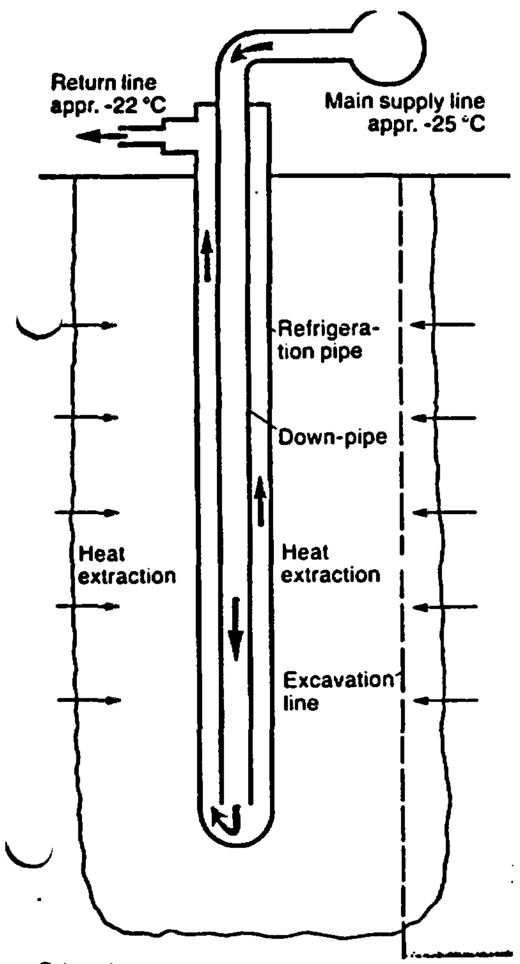
After the final watertight lining has been installed in the frozen section of the shaft, the freezing process can be terminated. Natural thawing is generally employed and when the thawing process has progressed sufficiently, the inner pipes are pulled and the refrigeration pipes, which remain in the ground, will be backfilled with cement grout.

3. Sinking and lining in salt

For the shaft excavation, conventional drill and blast techniques will be used to sink the shaft through the salt section. This consists of drilling a round with the shaft jumbo (Figure 6) and after loading and blasting, the muck will be removed with a grab and muck bucket (Figure 7).

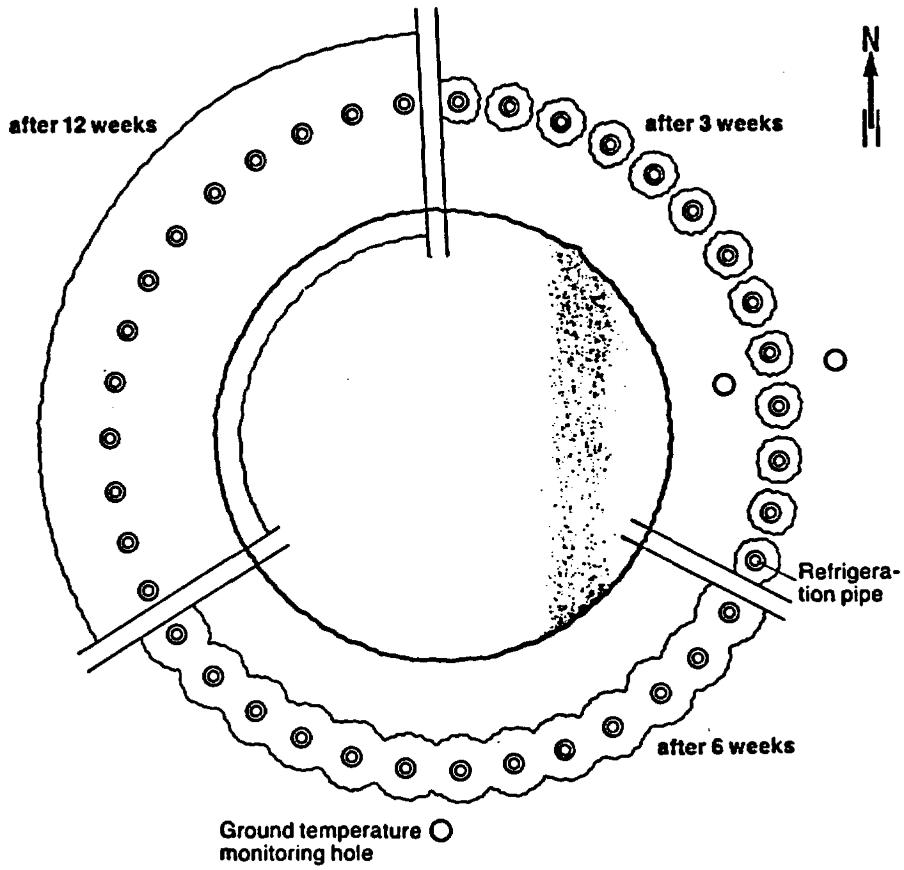
The lining will consist of reinforced concrete and will be placed in lifts from the sinking stage (Figure 8).

