US-GERMAN COOPERATION IN RADIOACTIVE WASTE DISPOSAL: ARE THE RESULTS OF TEN YEARS' EXPERIENCE A SOLID BASIS FOR THE FUTURE?

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ABSTRACT

A few comparative figures on size, population, gross national product, nuclear power, and the nuclear defence program of both countries set the scene for cooperation in radioactive waste management. This cooperation was initiated by a NAS/NRC report published in 1985. German participation in "Project Salt Vault" was a first step. The proper bilateral agreement was signed in 1974. A large number of assignments of scientists and of workshops were performed under this agreement. The "Brine Migration Test" in the Asse Salt Mine was a further highlight in bilateral cooperation. Site selection by US-Congress for the first repository in the United States was carefully observed in Germany. A further bilateral project agreement is being successfully proven at present, namely the test disposal of verified high-level radioactive waste in the Asse Salt Mine. Learning from the predominantly positive results of the past, more and better bilateral cooperation is strictly recommended.

INTRODUCTION

In order to set the scene properly, let me start with some figures.

- The Federal Republic of Germany is a small country. The area of the United States with its 9.63 million square kilometers is forty times larger than that of the Federal Republic. Its area is somewhat smaller than that of the State of Wyoming.
- 61.6 million people live in the Federal Republic of Germany as compared to 226.5 million people in the United States. This results in 248 inhabitants/km2 in the FRG with the equivalent of 24 inhabitants/km2 in the US. Vast areas and desert areas, like that at the WIPP site with seven cattle in a square mile, do not exist at all in Germany.
- The gross national product of the Federal Republic with about 967 billion US-$ per year is roughly five times smaller than that of the US with about 4,527 billion US-$ per year.
- The installed capacity of nuclear power plants in the Federal Republic of Germany is 23,838 MWe. The related 23 power reactors are all operating. Not one single further nuclear power plant is under construction or has been ordered for the future. The respective figures for the United States are: 106 nuclear power plants with a total capacity of 98,411 MWe are operating, 18 plants with a capacity of 22,050 MWe are under construction, and 4 plants with 4,752 MWe are ordered. That means that within a few years, the total installed capacity of nuclear power in the US will be five times larger than that of the Federal Republic.
- For the present time, 31.3% of the produced electric energy in the Federal Republic is nuclear as compared to only 18.3% in the US. The respective figures are 70.8% for France, 66.2% for Belgium and 49.2% for Sweden.
- Since World War II, the United States operates a large nuclear defence program whereas the Federal Republic of Germany has none at all. It was only allowed since 1955 to engage in nuclear energy for peaceful programs.

In summary, there exists quite a few differences between our two industrialized countries. But on the other hand, there also exist quite a few equalities. Among these is the public debate about nuclear power and, here especially, about the disposal of radioactive waste generated by it.

US-GERMAN COOPERATION

US-German cooperation in radioactive waste disposal already shows some history of more than thirty years. In 1957, the US-National Academy of Sciences/National Research Council published its Report No. 519 entitled "The Disposal of Radioactive Waste on Land." Let me read four short quotations from that meanwhile classic report:

- "Given a specific geographic site and specific type of waste, a specific answer as to feasibility and cost of waste disposal becomes possible. It is then a chemical engineering, geological and economical investigation with definite parameters for which a definite answer or a series of answers can be sought.
- Unlike the disposal of any other type of waste, the hazard related to radioactive waste is so great that no element of doubt should be allowed to exist regarding safety. Stringent rules must be set up and a system of inspection and instituted.
- We stress that the necessary geologic investigation of any proposed site must be completed and the decision as to a safe disposal means established before authorization for construction is given. Unfortunately, such an investigation might take several years and cause embarrassing delays in the issuing of permits for construction.
- The most promising method of disposal of high-level waste at the present time seems to be in salt deposits. The great advantage here is that no water can pass through salt."

This NAS-report together with the geological situation in the Federal Republic of Germany (there exist more than 200 salt domes in the northern part of the country), with the

quantitative experience gathered over more than 100 years in mining potash and rock salt, and with the advice of some outstanding scientists, formed the basis for the Federal Republic of Germany concentrating all its efforts from the beginning, already in progress in the early sixties, on the disposal of radioactive waste into geological salt formations.

