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August 7, 1987

Mr. Naïem Tanious
U. S. Nuclear Regulatory Commission
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Washington, D.C. 20555

WM Record File

106.1

WM Project

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Docket No.

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Dear Naïem:

Enclosed is my report on the Gorleben briefing as promised per our phone discussion. Also enclosed are all the articles we have gathered relating to the accident at the Gorleben site. I hope that this information will be of help to you. If there is anything else I can do, please feel free to call.

Sincerely,

A handwritten signature in cursive script, reading "Susan W. Zimmerman".

Susan W. Zimmerman, Geologist
Nuclear Waste Programs Office

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Report on the Thyssen Briefing on DOE on July 20, 1987
regarding the Gorleben Accident

On July 20, 1987 in Hereford, Texas, two representatives of the Thyssen Mining Corporation of West Germany gave a briefing to DOE personnel and contractors regarding the May 12, 1987 accident in Shaft 1 at the Gorleben site in West Germany. I attended this briefing as the representative of the State of Texas.

According to the representatives, problems started at Gorleben well above the site of the accident. At 170 meters, the first instance of swelling of clay was encountered, but had no major effect on the shaft sinking. At the 234 meter level, clay was again encountered that swelled; however, this clay did cause problems. A preliminary lining of concrete blocks was in place but the pressure of the shaft wall began to distort the preliminary lining. Convergences of up to 40 cm were measured. This occurred only 7 meters from the bottom of the shaft. The rock temperature at the center of the shaft was -10°C , the wall rock temperature was -20°C . There was no temperature increase noticed in the circulating brine in the freeze hole. Beginning in April, the temperature in the temperature control hole began increasing by 1°C per day. The temperature in this control hole increased from -16°C to -6.8°C . Approximately one-half of the freeze wall was lost. This popped the preliminary lining. Steel retainer rings were emplaced to control the convergence of the shaft wall. These rings were screwed together and then welded. This lining was put into place after approval of the mining inspector. The increasing pressure of the shaft wall caused one of the rings to break and fall down the shaft. One person as of this time has died of the injuries received.

I asked the German representatives if there had been any ideas proposed as to the reason for the loss of the ice wall and the temperature increase. Two hypotheses have been proposed. Apparently, there is an old test well located 63 meters from the temperature control hole. The water table level was being monitored in this well. The water table had a relatively rapid, sharp decrease and then an increase back to normal. The Germans think that a major water movement associated with a water-bearing sand above the problem clay caused the temperature to rise and subsequent loss of a major portion of the ice wall. What caused this water movement and where the water came from are the questions to be answered. The first hypothesis was that there might be other abandoned test wells around the shaft that were not properly plugged, thereby causing leakage down into the area around the shaft and thawing the ice wall. The other hypothesis is more closely associated with the freezing technology itself. The freeze holes at Gorleben extend 12 meters into the salt dome itself. As has been documented previously in other freeze ring shafts, when solid rock with low tensile strength is frozen, this rock, such as salt, can shrink and crack, opening fissures and fractures. At Gorleben, it is hypothesized that since it has been documented in many salt

Report on the Thyssen Briefing
Page 2

domes that shrinking of the salt occurs and fractures and fissures have been encountered, one or more of these fractures extended through the saturated caprock of the Gorleben dome and into the water-bearing sand above. This would more likely account for the large amount of water that must have moved for such a rapid increase in temperature to occur.

One thing stressed by the Germans was that part of their problem resulted from a lack of complete knowledge of the clay seam. One sample had been taken at the top of the clay for tests and the results extrapolated throughout the clay. The Germans feel that if more complete tests had been performed, they might have known about the problems that could occur and been more prepared. They also stressed the need for very experienced personnel to be in charge of the sinking and have the authority to make decisions as needed to compensate for problems encountered in the sinking.

The most notable thing about this incident is that the Germans did everything correctly to counteract this problem. The engineering methods they used were the correct ones and approved by the mining inspector. Unfortunately, the shaft still failed. Even more surprising is that the steel ring failed less than a month after installation. Usually, the rings either fail immediately or not at all. To prevent the total collapse of the shaft, the bottom 14 meters of the shaft was filled with concrete. If the Germans decide to continue with the shaft construction, this concrete will probably be removed by air hammers instead of drill and blast. Also, the Germans said that the new calculations for the area will be based on the lithostatic pressure, not the hydrostatic pressure.