Figure 1



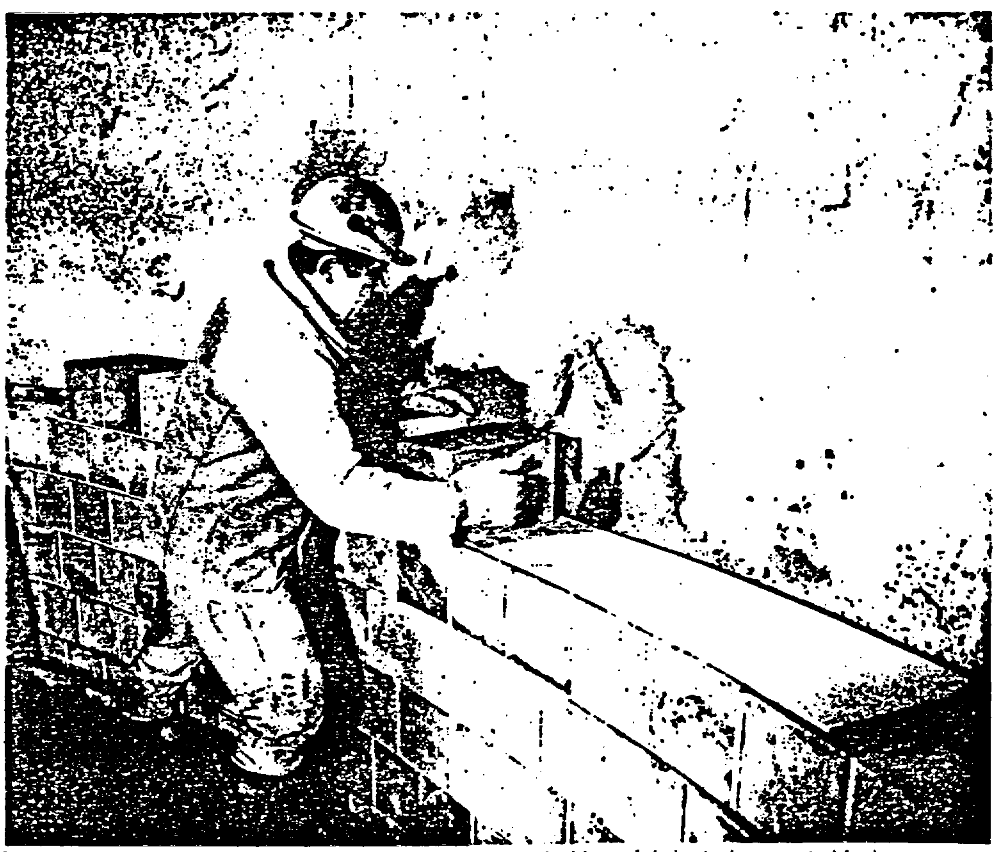
Brine circulatory system

Figure 2



Freeze wall formation

Figure 3



Installation of the preliminary flexible lining constructed with prefabricated concrete blocks

