Salt Mine Asse, Germany: Final Repository for Dreams of a Nuclear Waste Solution

by

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It is now likely that 126,000 barrels filled with radioactive waste have to be retrieved from the salt mine Asse in Lower Saxony, Germany. After massive water infiltration that threatens the integrity of containers and site, the planned final repository turns out not final after all. The unprecedented recovery of the waste from several hundred meters depth will cost billions.
The development shatters the illusion not only of salt as the ultimate, safe geology for radioactive waste but also for the reliability of geological assessments and thus for any long-term safety of nuclear waste repositories. In this case, it is so-called low- and intermediate-level[1] waste. What if high-level waste had been disposed of there?

The Asse

Photo: BfS

We dedicate our scientific competence to politics, legislation and society.[2]

Helmholtz Zentrum, Munich
Asse Operator 1967-2008

Between 1916 and 1964 about 3.35 million cubic meters of rock salt had been mined in part of the Asse. This is the only part that has not been backfilled and is still accessible today, two other parts drowned already decades ago. In 1968 the mine became the repository for a large share of the solid, low- and intermediate-level waste in the Federal Republic of Germany. No proper nuclear licensing procedure nor a long-term risk assessment had been carried out.[3]

Until closure in 1978, according to the operators, a total of 125,787 waste packages with a total volume of about 45,000 m3 have been introduced into the mine in 13 chambers in a depth between 500 m and 750 m.

After the cessation of waste deliveries, the "German Research Center for Environmental Health" Helmholtz Zentrum Munich (HMGU)[4] continued to manage the site under mining legislation basically as a research facility until the Federal Office for Radiation Protection (BfS) took over responsibility and operatorship as of 1st January 2009. Only since then the operations at Asse have been placed under the Nuclear Law, which stipulates public participation procedures and more stringent radiation protection rules.

Safety

The Asse mine presents a number of specific problems as a disposal site. The **stability** is highly questionable since the mining chambers have been excavated close to each other and the salt has been mined often right to the adjacent rock formation. Natural rock pressure has led to the opening of clefts that cause instability and allow severe **infiltration** of groundwater. Water has been identified seeping in since 1988. An estimated 12,000 litres of saline solutions per day enter the mine through clefts and loosened salt rock. The entered liquids are collected and directed to a basin (on the 658-m level) or, respectively, collected in swamps (725-m and 750-m level).

[1] We are not discussing the terms here. However, they are obviously a matter of perception and debate.
[2] Helmholtz Zentrum Munich, self-description, online, http://www.helmholtz-muenchen.de/ueber-das-zentrum/index.html (viewed on 24 March 2010)
[3] The Nuclear Act (Atomgesetz) that formalised the conditions was only enacted in 1976.
[4] Formerly GSF – National Research Center for Environment and Health

The infiltrations rapidly worsen instabilities in the mine. Parts of the intermediate ceilings between chambers have already collapsed. "Without additional stabilisation measures, the whole mine threatens to collapse", BfS concluded.[5]
The chambers represent very large cavities difficult to stabilise artificially. Former operator HGMU has blown in over two million cubic meters of salt grit, but this measure did not prevent further deterioration.

Figure 1: The 13 Chambers of the Asse Salt Mine Repository

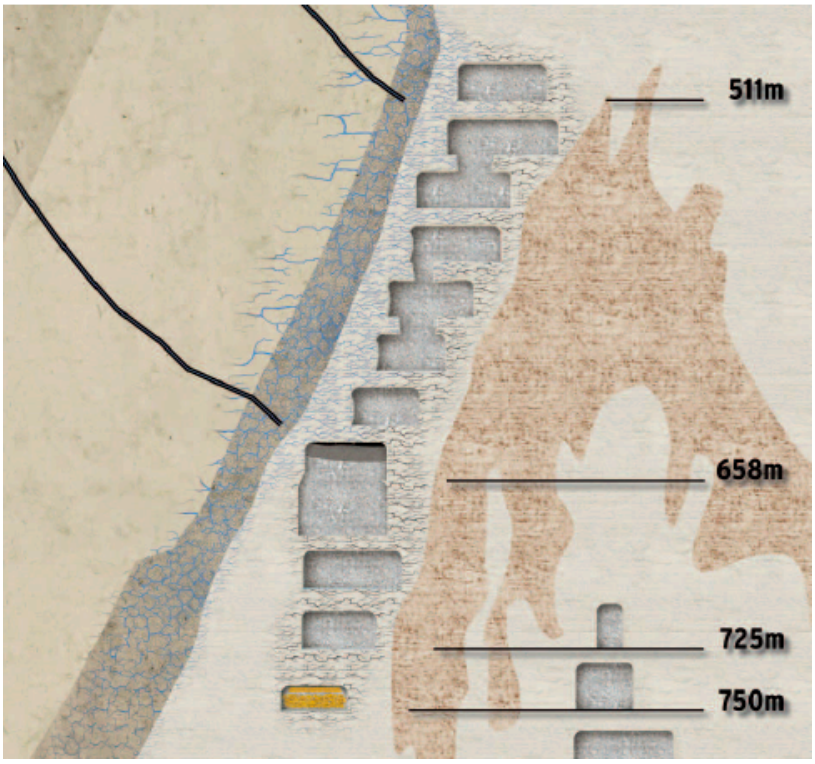

Illustration by BfS 2009

Note: The graphic illustrates water infiltration and broken through ceilings.