SWZ:dp

GORLEBEN ACCIDENT

From: DER SPIEGEL. Nr. 22/1987
Pages 253-260
(Translation).

AUG 4 REC'D

1. LIKE SOFT SOAP

Following a severe accident the work in the mine for the planned nuclear waste repository in the Gorleben salt stock had to be discontinued. Is the concept of storage burst now?

The victims had no chance. Their eyes directed downward, deafened by the noise of air hammers, the seven men working the early shift in shaft 1 of the characterization mine at Gorleben could not see the danger coming.

Only a loud crack was what the people with light injuries reported, if they heard anything at all when the ton and a half steel ring fell down upon them. The steel monster, which actually was intended to secure the shaft from a feared collapse, became the instrument of fate for three of the gangers. Severely injured, they were brought by helicopter to hospital; one of them, an experienced mine foreman, died two days later in a special clinic in Hamburg.

The Federal German nuclear community will not forget his death very quickly. The accident of Tuesday the week before last resulted — at least for the time being — in the halt of all construction plans in Gorleben, located in the district of Luechow-Dannenberg. This is where the subsurface cavern complex is to be built which is considered to last for eternity — as a repository for high-level radioactive waste from nuclear powerplants.

The first stage of the billion DM (=German Mark) project, as decided by the Federal Government in the summer of 1983 against the advice of respected scientists, was to be two 11-meter wide shafts driven to a depth of 840 meters.

From these entry shafts outwards, the nuclear waste guardians of the controlling PTB (Physical Technical Federal Research Center) in Braunschweig expected to use numerous drifts to characterize one of the kilometer-long and up to 3000-meter deep salt stocks beneath the Northern German Low Plain that arose as a result of the evaporation of prehistoric oceans 240 million years ago. The eternally radiating offspring of the nuclear industry is supposed to be

Gorleben Accident

isolated for at least 100,000 years in the salt caverns, shut off from any contact with the ground water and the living world.

Originally the first shaft was supposed to have been sunk to its base depth of 840 meters by January of this year. Instead, the round-the-clock working repository prospectors came directly upon the edge of a caprock sitting on the salt at about 239 meters depth.

This is where the entire enterprise met its temporary low point. Because the bottom-most portion of the shaft was in danger of collapse, it had to be filled 14 meters high with concrete the first of last week. In case there would even be a new advance into the salt, supported by new safety countermeasures, the miners would be faced with a hard piece of work. They would have to dig through the concrete column using compressed air hammers.

The causes of the never-ending problems of the first enterprise of its type in the world are the geologic properties of the approximately 250 meters thick burden over the salt stock. It is composed of different layers with loose rock in parts, and therefore is "incompetent." In order to be able to force a shaft through at all, the column of soil that had to be dug out first had to be deep frozen.

The DBE (German Society for Construction and Operation of Repositories) founded by the Union and the Electric Utilities ordered the drilling of 43 "freeze holes" on a circle of 18 meters around the planned shaft midpoint. Hooked up to a gigantic cooling system (with an output corresponding to 50,000 ice chests), the coolant circulating in the freeze holes up to a depth of 265 meters provides temperatures below -20 degrees Celsius. Once a huge, frozen block of rock was produced in this manner, the crews of the firm Thyssen Shaft Construction and Deilmann-Haniel could begin with the work of sinking the shaft.

The ice cold, as the Deilmann engineers believed, would maintain the shaft wall in a stable state. The inner wall was secured only against rock fall with a simple wall of concrete blocks. The concept appeared to work well — until 7 weeks ago. Arriving at a depth of 237 meters, the workers noticed that the shaft wall appeared to begin to give several meters above them.

Apparently the directing engineers have no accurate idea regarding the type of forces

Gorleben Accident

active there, because they were satisfied with taking only one emergency measure. A week after the movement had come into the shaft wall they began to outfit the bottom 12 meters of the shaft with 34 rings of steel girders, the individual segments of which were bolted under tension.

But the pressure of over 200 meters of rock and ice was greater. Ring number 20 held barely 4 weeks before it killed one of the crew.