Figure 4

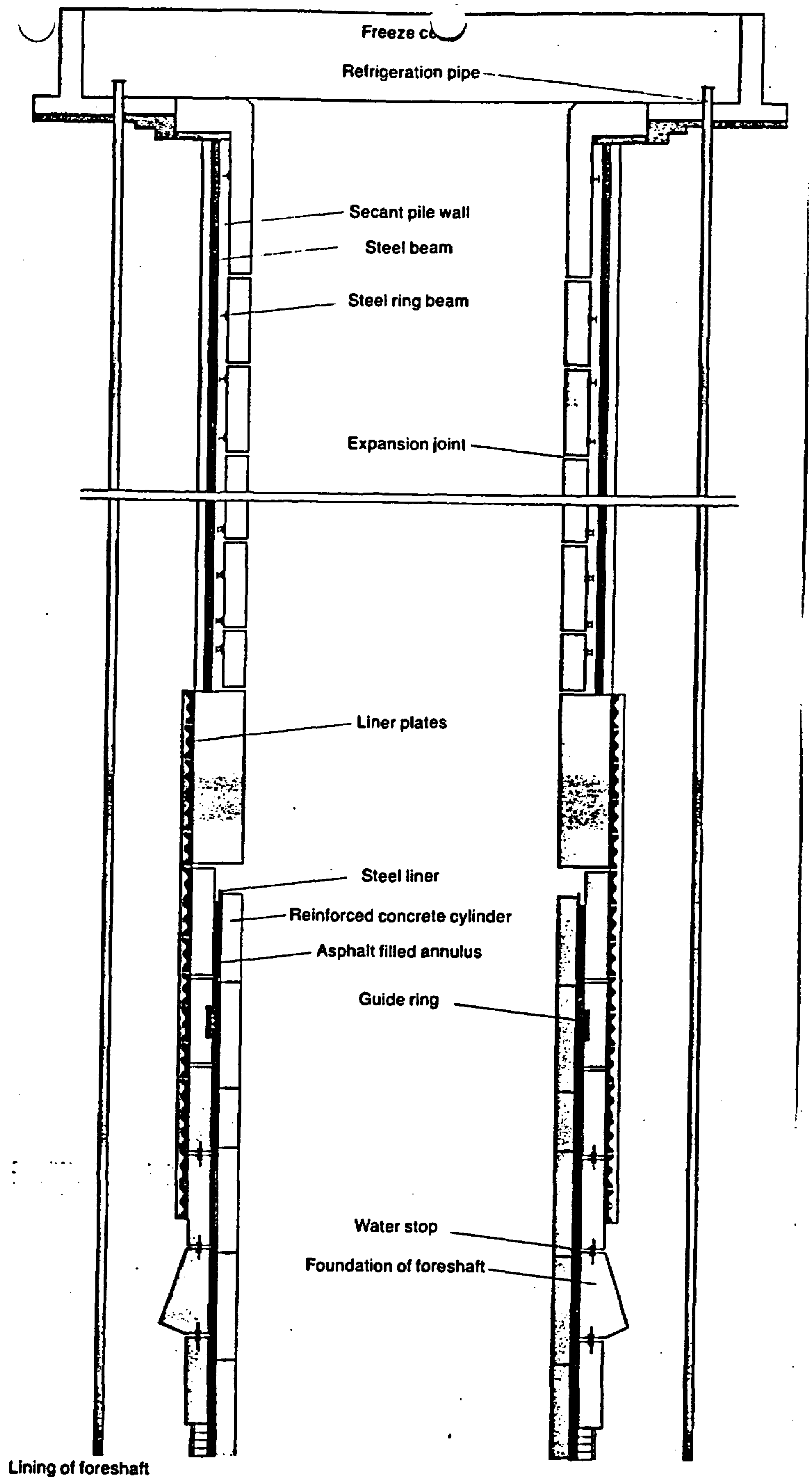
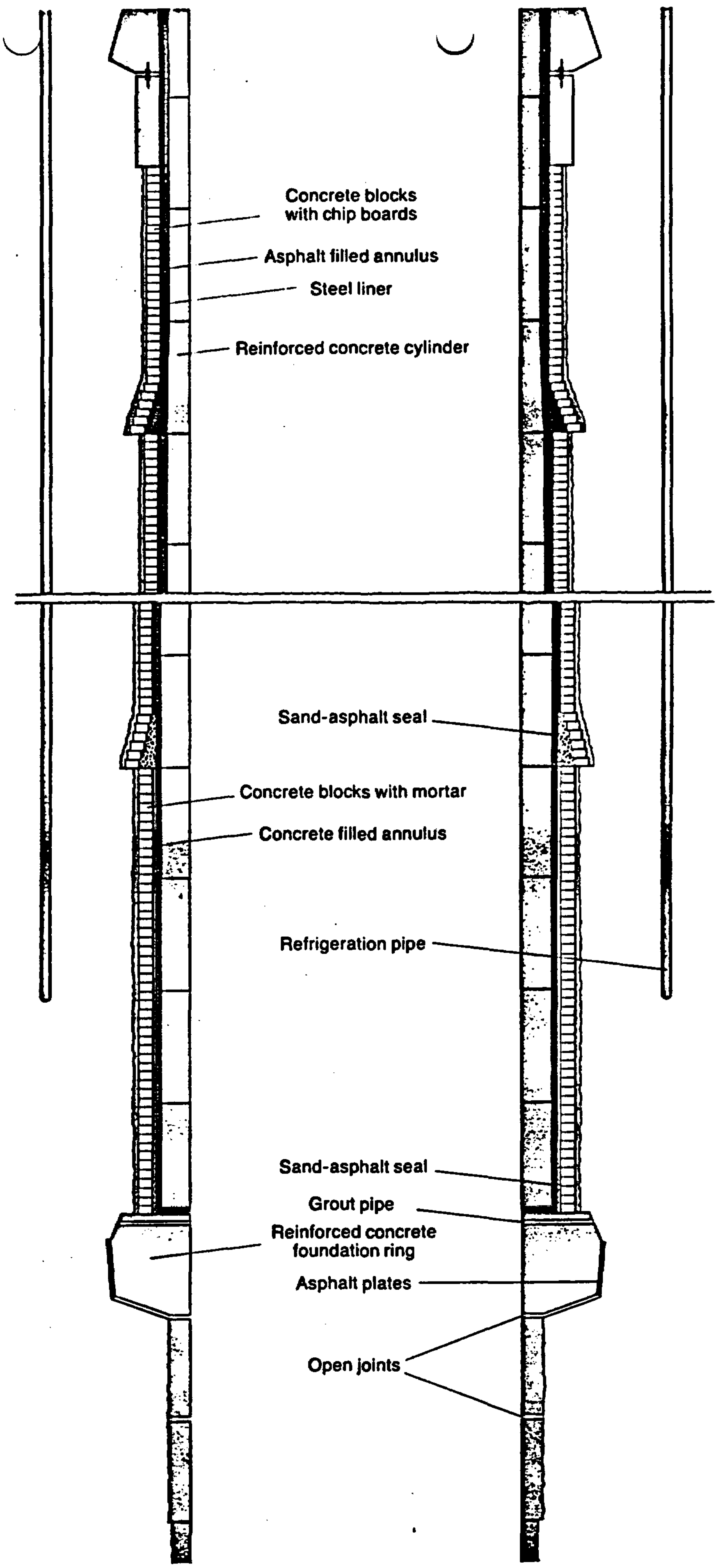
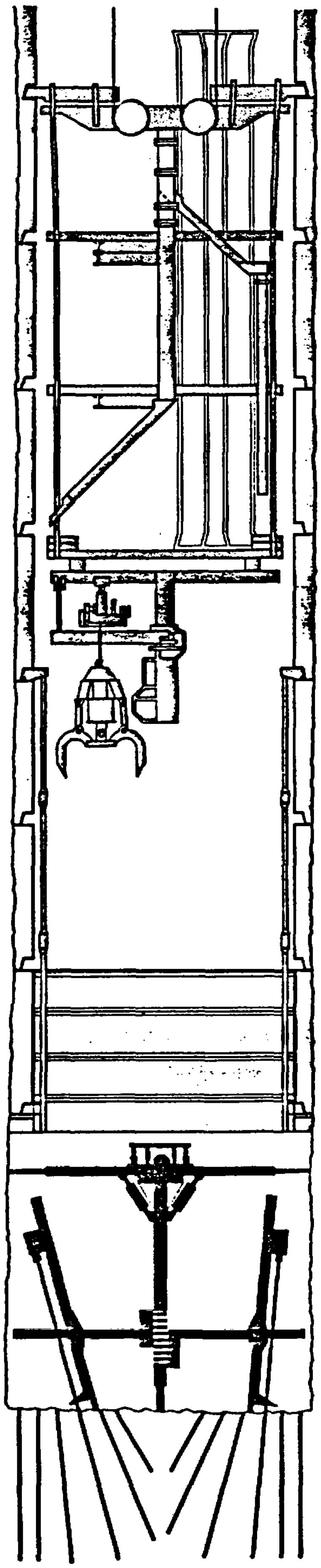

Freeze c
Refrigeration pipe
Secant pile wall
Steel beam
Steel ring beam
Expansion joint
Liner plates
Steel liner
Reinforced concrete cylinder
Asphalt filled annulus
Guide ring
Water stop
Foundation of foreshaft
Lining of foreshaft