As it happened, the Asse Salt Mine was shut down as a production mine in 1964. The Federal Government, which was and still is responsible for radioactive waste disposal, took advantage of this chance, bought the Asse Salt Mine, dedicated it to GSF in order to perform research and development for radioactive waste disposal in this mine, and simultaneously established the Institut fur Tieflagerung (IfT) for this purpose with GSF, which is one of the national laboratories. This occurred in 1965.

Project Salt Vault

At the same time, a small group at the Oak Ridge National Laboratory (ORNL) under the direction of Dr. Frank L. Parker, who is now and since many years professor at Vanderbilt University, Nashville, Tennessee, followed the same lines as we in Germany: Namely, to investigate salt formations for the disposal for radioactive waste. They had found an abandoned salt mine near Lyons, Kansas where they set up a large-scale underground experiment which was called "Project Salt Vault." One main objective of this project was to investigate the influence of heat and radiation on salt. For this purpose, spent MTR-fuel elements were shipped by truck from Idaho to Kansas, lowered through a 1,040 feet deep, lined borehole into the mine and then into a specially constructed transportation vehicle, which then emplaced the fuel elements in storage boreholes in the salt floor.

Because the German program on radioactive waste disposal had just started and also experience in handling radioactive waste was rather limited, the performance of "Project Salt Vault" was a good opportunity to test the American willingness for bilateral cooperation. The responsible offices agreed and so a young German mining engineer was sent to Lyons, Kansas and to Oak Ridge in 1967 to take part in the above-mentioned project.

Bilateral Agreement

From this starting point, bilateral cooperation in radioactive waste disposal was continuously increased and intensified. The same was true in the field of radioactive waste treatment and also, even if on a somewhat smaller scale, in reprocessing of spent fuel. Many personal contacts originated in time. After some time, the two responsible agencies, the then still existing Atomic Energy Commission on the US side and the Federal Ministry for Research and Technology on the German side, considered it worthwhile to concentrate all personal and institutional bilateral contacts under one official umbrella. These efforts finally led to the signing of a "Technical Exchange and Cooperative Arrangement between the United States Atomic Energy Commission and the Federal Ministry for Research and Technology of the Federal Republic of Germany in the Field of Radioactive Waste Management," on the twentieth day of December, 1974, by Frank E. Cash, Jr. for the AEC and by Hans Matthofer for the BMFT.

Slight Disharmonies

One article in this agreement foresees regular bilateral meetings. In consequence, a relatively large German delegation came to the United States in the summer of 1975 to negotiate technical details and to visit some facilities. We on the German side were quite surprised by the message:

- that the Atomic Energy Commission did no longer exist.
- that a new organization called the United States Energy Research & Development Administration (US-ERDA) had been established and had taken over responsibility for radioactive waste management.
- and that a new very generic approach for radioactive waste management had been initiated in the US.

This latter initiative finally resulted in the publication of a voluminous document in 1976 called "Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle." The basis of this report still was reprocessing of spent fuel from reactors. For the disposal of radioactive waste, besides storage in geologic formations, further options were also investigated:

- Seabed Embedment,
- Ice Sheet Disposal,
- Extraterrestrial Disposal,
- Transmutation.

I still now have to confess that the German side was somewhat confused by this new direction of the American program.

Another difficulty in the hitherto excellent bilateral relations occurred shortly later when President Carter tried to convince his allies to stop reprocessing of spent fuel from nuclear power reactors. As you certainly all know, this initiative of the Carter administration led to a series of conferences and a working group named the "International Nuclear Fuel Cycle Evaluation," better known by its acronym "INFCE." The final report of INFCE was published in 1980 and came to the conclusion that both options, namely direct disposal of spent fuel as well as reprocessing with treatment and disposal of radioactive waste, are possible.

Assignments and Workshops

The bilateral agreement on radioactive waste management was only slightly touched by these disturbances in the general weather situation. We *had started to* make use of another benefit of the agreement, namely to exchange scientists for longer time periods. The first scientist who came to Germany in January 1977, was Dr. Alan Sattler from the Sandia National Laboratories. By this fact, it is documented that the US side was willing to include its activities for the "Waste Isolation Pilot Plant (WIPP)" into the bilateral cooperation in spite of the special situation of WIPP within

the US-program. This inclusion of WIPP still exists today and is of great benefit for both sides.