Even then the responsible staff of the DBE and the regulatory Mine Authority in Celle did not believe there was a flaw in the concept, although three of the steel rings, as reported by the Green-Representative Hannes Kempmann after an inspection tour, had "a definite dent." Only on Sunday before last, when the slipping rock threatened to destroy the nearby coolant pipes, did the Mine Director Hans-Karl Moritz and the DBE Company Head Hans Juergen Krug apply the emergency brake and fit the concrete plug to the crumbling repository entrance.

That the danger in this zone of the burden was particularly great was something the shaft sinkers in the service of nuclear energy could have known ahead of time. Professor of Geology at Kiel, Klaus Duphorn says, "I had warned quite clearly against it already in 1982." Duphorn, who has been an expert for years for the repository project, pleaded in his time against the Gorleben site. Together with the Goettingen expert on salt stocks, Professor Albert Guenter Herrmann, he had come to the conclusion that precisely the Gorleben salt stock was least suited for the takeup of nuclear waste over 200 degrees hot. Duphorn's recommendation back then: "Select different sites."

However, the vote resulted in the bitter enmity of his superiors. They cancelled his research funds. Remarks from the Bonn Research Ministry branded him with "gone far beyond his area of expertise," and in part "unscientific."

The Gorleben fans found particularly disturbing the determination of Duphorn that the entry shafts were incorrectly selected.

According to Duphorn, these shafts were in so-called fracture zones which make a sinking operation particularly dangerous. The individual rock layers were deposited there as though cut

Gorleben Accident

through diagonally several times. Also the water at great depths was warm and high in salt content, and would hardly be easy to freeze. The water thus could advance between the tilted strata lying one on the other and penetrate to the shaft edge under certain conditions, despite the cooling. Duphorn says, "This has an effect like soft soap." The rock begins to move.

One would need only to say precisely where the weak point occurred, Duphorn believes. Then he could see from old drilling profiles whether a rupture point would have been expected there. But that is something the unloved critic of the Gorleben project, and the public, will perhaps never learn. "Regarding the geologic details," one DBE-speaker said, "I am permitted to say nothing." That is still supposed to be a subject of the legal enquiries.

Which is being led — in the interest of assistance — by the Mine Authority at Celle, which is responsible for the provision of safety in the shaft. Mine Authority head Moritz in his day had termed Duphorn's objections as "rock mechanical nonsense." His superior, Mine Director Juergen Schubert still holds fast to this opinion. Thus, according to Schubert, the Professor from Kiel "should have had nothing at all to say."

Certainly a rock can be different from what it is thought to be up on the surface; that is known from the old maxim of the miner: it's dark before the axe.

Dark, says the Hamburg Professor of Geology Eckard Grimm, possibly describes as well the information behavior of the construction heads of the nuclear grave. Several results of research gained during the drilling of the freeze holes have not been disseminated to this day. He suspects that "under normal conditions the tasks would have had to be interrupted already back then." Grimm therefore demands from the Bonn Research Ministry an immediate and complete publication of all available data. Then, according to Grimm, it would probably be shown that the condition in shaft 1 would be "hardly manageable."

The PTB chief geologist was not able to agree quite so clearly at the end of last week. Although the abandonment of the salt stock expedition in Gorleben was not completely precluded, "in principle," he holds the opinion, "the technical problems are solvable."

He and his Bonn superiors have to stick with this assumption — because with the Gorleben hope construction (Note: apparently a play on the name of such enterprises as

Gorleben Accident

Gute-Hoffnung) the so-called storage concept, with which all the federal governments since 1979 have permitted the operation of nuclear powerplants, will stand or fall. It provides for finding, by about the year 2000, a safe place for thousands of tons of deadly radioactive waste. Until that time, the waste is to remain concealed in the water pools of the nuclear kilns and plutonium factories in France and England.

Perhaps, then, it is good that the nuclear waste regulators make their way with even greater technical expense into the salt subsurface, under the pressure of their promises. It is not a matter of the originally estimated costs of around 1.2 billion Marks increasing by several hundred million more. The electricity consumers have to pay anyway. The accumulated costs are entered at the end of the year by the PTB to the account of the electricity suppliers.