Figure 5



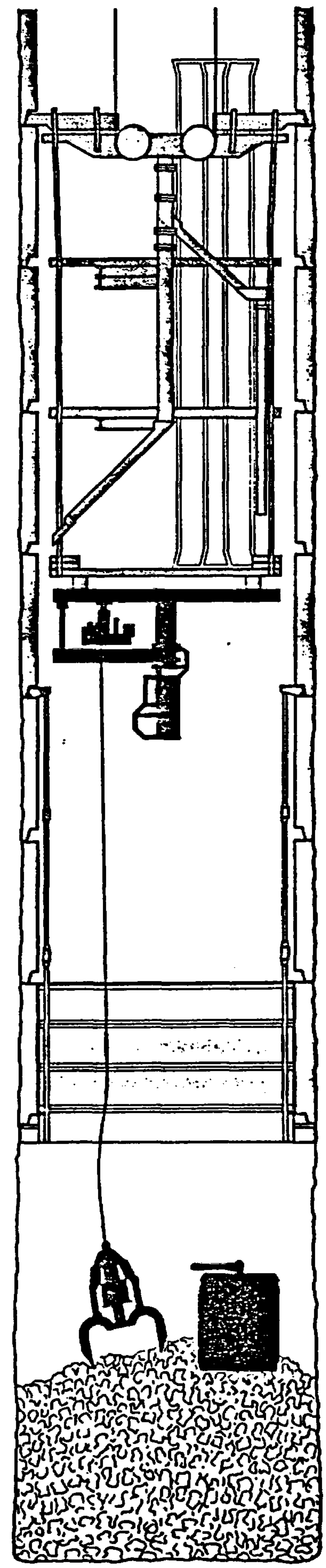
Lining in the frozen shaft section

Figure 6



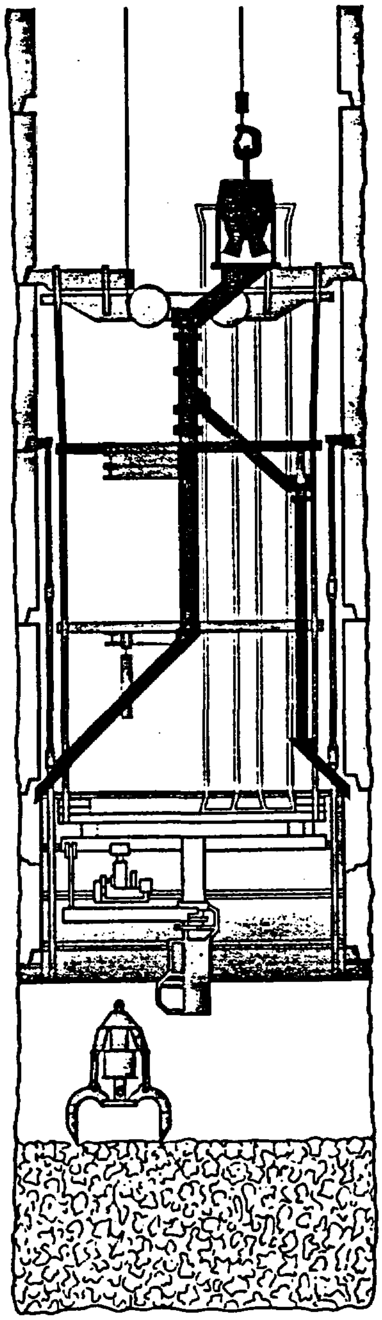
Drilling of a shaft round

Figure 7



Mucking

Figure 8



Pouring of a lift

Date: April 30, 1984

Location: Bonn offices of BMFT

Purpose: Review of U.S. and FRG National Programs and Preliminary Discussion of Future Bilateral Effort

Participants: See Attachment 5

Discussion:

After opening courtesies, the meeting began with a quick summary review of the FRG situation as regards the back-end of the fuel cycle, given by Dr. Rolf Randl of BMFT (ministry of Research and Technology). The general strategic and legal framework of the FRG fuel cycle was first summarized. Power plants cannot be licensed without proof of storage or disposal capability through a period of 6 years. Storage has been demonstrated both by licensing of poisoned compact storage racking at reactor pools and by availability of the recently completed DWK facility at Gorleben for away-from-reactor storage of spent fuel in Castor casks. German law is seen to allow presumption of reprocessing for disposal of solidified (glass-form) HLW because reprocessing is a demonstrated technology, but not to allow presumption of disposal of spent fuel because the concept will not be real (demonstrated) within the requisite 6 years. They plan to have demonstrated feasibility of spent fuel disposal by 1992 date required for Gorleben licensing. FRG analysis shows that under some situations (low uranium price) spent fuel disposal may be cheaper than the reprocessing option so they expect that direct disposal may become attractive to German utilities. So far (CY 81 thru 84), BMFT has spent or committed 50 million D.M. (~$20 M) to spent fuel disposal studies.

German industry is directly responsible for storage and treatment of spent fuel and HLW, while disposal is the responsibility of the National government through the PTB (the FRG National Bureau of Standards). Costs for government R&D will be reimbursed by the waste generators (utilities for HLW) where such R&D is site-specific. Generic research such as that at the Asse salt mine will not be reimbursed; the costs are born by the taxpayer and funded through the BMFT. Finally, costs for disposal facilities and operations will be born by the waste generators.

The nominal reprocessing option is designed with the assumption of shipment of liquid HLW. Reprocessing is planned to be done in Germany while the vitrification treatment is to be done at the Pamela facility in Mol, Belgium. Shipment will be by a cask designed and licensed to carry 1.5 m^3 (396 gallons) of liquid HLW having a specific activity of 40 curies/liter. The FRG plans to locate a 350 metric ton per annum reprocessing plant at one of two sites: Wackersdorf, Bavaria or Dragahn, Lower Saxony. Both States of Germany have expressed a positive interest in having the facility. An application for a reprocessing license was filed in 1982.

Prominent in the plans for disposal developments at Gorleben is the design for only two shafts in the final facility, in order to minimize penetrations to the host salt stock. This means that the two exploratory shafts will be constructed at the final location and at full size. Also, they plan approximately 25 km of drifts in their evaluation program. The question of "overcommitment" to the site which has been raised in the U.S. is not a question in the FRG because, at best, they have chosen their site prior to final site characterization and, at worst, they would choose a second serial alternative if a fatal flaw were found at Gorleben.