During the last ten years, a large number of scientists were delegated to both countries. This has paid off very well because these scientists could not only work together with their colleagues on specific items but they also acted at the same time as "liaison officers," thus, making possible a quick, easy and confidential transmission of information, issues and arguments. They also helped quite successfully in planning and organizing travels and visits of small, large and very large groups into both countries. In addition to these long-term assignment, quite a few scientists and technicians were also sent to both countries for short periods or visits in order to discuss and to solve special problems.

Already a few years after signing, it turned out that workshops are an excellent instrument to put life into the bilateral agreement. The ideal workshop brings together specialists, in my personal opinion not more than 20 to 25, in a possibly screened environment where they should have plenty of time for technical and scientific discussions. It is also very important that workshop participants find time to come to know and understand each other. I hope that this was and will be the case at workshops organized under the US/German agreement. I surely know it for that workshop which was held in Berlin in October 1979 and which was entitled, "Waste Isolation Performance Assessment and In-Situ Testing."

Brine Migration Test

At this Berlin workshop, the cornerstone was laid for another bilateral cooperation possibility which is the most important one, at least in my view. We agreed at this meeting to perform a common bilateral in-situ test which later on was named the "Brine Migration Test." The issue of small brine inclusions or of very small water content in salt formations and their possible migration in a superimposed temperature field within a salt repository was discussed in both countries. Some preliminary in-situ tests had already been performed in the Asse Salt Mine. So, it was a nearly logical consequence that both countries focussed their interests in one common test.

The American partner for the Brine Migration Test was the Battelle Office of Nuclear Waste (ONWI) with its subcontractor Westinghouse-Advanced Energy Systems Division (WAESD), the German partner was the GSF-Institut fur Tieflagerung. Under the bilateral "Project Agreement between the Department of Energy of the United States of America and the Federal Ministry for Research and Technology of the Federal Republic of Germany for the Conduct of Experiments at the Asse Salt Mine" was set up and signed in Bonn on October 1, 1981. The signature for DOE was given by Arthur F. Burns, the then US-Ambassador in the Federal Republic who was a well-known and highly-respected gentleman in Germany.

The proper test was performed in the Asse Salt Mine after a preparatory phase of about two years between May 1983 and November 1985. Its results were documented in four summarizing bilateral reports and in a great number of further publications. In spite of all obstacles, among these especially the great distance between Columbus/Ohio and Asse, the "Brine Migration Test" can be called a full success of bilateral cooperation. I hope that my American colleagues can agree to my judgment.

US Site Selection

During the performance of the Brine Migration Test, US-Congress passed the "Nuclear Waste Policy Act of 1982" shortly before Christmas of that year. This Act prescribes precisely, even with time schedules (which is unusual for German Acts), the procedure to select a site for the first commercial repository. We in Germany studied the NWPA very carefully.

The main question for us was if the first repository will be located in a salt formation. We estimated that the chances were very good because seven candidate sites were located in salt, one in tuff and one in basalt. The seven salt sites were:

- Deafsmith and Swisher County in the Permian Basin, Texas,
- Vacherie Salt Dome, Louisiana, Richton and Cypress Creek Salt Domes, both in Mississippi, all located in the Gulf Interior Region,
- Davis Canyon and Lavender Canyon in the Paradox Basin, Utah.

We realized that the chances of a salt repository were drastically reduced when the Secretary of Energy recommended three sites out of the nominated ones to the President. His recommendations were:

- Hanford, Washington - tuff,
- Yucca Mountain, Nevada - basalt,
- Deafsmith County, Texas - salt.

A first disappointment for us in Germany was that not one salt dome was recommended to the President. Nevertheless, there was still hope for a salt repository. This hope was supported by the fact that responsible DOE- and ONWI-offices were transferred from Columbus, Ohio to Hereford, Texas. But in December 1987, we were really very surprised by the decision taken by US-Congress: "It is Yucca Mountain!"

