Flawed plans for a Swedish repository

In March 2011 the Swedish nuclear industry applied for a license to build a repository for final disposal of spent nuclear fuel. The repository has to be tightly sealed for hundreds of thousands of years. But in a worst-case scenario the copper canisters may rust and start to leak after only some hundreds of years.

The question of what to do with the spent nuclear fuel—the most hazardous nuclear waste from the Swedish nuclear reactors—has been discussed for forty years. On March 16, 2011, after many years of research and decades of site investigations, the nuclear industry's jointly owned company for nuclear waste management, SKB, submitted an application for a license to build a final repository for spent nuclear fuel. The Radiation Safety Authority, and the Environmental Court will use at least five years to evaluate the application. It will finally be the Swedish Government that will decide if a license will be given or not. If permission is granted, SKB plans for the repository to be filled and sealed by the mid-2080s.

Copper corrodes

But there is a problem. There is reason to believe that the KBS method that the company has designed will not perform as planned. The method involves the disposal of the spent fuel in copper canisters in tunnels 500 metres down in the Swedish bedrock. The waste has to be held in isolation for at least 100 000 years—an incomprehensibly long time. Worrying recent research results warns that copper is not at as stable in the bedrock environment as has previously been assumed.

The understanding that copper would not corrode in the oxygen-free environment of the deep bedrock is a cornerstone of the KBS project. But now scientists have found indications that in the residual heat from the spent fuel in the canisters the copper may suffer severe corrosion, even in an oxygen-free environment. At worst, the corrosion may cause the canisters to start leaking radioactivity after only some hundreds of years. Carried by groundwater flows, radioactive particles will find their way up out of the bedrock and disperse uncontrollably in the biosphere.

The processes involved are complex, and there are many uncertainties, but one thing is clear. We need much more knowledge before anyone can say with confidence that a final repository of the KBS type has even a chance of remaining safe for hundreds of thousands of years.

High risks

One of the reasons Sweden finds itself in this quandary is a lack of transparency surrounding the work of the waste management company SKB. The company has not felt any obligation to report all of its findings, so there has been a tendency to report findings that lend support to the KBS concept.

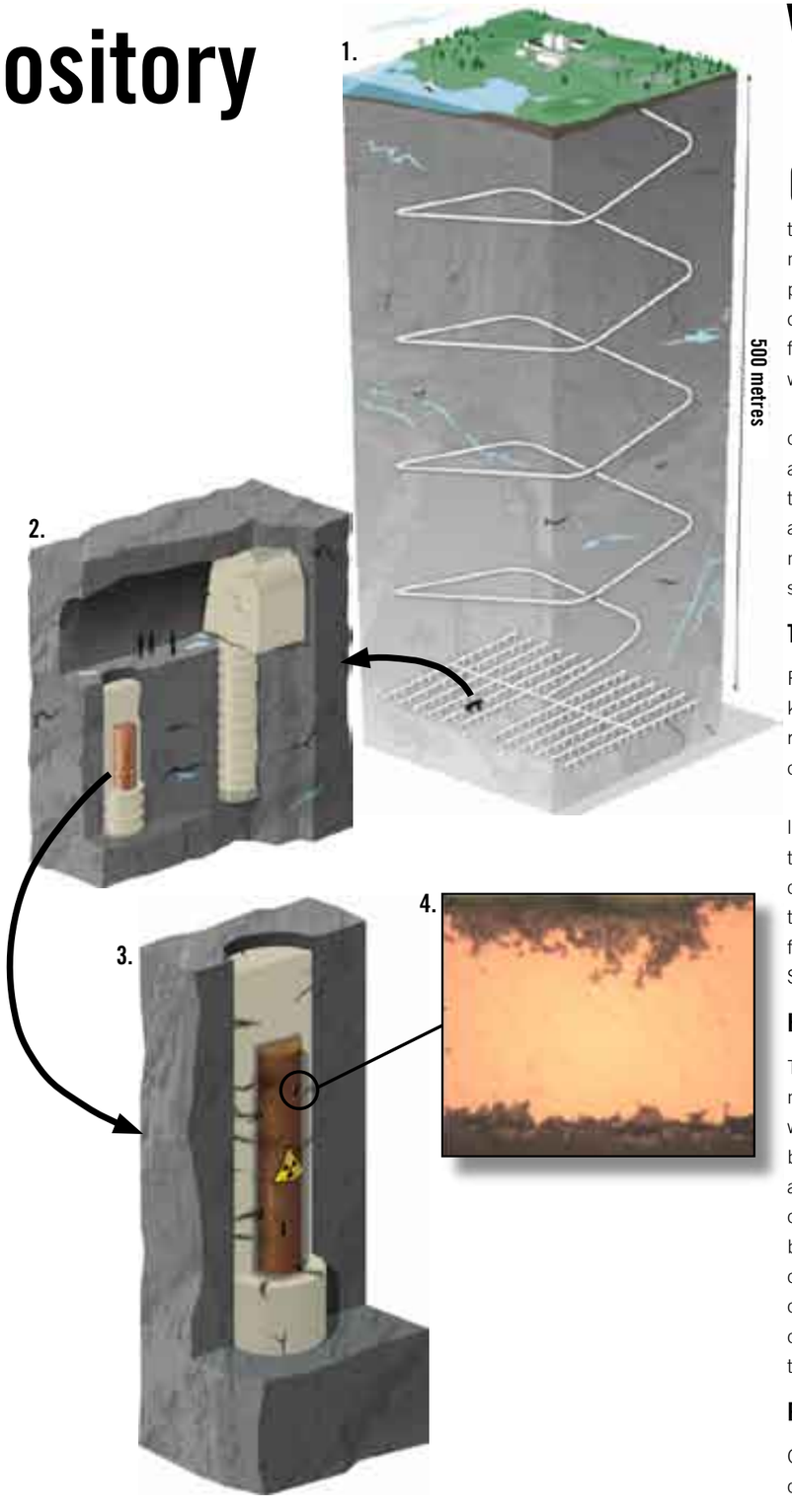
An inquiry on the part of the regulatory authority in 2010 found that SKB had suppressed findings from their experiments on copper corrosion. Confronted, the company agreed to release some reports, but refuses to release consultancy reports from the company's Äspö hard rock laboratory that likely contains unfavorable research results. Projects as complex and unique as a final repository for nuclear waste call for transparency and a free exchange of research findings.