The U.S. NRC representative raised the question of QA on R&D. There are no detailed QA requirements or procedures written down in the FRG. The issue of proper technique seems to be dealt with through the qualifications of participants, open peer review, etc. The organization (PTB) which determines the data needs and experimental techniques (e.g., instrument calibrations), as part of its comprehensive technological responsibility, is the equivalent of the US National Bureau of Standards so its "quality" certifications should be nearly unchallengeable. Apparently, also, state and federal licensing authorities are included in working sessions which map out development and experimental plans, are aware of all the ongoing work, and have broad opportunities to comment throughout the technical agenda.

Through various questions by U.S. attendees, a discussion of certain specifics of the waste disposal containers resulted. In contrast to containers for vitrified waste, spent fuel containers would be designed for corrosion resistance over 500 years. They are also to be gas tight for 50 years. They are constructed of a "sandwich" of metal layers, the inner providing structural strength sufficient for lithostatic pressure and the outer layer for corrosion resistance. They have chosen Hastelloy C-4, a nickel alloy, through corrosion screening tests done at Karlsruh in 150 C brines (magnesium-rich). In such brines, titanium was found <u>not</u> to be as good as the chosen nickel alloy. Apparently, Battelle's ONWI has <u>all</u> the reports on this work. The resulting spent fuel disposal cask is 1.4 meters in O.D. and 6.4 meters long (to hold three fuel elements), as compared with 43 cm O.D. and 1.2 meters length for containing COGEMA glassified HLW product. The large size results in a different emplacement for spent fuel: one canister placed on the floor of one mine chamber which is immediately backfilled.

During the German presentation, schedules for all of the components of their program were quickly covered. A copy of the schedule visuals is shown in Attachment 6. Most notably, only one licensing review, occurring after site characterization (completed in 1992), allows both construction and operation. Prior to construction, they decide upon permanent irretrievable disposal at the candidate site. The Gorleben schedule is almost identical to the U.S. repository schedule, except of course that they have only considered seriously one site at Gorleben and are now starting shaft sinking.

Following this discussion of the German program, the DOE participants gave a presentation covering our broad repository activities, detailed status of the salt project, and specific design plans for the salt exploratory shaft. Rolf Randl (BMFT) expressed puzzlement over the parallel procession of regulatory activities (EPA's 40 CFR 191, NRC's 10 CFR 60, and DOE's guidelines) and wondered how we can coordinate convergence. Other questioning was for clarification of detail.

The NRC participant next presented remarks on the nature of NRC activities and regulatory process. Questioning was primarily on the meaning of "reasonable assurance" (reply was in terms of legal "prudent man" findings) and on exact functions and authorities of the ACRS, ASLB, and the Commission itself.

The NRC representative wanted to know how to get more information on the FRG program in future (specifically on borehole sealing at Gorleben and other information on the Konrad mine). The FRG would be happy to respond and suggested writing directly to the appropriate FRG organization (GSF, PTB, or BMFT) but it was emphasized that the bilateral agreement is with the U.S. DOE. Hence, NRC letter requests should be copied to DOE (Alex Perge, OCRWM) and FRG organizations should assure that their interior ministry is informed.

With respect to future bilateral efforts, two matters were discussed: a joint test of PNL Cs- and Sr-doped glass logs in the Asse mine (proposed by the FRG) and resumption of an exchange of observers (proposed by DOE/SRPO).

The glass logs test had been discussed before in the U.S., most recently with Frank Coffman and others in February 1984. It is important to the FRG that there be no α-radiation and for activity to have a short half-life. The objectives of the test are to prove the handling of such "hot" packages at depth, to look at thermal and radiological effects locally, and to measure pillar deformation. The FRG wants to meet a January 1987 emplacement schedule in order to give 5 years of in situ data for the Gorleben license application. PNL has told the Germans that they can produce to that schedule with a run of their ceramic melter that must follow vitrification of West Valley Waste and decontamination to remove α-radionuclides.

Test galleries are being mined at the 800 meter depth at Asse and the present shaft will be deepened to allow movement of the test logs over flat drifts rather than the present inclined ramps.

The FRG is proposing to bear the institutional commitments. They will have to assure retrievability and provide for disposal of the glass logs after tests are completed. The tests may be extended beyond the 5 years useful for the Gorleben application, and interim storage at the DWK-owned AFR at Gorleben is possible. Further, the U.S. would be committed only to supply the glass logs F.O.B. Hanford, with the Germans assuming responsibility for shipment to a seaport and transport from the U.S. port to the Gorleben site. The FRG would supply the transportation casks. Some German company has told the researchers that there is no licensing or other problems along this entire path. We cautioned the BMFT and other planners to not be <u>too</u> optimistic in this regard.

The FRG emphasized that their schedule was very tight and they hoped to get firm agreement at the August 30 and 31, 1984, bilateral meeting in Jackson Hole, Wyoming. This would allow ratification by the FRG Deputy

Secretary of State in a September visit to the U.S.A. A letter proposing all this is forthcoming. In 6 to 8 weeks, the U.S. DOE will receive a first draft of the FRG test plan. They welcome DOE/ONWI suggestions in any aspect of the plan. They particularly suggested the value to the U.S. of measurements of stress and strain in newly mined salt cavities also subjected to heat. There are really two places to address the needs of each party: the test plan and the project agreement. Finally, the FRG at least prefers that, beyond specific project undertakings, the umbrella agreement be formally extended rather than employing the ad hoc extensions used recently.

The BMFT reacted positively to U.S.-proposed exchanges of observers but need a structure to preclude a U.S. competitor acquiring proprietary shaft technology from a German firm to use in "third application" areas (other than HLW repository). For these protections, it is important to the FRG who the observer would be. Much preferable to them are observers from DOE or Battelle, rather than Parsons-Redpath. Any contractor to the DOE program could probably be structured into a participation that would assure proprietary protections, however.