Politicians were certain it's safe

With the salt mine Asse close to Wolfenbüttel the Federal Republic of Germany has created a final repository that, after full expansion, will be able to take in safely the ca. 250,000 m3 of radioactive residues generated until 2000.

Hans-Dietrich Genscher
Federal Minister of Internal Affairs in charge of the environment
in 1971

The Waste

Officially, a total of about 124,500 drums of low-level and close to 1,300 packages of intermediate-level waste have been delivered to the Asse by nuclear operators, research and medical establishments. The waste typically would consist of contaminated filters, scrap, liquids, slugs or mixed waste. However, the facility has also accepted absorber elements from a high temperature reactor in Jülich and a "mix of fission products" that has not been further specified.
The intermediate-level labelled waste is located in one chamber on the 511 m level and the low-level waste in twelve chambers in up to 750 m depth. The lion share of the waste, about two thirds of the volume or over 80% of the radioactivity, stems directly or indirectly from the utilities operating nuclear power plants (E.ON, Vattenfall, RWE, EnBW) and the former Karlsruhe reprocessing plant that processed spent fuel from the nuclear operators. The activity of the waste as of the beginning of 2008 has been estimated at 7,800 TBq (terabecquerel or 1,000 billion becquerel). The radionuclides

[5] http://www.endlager-asse.de/cln_137/EN/2_WhatIs/C_TheMine/_node.html (viewed on 24 March 2010)

present are in particular, but not exclusively, cobalt-60, nickel-63, strontium-90, caesium-137, plutonium-241.
The exact content of the drums remains unclear. In particular the content of plutonium and tritium has been revised upwards dramatically. As of the beginning of 2010, the official estimate is about 28 kg of plutonium and 35 TBq tritium, besides 102 tons of uranium and 87 tons of thorium.
As a hearing of former Asse officials in the Lower Saxony Parliament revealed, 12,000 waste drums would have been "erroneously" labelled as low-level, some might actually belong into the high-level waste category. Significant amounts of non-solidified liquids and containers with radioactive krypton-85 have been introduced.[6]

Mitigation Options

There is probably no good solution to the Asse problem. Three basic options and multiple variations have been suggested, but all present not only extraordinary technical challenges but also potential severe drawbacks. The three basic options are:

• **Retrieval.** All the waste would be extracted from the mine. Some contamination though would most likely remain. There are numerous problems linked to the retrieval option. Considering the lack of knowledge of the precise nature of the waste, there might be some unpleasant surprises that could result in additional radiation exposure for staff. The instability of the site constitutes a permanent risk for workers. The disorderly storage of the waste drums and the saline solution infiltration has led to an unknown level of degradation of the waste conditioning. Furthermore the retrieved waste will have to be stored for a significant intermediate time period in an above-ground storage building. In the foreseeable future there is no other repository available where the waste could be disposed of.

• **Relocation.** The waste would be extracted from the current locations in the mine and transferred to other locations. Several new shafts would have to be driven several hundred meters deep into the salt rock formation. Some of the risks to workers are identical to the retrieval option, additional dangers are linked to the new mining activity. This option would take by far the longest time to implement. The long-term safety could not be guaranteed due to the overall instability of the geological environment.

• **Backfilling.** The waste would essentially remain in the current locations. The cavities would be backfilled with a material that is aiming at reducing the speed of lixiviation and transfer of radionuclides into the surrounding biosphere. Long-term safety remains unproven. Rough estimates have shown that an immigration of radionuclides in the biosphere can take place after several decades and would likely exceed radiation limits.

In January 2010 the Federal Radiation Protection Office BfS published the results of its option comparison and the conclusion is that it considers that by today's state of knowledge only the retrieval option could guarantee long-term safety. An emergency plan should prepare for the possibility that massive water intrusions or other events render further work impossible. In that case, backfilling would be the only fallback option.

However, nothing is decided yet. Wolfram König, President of the Federal Office for Radiation Protection (BfS), has stated: "Not only do we confront a great scientific-technical challenge, but we will only be able to walk this road to permanent safety together with the people living in the area."[7]
The plans for retrieval need to be completed in order to make appropriate decisions. The examination of some of the content of the chambers will help to lift some of the uncertainties (state of the drums, environmental contamination, etc.). The stabilisation work of the mine will indicate to what extent safe operations are feasible.

The costs, depending on the remediation scenario, have been estimated at €2.5 – €4 billion. While it is clear who has generated the waste, there is a considerable risk that the taxpayer will be asked to shoulder a significant part of the financial burden.

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[6] Bündnis90/Die Grünen im Niedersächsischen Landtag, Press Release, 22 October 2009

[7] www.endlager-asse.de/SharedDocs/Pressemitteilungen/EN/2010/0115_result_comparison.html?nn=809374 , viewed 26 March 2010