Looking back, we find that SKB decided on the KBS method very early on, in the early 1970s. As a consequence, alternatives to the KBS concept have not received proper attention. Now, when it turns out that the KBS method implies a serious risk—not only because of corrosion, but also because of the coastal siting in a fault zone—the focus must shift to alternative methods, especially the deep borehole alternative. Disposal in boreholes at a depth of 3–5 km has a good chance of offering better long-term safety than the KBS method.

No rush

There is really no reason to hurry. The spent fuel that has been produced to date can continue to be stored in CLAB, the central interim storage facility at the Oskarshamn nuclear power plant, for at least the next 100 years. Furthermore, there is plenty of money left in the Nuclear Waste Fund. We thus have no reason to rush to a decision.

Confidence in democratic processes and a readiness among politicians to take their responsibility are important in order to achieve a safe final repository. Allowing the nuclear industry, which has its self-interests to protect, to continue to exert such power over where and how this lethal waste shall be disposed of, is to put both the environment and future generations at risk. There is a need to reassess how the division of responsibility in the Swedish nuclear waste system has worked up to now. Should the Nuclear Safety Authority and the Environmental Court in the course of their deliberations find serious flaws in the KBS method, a Parliamentary oversight commission should promptly be appointed to find out what went wrong and why.



Why the KBS method will not work

Copper was initially chosen as the canister material because it was believed to be able to tightly seal around the waste for hundreds of thousands of years. In the KBS method the canisters containing spent nuclear fuel are deposited in holes in the floors of tunnels in the bedrock at a depth of about 500 metres. In order to protect the canisters from the groundwater flow, the holes and tunnels are filled with bentonite clay that swells in water. (Figs 1 and 2)

After the emplacement of the canisters and clay the oxygen in the repository is quickly consumed by bacteria and chemical processes. The fundamental assumption in the KBS method is that very little corrosion takes place in an oxygen-free environment. The canister walls are 5 centimetres thick and only a millimetre or two of the copper is supposed to corrode in a million years.

The corrosion continues

Recent research on copper corrosion has revealed that this key assumption about what can or cannot happen in the repository environment is false. Copper has been found to corrode even in oxygen-free environments.

Experiments at SKB's Äspö Hard Rock Laboratory very likely show this. The company, however, refuses to release these research results, and stubbornly insists that its model of how copper will behave in the repository is correct. Even though there are research results that show corrosion rates for copper 1 000 to 10 000 higher than those assumed in SKB's modelling work.

Heat hastens the process

The copper may corrode especially fast early after emplacement because the canisters are then hot, heated by the fuel waste in them. The surfaces of the canisters gradually cool, but remains heated the first thousands of years. The bedrock at Forsmark is also uncommonly dry which complicates the corrosion problem. The lack of water means that the clay buffer cannot expand quickly enough to help protect the copper from corrosion. Instead salts can evaporate on the canister surface, heightening both the risk and the rate of corrosion. The corrosion products can also damage the long-term ability of the clay to protect the copper. (Fig 3)

Pitting can result in penetration

Once copper begins to corrode, the process can proceed quickly through so-called pitting, which gives pox-mark indentations in the surface. The risk of pitting has led critical researchers to fear that the copper canisters may start to leak after only some hundreds of years—instead of after hundreds of thousands of years. (Fig 4)

In March 2011 the Swedish nuclear industry applied for a license to build a repository for final disposal of spent nuclear fuel—the most hazardous of all nuclear wastes.

The industry wants to place the nuclear waste in copper canisters that are then deposited in tunnels 500 metres down in the Swedish bedrock. The safety of the method—now 40 years in the making—relies on the assumption that copper will not corrode and that the canisters will isolate the waste from humankind and nature for hundreds of thousands of years.

Recent research, however, suggests that this assumption is not correct. Copper has been shown to corrode also in the oxygen-free environment of the repository. The canisters may start leaking radioactive particles after only some hundreds of years. Via groundwater flows the particles can then be carried up out of the bedrock and spread through the biosphere.

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Rust is always a risk when using old technology

A critique of the planned Swedish repository for spent nuclear fuel

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