Rolf Randl suggested that their travel problems would be greatly eased if the bilateral could provide that travel to implementing meetings, workshops, etc., would be paid by the host country. He said exactly such a BMFT/U.S. DOE agreement exists in solar energy. DOE officials were named for follow-up inquiries (R. San Martin and Ron Loose). The FRG would like to know also if there is any possibility of FRG participation with WIPP in situ testing.

BMFT, PTB, and DBE reacted favorably to possible future discussions on the nature, evolution, and management of institutional difficulties in Germany and reciprocal discussions of the U.S. situation.

ATTACHMENT 5

ATTENDEES AT MEETING WITH BMFT

April 30, 1984

NAME	AGENCY
Helmut H. Geipel	BMFT
R. P. Randl	BMFT
K. Hubenthal	BMFT
H. Homacher	BMFT
R. Ollig	BMFT
John Greeves	U.S. NRC
Critz George	U.S. DOE, HQ
Jeff Neff	U.S. DOE, Salt Repository Program
Stanley Goldsmith	Battelle, ONWI
Bill Klemt	Texas Department of Water Resources
John Green	Mississippi Energy & Transportation Board Nuclear Waste Division
Glen A. Stafford	Parsons-Redpath
Klaus Kühn	GSF-IfT
R. Kroebel	KfK-PWA

EMFT 4/30/94

Final Disposal of Rad. Waste

"Konrad" Mine

since 1976	●	R & D investigations
1982	●	Application for license
1987	●	License
1988	●	Start operation

ATTACHMENT 6

Final Disposal of Rad. Waste

"Gorleben" Salt Dome

since 1980	●	Site investigation (hydrogeologic and deep exploration drillings)
end 1983	●	Start shaft sinking
1987 - 1992	●	Underground site investigation
1992 - 1995	●	Licensing
1996	●	Start construction
1998	●	Start operation

Direct Disposal of Spent Fuel

1980	●	Beginning of studies
since mid 1982	●	Selected reference concepts
end 1984	●	Conclusive assessment

AFR Storage Facility Gorleben

april	1980	●	Application for license
mid	1982	●	Start construction
august	1983	●	License
	1984	●	Start operation

Reprocessing of Spent Fuel

1982	●	Application for license (WAA 350)
sept. 1983	●	Start public hearings
end 1984	●	1st partial license
1985	●	Start construction
1992	●	Start operation

PAMELA Vitrification Plant

since	1978	●	Planning
mid	1981	●	Start construction
	1984	●	Start cold operation
	1985	●	Start hot operation

Date: May 3, 1984

Location: Mol, Belgium

Purpose: Review of Belgium Waste Management Program

Participants: Dr. P. DeJohnge, Dr. Bahner, and Dr. DeBaptist; J. Neff and C. George, DOE; J. Greeves, NRC; J. Green, Miss; W. Klemt, Tx; S. Goldsmith, Battelle-ONWI; and G. Stafford, P-R.

Discussion:

Dr. DeJohnge of the CEN/SCK met with us on Wednesday evening and early Thursday morning and reviewed the general history of the nuclear industry in Belgium. The general organizations of companies and various interests in Belgium were presented. Of particular note is the fact that CEN now has a large interest in Belgonucleaire and that CEN/SCK is currently funded about two-thirds by the Federal government and one-third by private interests.

The area near Mol houses four organizations related to the nuclear industry. There is CEN/SCK, which is a national laboratory; Eurochemic, which is concerned with waste treatment and reprocessing; Belgonucleaire, also interested in waste treatment; and a company called Franco Belgium Company of Nuclear Energy (FBFC), which is interested in the fabrication of light water reactor fuel. The combination of these four sites occupies something on the order of 750 hactares, approximately 1,500 to 1,600 acres. As a result of these four sites, Mol is the de facto center in Belgium for nuclear waste disposal and processing. In addition, at Mol, the Pamela facility is being constructed for vitrification work for the Germans.

A law was passed in Belgium in 1980 that set up the funding for applied research for the nuclear fuel cycle. It stated that a kilowatt-per-hour charge should be levied on the utilities. This law led to a royal decree which set up a new organization called Viras/Ondrof which has to construct treatment and disposal facilities for Belgium and also has to judge the acceptability of any waste for disposal. This organization would seem then to take much of the responsibility that currently is housed in CEN/SCK. An interesting aspect of the law also is that the waste producers must control waste for 50 years. This is a particular problem, as many companies have licenses that exist only for 30 years.

The organization of the Belgium program is under some degree of change as a result of the 1980 law and as a result of a liquidation process that is ongoing for the Eurochemic corporation.

The impression that Dr. DeJohnge gave was one of some sense of uncertainty of what might be happening in the near future and of the eventual role of CEN/SCK.

The team was then escorted to the underground facility by Dr. Bahner, who gave a presentation on the general geologic and hydrologic configuration at Mol. In general, a national study had been done evaluating argillaceous rocks, having thicknesses greater than 100 meters and depths greater than 200 meters. Underneath the Mol site is a structure called the "Boom Clay". It is approximately 32-35 million years old and is considered to be a primary candidate for disposal of nuclear waste in Belgium. From 1975 to 1979, the objectives of the studies at Mol were to characterize the site and to evaluate potential construction technicalities. As a result of those evaluations, it was concluded that the Boom Clay has good homogeneity. Additionally, the geochemical environment at depth is reducing. As a result of this, a program was proposed in 1980 to construct the test facility (their exploratory shaft and gallery at depth) and to perform a regional hydrologic evaluation over about 2,500 square kilometers.

In completing the hydrologic evaluation, 116 wells in 36 locations have been completed and are under continual surveillance. A detailed seismic survey looking for resolution on the order of two to five meters has been completed at the Mol site. During this same time frame, materials testing at three different temperatures (50, 100, and 150 C) has been under way to evaluate the impacts of the clay and any volatiles.