If they remain at the Gorleben site, warns Professor Duphorn, "even greater dangers will befall the project." Because there is much to suggest that the actual salt stock, which begins at 300 meters depth, is not as impermeable and homogeneous as was originally thought:

- In the middle of the stable rock salt mass one must take into account strong beds of carnallite (potash salt). They contain water and might therefore not stand up to hot nuclear waste.
- One can also expect the rock salt to contain layers of so-called main anhydrite, a rock that is penetrated with fissures. The cavities are filled with brine; drift collapses should not be precluded.

These layers, according to Duphorn, would thus have to be avoided during the construction of a repository, but that will be a difficult task for the miners. The worst, however, is that deep water has penetrated deep into the salt stock at many places, believes Duphorn, and that instead of potash salt there are water-bearing sand channels now.

However, this information was acquired via a sample boring long after the political decision had been made for the Gorleben site. In this boring, sand was found yet at 92 meters depth below the salt surface; however, in the repository concept the provision is for at least 300 meters safety spacing to the next ground-water level.

The expert from Kiel believes that nobody can guarantee that the sand does not reach

Gorleben Accident

even much deeper at some other point. This would mean, according to Duphorn, that "the whole concept of safety has gone to the devil."

If he proves to be right again this time, then the nuclear community has had a bit of bad luck again: billions stuck in the sand.

The photo is captioned Test Drilling in Gorleben 1979; the text runs "Hit Sand in Salt."

The diagram carries the headline: Death in the Shaft and runs further The Accident in the Gorleben Nuclear Waste Mine .

The callouts at left refer to the coolant pipe, steel ring; at right to the rupture location.

Boxed text: On the morning of 12 May strong pressure of the surrounding rock sprung the steel ring number 20 at a depth of 234 meters in shaft 1 of the Gorleben mine. Thirty-four of the steel rings (each 30 cm thick) were deflected inwards because the external pressure increased, although the engineers had brought the rock temperature down to -26 degrees Celsius with the aid of deep reaching coolant pipes. During the accident the ton and a half steel ring separated from the joint and fell on the miners working at the shaft wall. Two miners were severely injured; a third died. The shaft floor — diameter 11 meters — was later filled up 14 meters high with concrete.



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WISE NEWS COMMUNIQUE

No. 275

In this Issue:

Gorleben Worker Killed/FRG	1
Spanish Waste Dump Protest	2
SERI Plans Criticised/Sweden	2
Radhealth Conferences/Europe	3
Food Contam Limits Up/EC	4
Downs Syndrome Increase/FRG	5
Downreay Report Delayed/UK	6
Wackersdorf Doubts/FRG	7
Nuke Safety Record Down/US	7
Secret Nuclear Accidents	8
Sleeping on the Job/US	9
Military Reactors Unsafe/US	9
Workers Rad Exposure/US	10

waste

GORLEBEN WORKER KILLED IN SHAFT COLLAPSE (275.2338) WISE- Amsterdam

On May 12, there was a serious accident in the high level waste repository under construction in Gorleben, West Germany. Six workers were injured by a falling support as the shaft collapsed. One of the workers later died.

The cause of this accident was not faulty building material as the construction company first announced but a direct consequence of the geological conditions of which experts had already warned the PTB years ago. The PTB (Federal Institute for Science and Technology) is a department of the federal research ministry, which in fact owns the construction site of the permanent nuclear dump in Gorleben.

The shaft builders used several emergency methods to counteract the unexpectedly high underground pressures, including freezing the ground prior to sinking the shaft. To do this, 43 boreholes arranged in a circle 25 meters in diameter were sunk to a depth of 270 meters and filled with a calcium chloride brine at -40 degrees C. The freezing took one year, and the ground was to be kept frozen for two years while the shaft was sunk. Nevertheless, at a depth of 225 to 237 meters below the earth's surface, the shaft became severely deformed. Since the accident, this part of the shaft has been filled with concrete.

Neither the PTB nor the construction company know how to continue the

construction of this permanent dumping facility for high level radioactive waste. "In this situation I can honestly not exclude the possibility, that the entire construction of the permanent dump will be stopped," said a spokesman of the PTB.

According to federal German nuclear law, a solution for radioactive waste has to be guaranteed before operating licences can be granted for nuclear power plants. Although there are not yet any facilities for reprocessing or dumping, state and federal governments agreed on a plan for radioactive waste management which was considered sufficient for granting licenses. Each step in the construction of the permanent dump facility in Gorleben (as well as that of the reprocessing plant in Wackersdorf) are considered as legal proof of this guarantee. If Gorleben is proved unsuitable for geological reasons, the fiction of a guaranteed solution for radioactive waste will be exposed and the legal basis for operating nuclear plants in Germany will no longer exist.