Obviously, we can only accept this decision. Nevertheless, we are very interested in the complete set of reasons and arguments, especially in the technical and scientific ones, which led Congress to this decision. This is not only to understand the US position, but mainly to have enough and efficient ammunition in order to successfully overcome the discussion with nuclear opponents in Germany who already demand that we should rapidly give up our plans to construct a repository in salt "like the Americans have already done!"

HAW Test Disposal at Asse

In parallel to this high-ranking, decision-finding process, technical and scientific cooperation between the US and Germany continued successfully. The German regulatory bodies, in this case the Reaktor-Sicherheitskommission, which is the equivalent to your Advisory Committee on Reactor Safeguards, elaborated "Safety Criteria for

theDisposal of Radioactive Wastes in a Mine." These criteria were published in March 1983 by the then responsible Federal Ministry of the Interior. One passage of these criteria demands that emplacement of radioactive waste in a repository should only be performed with already proven technology.

Along these lines, we already discussed since the late seventies a necessary test disposal of high-level radioactive waste in the Asse Salt Mine. One question among many was: From where can we get a sufficient quantity of solidified high-level radioactive waste which is representative for that HAW which will be generated by a future German reprocessing plant? Our inquiry in Germany in Europe was negative. So, we contacted our American friends.

In the early eighties, DOE held annual meetings to present and to discuss progress of its radioactive waste disposal program. The "1982 NWTS Program Information Meeting" took place in December 1982 in Las Vegas. During a break of that meeting I had a conversation with Al Platt and Jack McElroy, both from Battelle Northwest Laboratories, in the sun-splashed inner court of the Silver Slipper Hotel to discuss if they knew any possibility to get solidified high-level radioactive waste. During this discussion, the idea was born to fabricate heat and radiation sources using PNL's radioactive liquid-fed ceramic melter (RLFCM) and to dope these sources with Sr-90 and Cs-s137 isotopes which were available in separated form at Hanford.

In a short sequence, many bilateral negotiations followed this discussion of Las Vegas. All these successful efforts finally led to another DOE-BMFT-Project Agreement. This time it was on "Methods of Treatment for Immobilization of High-Level Radioactive Waste." This project agreement was signed in November 1984.

Due to an enlargement of the Asse HAW test disposal project, the German site asked for more Cs-137 and Sr-90 than was originally planned. I remember quite well that this German demand caused very intensive discussions within DOE; if it should accept this request or if the cesium and strontium should be reserved for American customers for irradiation. But because of the long and successful cooperation, we had some very good friends within DOE who represented the bilateral interests in an excellent manner. One of these DOE-managers is here today and I take this opportunity to thank Mike Lawrence very much for all his personal efforts which he put into this bilateral agreement.

It is not necessary at this time to outline the scientific and technical scope of this agreement because there is a special session on Wednesday morning entitled: "Effect on Salt of the Combined Radiation and Thermal Fields Produced by High-Level Waste Glass with Heavy Loadings of Cs-137." Six papers during this session will prove that the bilateral cooperation between the United States and the Federal Republic of Germany in the field of radioactive waste management is fully alive.

OUTLOOK

In summary, I believe I could show that our two countries have a long and successful cooperation in radioactive waste disposal. Let me close my presentation with a short outlook into the future.

There is non reason at all to dispense with further bilateral and international cooperation in radioactive waste disposal. Nuclear opponents intensively try to use what they call "the unsolvable problems" in this field in order to stop nuclear power in general. If we are not able to construct and to operate a repository in the not too distant future, we will contribute to the chance to create a "zone free of nuclear power" in central Europe early next century.

There are two further areas which should encourage us to intensify cooperation.

1. We are living in a world with high-speed communication. Decisions, events, especially mistakes and failures, which occur in one country are known in other countries within hours. Examples are the decision of US-Congress for Yucca Mountain, the accident which occurred on May 12, 1987, during the shaft sinking for the Gorleben repository, or the issue of brine accumulation in the Waste Isolation Pilot Plant.
2. Radioactive waste disposal is not a national problem, especially if we are looking at the long-term safety of a repository. It is absolutely necessary that we understand the different approaches in both countries in order to upgrade and to harmonize our different and common arguments.

Therefore, I clearly confess that I am very much in favor of more and better cooperation in radioactive waste management.