In the construction of the shaft, freeze tubes were drilled down to 240 meters on two rings around the shaft at seven meters and at 12 meters--with 16 holes in each ring. Using a -25 C brine, the section was frozen in 12 weeks, and a 4.21-meter diameter shaft was sunk to a depth of 207 meters. At that point, a plan to enlarge the shaft at depth to create a working cavity could not be done because of collapsing shoulders of the Boom Clay. In order to control water in the aquifer region, a polyethylene sheet was sandwiched between two concrete structures. Water leakage into the shaft was expected to be 20 liters per hour, but is currently 80 liters per hour. There does exist a question of liability, and this is being worked out with the company that constructed the shaft (Foraky).

Currently, the ground freezing is halted, and additional construction is now being done in unfrozen clay to evaluate construction problems. They have found less stability problems when prefreezing is <u>not</u> used. Upheaval of the floor of a deeper gallery constructed without freezing has been 1 cm/week where upheaval in the first gallery constructed with freezing was 1 cm/day. In general, the kinds of activities that are going on at the base of the shaft include stress measurements, extensometer measurements, and other activities looking at the movement of the clay.

In the afternoon, general discussions were held by Dr. DeBaptist on waste packaging. The Belgians are concentrating on reprocessed waste and evaluating several different types of glasses for disposal.

Finally, a presentation of the United States program was given by the team, and most questions were related to the issue of criteria.

Date: May 4, 1984

Location: Brussels, Belgium

Purpose: General Review of CEC Efforts

Participants: See attached list.

Discussion:

Several members of the team met with Dr. Orlowski of CEC and reviewed the DOE program, particularly stressing status of criteria, guidelines, and the Mission Plan.

Dr. Orlowski raised specific concerns about lack of United States attention regarding the bilateral agreement with the CEC. He specifically urged that there be more discussion and interaction on a one-to-one basis.

The CEC people gave the team a rundown of the work that was going on at their national laboratories and a description of their cost-sharing 1985-1989 programs. The 1985-1989 budget for their national laboratory programs is about $40 M. CEC has contributed about $90 M, 40 percent of the total 1985-1989 cost-sharing programs. The remaining 60 percent (~$110 M) is provided by the participating countries as direct support. The categories of activities being supported by CEC and the funding for these activities is shown in Attachments 8 and 9. In particular, they will be looking at waste form work and at the design and building of underground experimental facilities. Already, France, Belgium, and the Federal Republic of Germany have volunteered to let CEC use Asse and Mol, and a new facility would be constructed in France at an unnamed site.

Of particular interest was the overall safety assessments that are being done by CEC for such settings as Mol and Gorleben. A probabilistic methodology is being developed and could potentially be applied to clay, granite, salt, and sub-seabed sites. A couple of points of interest for the salt program were that (a) there is no modeling of Darcian flow for salt; and (b) scenarios for performance assessment of salt sites include anhydrite seams with unlimited water flow, human intrusion, and climatic changes.

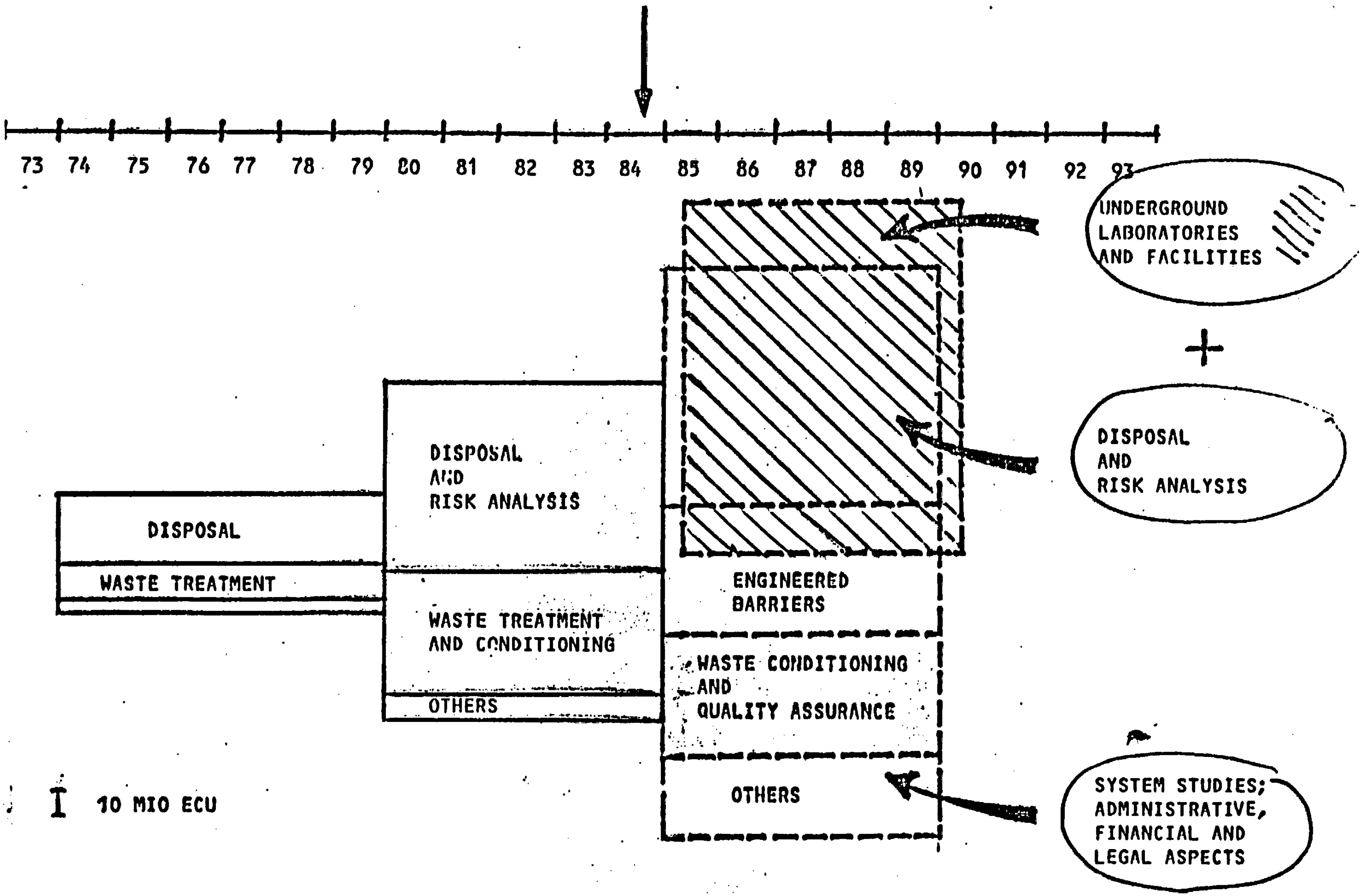
Work is also ongoing in the area of seals, with the primary consideration on mechanical behavior in situ.