Source: TAZ, May 20/21; DIE ZEIT, June 6, 1987

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WISE-Amsterdam
Issn: 0169-4022

WISE NEWS COMMUNIQUE 275
12 June 1987

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TEST-BORE ACCIDENT WILL DELAY GORLEBEN DISPOSAL PROJECT



An accident at the planned Gorleben nuclear waste disposal site in the West German state of Lower Saxony last week will cause a three- to six-month delay in salt dome boring, according to officials at the Physikalisch-Technische Bundesanstalt (PTB), the federal body in charge of the project. Opponents said the accident confirmed their view that the Gorleben site is geologically unsuited to the task of storing the 6,000 cubic meters of medium- and high-level radwaste projected to be generated in West Germany through the end of the century. But PTB said that the borehole problem which led to the death of one miner and injuries to five others has no bearing on the suitability of the salt dome for radwaste and spent fuel disposal.

The accident occurred May 12 in the first of two excavation shafts at Gorleben. High pressure at a depth of 234 meters dislodged a 1.5-metric-ton steel ring that was supporting the excavation shaft wall. The ring fell on several workers

at the bottom of the shaft. One was killed and two others suffered severe injuries. High pressure in the shaft developed after the bore had passed through a layer of tertiary sand at a depth of 229.5 meters and encountered a layer of subtertiary clay at a stage "earlier than we had expected," said a PTB official. To handle the high pressure, PTB implanted 34 steel rings 30 centimeters in diameter into the wall of the shaft. The 20th ring sprang loose from the wall after it had been in place for about one month, triggering the accident. After the accident, PTB ordered the bottom 14 meters of the 7.5-meter wide shaft filled with concrete to prevent the shaft from collapsing under pressure. With that step taken, a PTB official said, "we will then decide what technique to use to handle the high pressure encountered in the boring." Up to now, PTB has countered the problems generated by high porosity of the rock by freezing it to minus 20 degrees C. Following discussion with PTB officials, Federal Minister of Environment and Nuclear Safety Klaus Toepfer proclaimed May 28 that work at Gorleben would proceed. "The accident was merely an excavation accident which has no bearing on the validity of our radwaste solution," Toepfer said.

Antinuclear opponents of the Gorleben project charged, however, that the Gorleben exploratory drilling should be terminated. In March, three workers were injured in Shaft 1 and, the opponents claim, freezing of the geological formation has not been successful in Shaft 2 because of heat buildup. Contrary to official reports by PTB, one environmentalist in Hanover said, the Gorleben geological formation is "unstable and filled with pockets of water and gas which PTB doesn't want to take seriously."

Harald Schaefer, environmental spokesman of the Social Democratic Party's parliamentary group in Bonn, said that the Gorleben salt dome should be abandoned and that the possibility of burying spent fuel and waste in granite or basalt formations should be explored instead. The Green Party went even further. Pressed by NuclearFuel to explain her party's preferred solution for German spent fuel and radwaste at a May 26 press conference, Green Party leader Jutta Diufurth replied that "it is not our responsibility" to propose an alternative. Instead, she said, "we take the logical position" that if a spent fuel disposal site can be blocked, the country's nuclear power program can be terminated, since Germany's Atomic Energy Act requires nuclear plant operators to have complete spent fuel forward plans.—Mark Hibbs, Munich

tion per reactor can be increased, which would have "practical advantages" in that the number of reactors recycling Pu would be smaller.—*Ann MacLachlan, Paris*

GEOLOGISTS PROBING PROBLEMS AT GORLEBEN TEST SHAFT

Consulting geologists investigating a fatal mining accident in the first of two shafts at Germany's planned monitored retrievable storage (MRS) facility and repository site at Gorleben have tentatively concluded that the shaft buckled at a depth only 10 meters from the end of the pressure-producing sand formation which caused the accident. Arbeitsgemeinschaft Schaechte (Shaft Working Group, AGS), the engineering company carrying out the exploratory shaft excavation under contract to the federal agency Physikalisch-Technische Bundesanstalt (PTB), which is responsible for the Gorleben project, halted test boring in the Gorleben salt dome six weeks ago following the accident.

Meanwhile, federal court officials are investigating the accident at the request of environmentalists in the state of Lower Saxony, whose own geologist says that he warned PTB in 1982 that the likelihood of such an accident was high.

On May 12, extreme pressure at a depth of 234 meters in Shaft-I at Gorleben dislodged a 1.5-metric-ton steel support ring which fell on several workers, killing one (NF, 1 June, 9). The accident will delay boring at Shaft-I for at least three to six months, PTB officials say. At Shaft-II, work has also been halted through August because of difficulties in freezing porous rock prior to excavation.

AGS has enlisted geologists to determine the precise cause of the May 12 accident, and their report will be evaluated by PTB later this year. Only then, PTB said, will a decision be made on how to proceed in the Shaft-I test bore. However, officials say, project engineers are already leaning toward a solution calling for implanting of pressure-resistant linings or casings at 1.5-meter intervals in the part of the bore subject to high pressure. "We are still certain that the mining accident has no bearing on the suitability of the Gorleben site" for long-term geological storage of German LWR spent fuel, a PTB official said July 7.

Because investigation indicates that the geological layer which caused the high pressures in the bore should terminate after the next 10 meters are excavated, Gorleben officials are optimistic. According to the tentative conclusions of the geological team enlisted by AGS, a layer of tertiary sand, encountered first at a depth of 229.5 meters, should be traversed at a depth of about 245 meters, where a formation of gypsum will replace the sand. The gypsum "should cause fewer problems because it is solid," a PTB official said. The sand layer, PTB has concluded, had made boring difficult because the water-particulate mixture created tremendous pressure on the shaft. PTB officials acknowledged, however, that they

could not discount the possibility of "other surprises" in subsequent excavation.

Environmentalists opposed to the Gorleben project said, however, that the May accident itself was no surprise, since experts had predicted it five years ago. Klaus Duphorn, a geologist at the University of Kiel, says he "warned" PTB in a 1982 study that the sub-200-meter zone where the problem occurred would produce "severe pressures" which "would prove extremely difficult to handle" for excavation teams. Once the bore entered the tertiary layer, Duphorn said, a large deposit of groundwater under high pressure would cause the slippery sand-water mixture to rise. Loose rock located in the sand formation, Duphorn said, "could be very easily forced" against the excavated bore. "If PTB had listened to us then," he said, "the accident might never have happened."

Duphorn's 1982 report will be studied again by federal judicial officials now investigating the decision-making sequence leading up to the accident. In addition, PTB officials have asked Duphorn to explain his position that the accident indicates that the geology of the Gorleben site may not be sufficiently stable. PTB officially denies that the accident sequence implies that the geological foundation at Gorleben is shifting. But a nuclear regulatory official told NuclearFuel that since the accident, Gorleben proponents are privately "concerned" about the possibility and are in fact studying the matter.

After the May 12 accident, PTB ordered the bottom 14 meters of the 7.5-meter-wide Shaft-I filled with concrete to prevent the shaft from collapsing. The concrete must be removed before boring continues, but because of the delicate conditions in the shaft, the concrete will be broken down with jack-hammers and not—as otherwise would be the case—with dynamite, PTB said. The concrete mix used to fill the shaft was chosen for its ease of removal, officials there added.

In the meantime, other problems have halted progress at Gorleben's Shaft-II. Whereas at Shaft-I PTB froze the ground to minus 20 degrees C, high rock porosity in Shaft-II will require freezing to minus 40 degrees. Work at Shaft-II will resume in four to six weeks once temperatures inside the shaft reach minus 10 degrees, a PTB official said.—*Mark Hibbs, Bonn*

EUROPEAN PARLIAMENT AND COMMISSION LOCK HORNS OVER SELLAFIELD

The European Parliament (EP) is taking first steps toward a possible legal battle with the European Community's administrative body, the Commission, over the latter's refusal to reveal safeguard procedures at the Sellafield reprocessing plant in Britain. EP members are "fed up" with the commission's "consistently arrogant" disregard of parliamentary requests for information, they say. Commission officials, however, point out that disclosure would compromise military secrecy agreements with the U.K. government, since Sellafield is a mixed-use facility.