ATTACHMENT 7

ATTENDEES AT MEETING WITH CEC

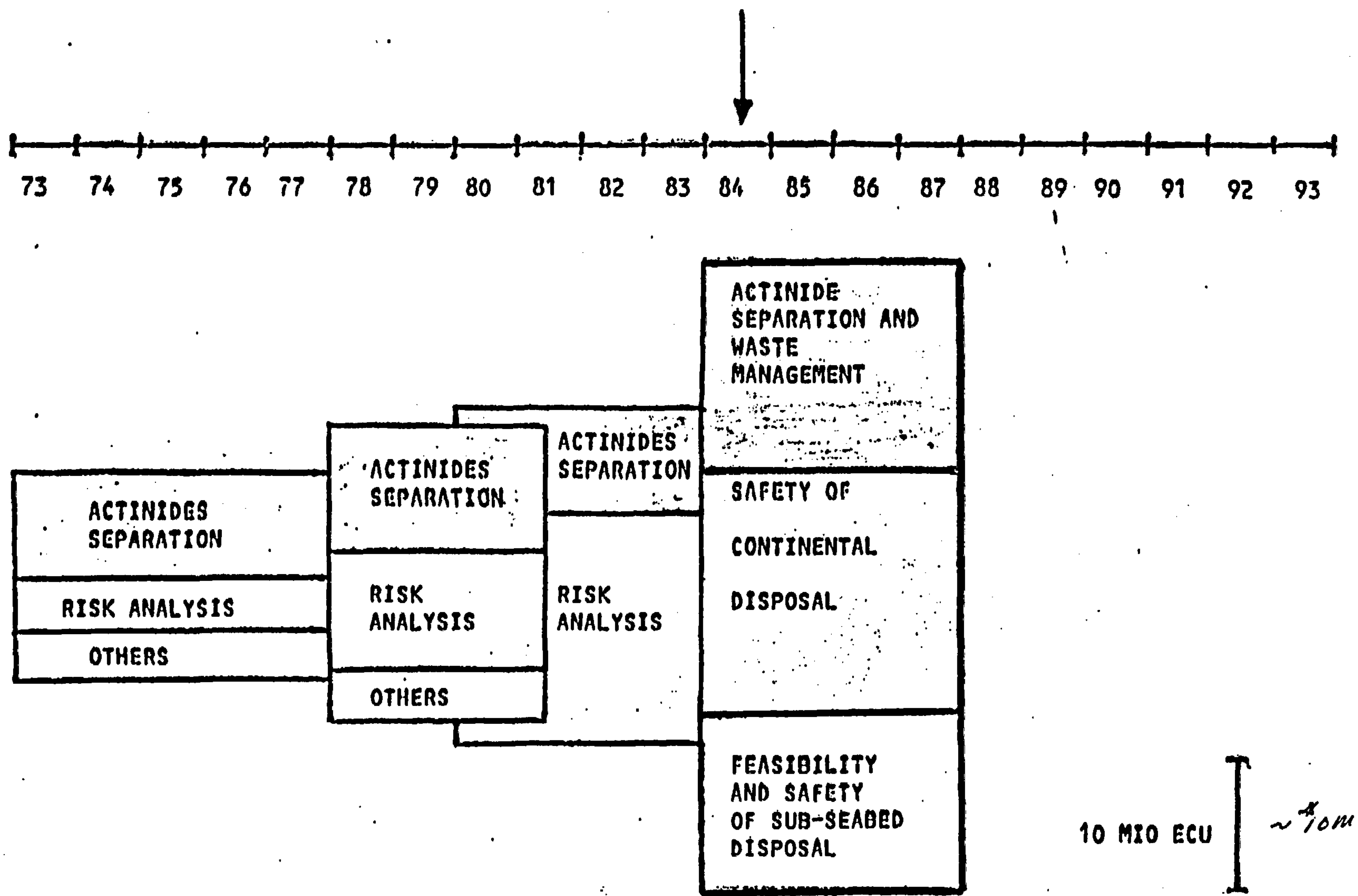
May 4, 1984

NAME	AGENCY	ACTIVITY/TITLE
Critz George	U.S. DOE	Special Staff of the Director
Stan Goldsmith	Battelle-ONWI	Director
Jeff Neff	U.S. DOE	Program Manager, Salt Program
Serge Orlowski	CEC	Head, Nuclear Fuel Division
Nico Cadelli	CEC	Nuclear Fuel Division, safety aspects
Pierre Venet	CEC	Nuclear Fuel Division, geological disposal
Aldo Cricchio	CEC	Nuclear Fuel Division
Raines Simon	CEC	Nuclear Fuel Division, radwaste programme



THE COST-SHARING PROGRAMME OF THE EUROPEAN COMMUNITIES ON RADIOACTIVE WASTE

SHARED PROGRAMS/COSTS
WITH INDIVIDUAL COUNTRIES



THE JOINT RESEARCH CENTRE PROGRAMME ON RADIOACTIVE WASTE
(JRC - ISPRA AND JRC - KARLSRUHE)