

SWEDEN: RADIATION PROTECTION AUTHORITY FAULTS FUNDAMENTS IN KBS REPOSITORY SCHEME

May 16, the Swedish Radiation Protection Authority, SSI, filed its comments on 'Fud 2007' (1), the most recent progress report to come out of the Swedish nuclear power industry's 'Fud' program to develop a final repository for high-level waste, irradiated nuclear fuel. (2) The comments, surprisingly critical, focus on basic components in a 'system' that has been touted as the world's first feasible scheme for isolating nuclear fuel waste for the period of its radio-toxicity, i.e., hundreds of thousands of years.

(673.5872) WISE Sweden - The most devastating criticism in SSI's report actually relates to the nuclear industry's program for low- and medium-level waste. (A sample: SSI sees "no comprehensive and complete program for the measures that will be needed to decommission and dismantle Sweden's nuclear power plants" (p 11 of the report), and "In some respects they don't even live up to what the law requires" (SSI's spokesperson in an interview on Swedish Radio). Nonetheless, the focus here will rest on KBS-3, the scheme for storing high-level waste, irradiated nuclear fuel - mainly because it is best known outside Sweden, thanks to the industry's marketing efforts.

SKB AB, a company jointly owned by all Swedish nuclear operators, has been planning to submit its application to build a final KBS repository for high-level waste to the Environmental Court in late 2008. Now, the timetable has been extended roughly nine months. Some experienced observers believe there may now be a delay of a year or two, perhaps longer.

The KBS scheme has been about 35 years in the making. It foresees depositing fuel waste in bedrock at depths of 400-600 meters. At the time the scheme was conceived it was believed that the bedrock in much of Sweden - a shield zone - was dry. That may or may not be, but over the years strong local opposition to the siting of a final repository nearby narrowed the choice of location to two coastal sites, both adjacent to nuclear power stations that employ many local residents. The bedrock in these two candidate sites is far from dry; the coastal location also involves a high probability of massive infiltration of saline and/or oxygen-rich water (particularly in one or more post-

glacial periods) during the lifetime of the repository.

A second factor that has changed the setting around the KBS scheme is the introduction in 2002 of an Environmental Code in alignment with EU environmental law. One of the principal differences that the Code entails is that the risk analyses and environmental impact statement (EIS) will be submitted to an Environmental Court, not the regulatory agency. Another is the requirement of comparative analyses to ensure the choice of 'best available technology' (BAT). The change came late in the KBS scheme's history, and the regulator, the Reactor Safety Inspectorate, seems to have failed to impress on SKB AB that compliance with the letter of the law would be an absolute requirement (see Monitor 652, February 8, 2007: *'Sweden: Nuclear challenge to Environmental Code fails'*).

Serious gaps in elaborate scheme

"... SKB's documentation is not sufficient for SSI to be able to determine that the program for a final repository for irradiated nuclear fuel is suited to its purpose... ."

So reads SSI's press release announcing the report. The rest of the sentence expresses doubt that the gaps can be filled within the next couple of years.

SSI's criticism principally revolves around three factors:

- (1) the feasibility of the scheme in a wet environment,
- (2) the shift to popular acceptance as the prime criterion in siting, and
- (3) SKB's failure to consider and evaluate alternative methods.

SSI is also concerned about SKB's heavy reliance on numerical modeling, based on limited empirical knowledge, when it comes to assessing the long-

term consequences of a KBS repository in the biosphere.

Copper is not gold

The KBS scheme involves natural and man-made barriers. The man-made barriers consist of copper canisters surrounded by a bentonite clay buffer. The hydrogeology of a coastal site is a worry, with regard to both the clay and the possibility of corrosion.

When it comes to research needs SSI urges more attention to the risk that the clay buffer may erode - either due to physical flows or as a consequence of chemical reactions - and the radiological consequences of various degrees of erosion (in a worst-case scenario, the risk of criticality). SSI points to the need for empirical materials testing, but also to gaps in the company's conceptual understanding of the processes at play.

For years, SKB AB has assured the environmental movement that copper would not corrode in an oxygen-free environment. Copper was virtually as durable as gold, they said. But two factors raise major doubts about those assurances: First, aquiferous bedrock at the depths planned is not likely to remain oxygen-free. Second, recent research has found evidence of copper corrosion in anaerobic environments, as well. Another new scientific finding is the activity of microbes in deep bedrock and highly inhospitable environments. Sulfide produced in microbial processes is a new concern that needs to be followed up.

Acceptance more important than geology?

As noted above, SKB met local resistance when it first started 'prospecting' for a suitable site. One after another, prospective sites had to be abandoned. (The Swedish

Constitution gives local government the right of veto over physical planning and land management.)

Geologists and the environmental movement have pointed out that the two candidate sites - near Forsmark and Oskarshamn reactors, both on the Baltic - are areas of groundwater outflow. They point out that zones of inflow do exist, and if containment of possible leakage is a concern, zones of inflow are definitely preferable. The Swedish environmental movement has also criticized the concept of the Baltic Sea as an "appropriate recipient" of discharges (planned and unplanned) from nuclear installations - a view even SSI held some years ago - and opposes a coastal siting for that reason, as well.

SKB has been unwilling to follow this advice and start the search anew. That leaves the company in a weak position vis-à-vis the coming application and EIS. How can SKB AB show that they have chosen the optimal site? At a recent EIS consultation SKB was asked whether the initial criteria for the choice of site (dating from the mid-1970s) would be included in the EIS. The company spokesman answered, "No. They are quite irrelevant."

What about deep boreholes?

Two principal alternatives to the KBS-3 scheme have been on the table for rather many years. (3) One is Dry Rock Deposit, the other deposition in deep boreholes (at depths of 3-5 km). The DRD concept has been rejected out of hand, as it requires active surveillance and therefore cannot be considered a final solution. (SKB AB and the authorities seem to be of the same mind on that point.) In the case of deep boreholes, however, SKB AB has ignored SSI's urgings.

The KBS-3 scheme does not provide for retrievability. Neither do deep boreholes. The advantage of the deep borehole approach is that it relies on robust natural barriers. Groundwater mobility at such depths is significantly less than near the surface; and the sheer distance to the biosphere gives added security. Furthermore, deeper down, stagnant pools of heavy, stratified saline groundwater are believed to have

remained intact for hundreds of thousands of years. Deposition of waste below such pools would further reduce the upward mobility of possible leakage from a repository.

Naturally, there are many aspects of the deep borehole method that need to be explored. But SKB AB has been totally unwilling. In 2000, when authorities asked SKB to look into the alternative, the company claimed that it would take 30 years and some four billion Swedish crowns, over 400 million euro (SKB R-00-28) - which most regard as a gross exaggeration. As late as 2007 the Directors' Action Plan included the following declaration: "One objective is approval of the [Fud] program in its present state and without demands for major complements, like the deep borehole alternative, for example."

SSI cannot entirely contain their frustration over SKB AB's neglect of the deep borehole alternative and now, once again, reminds SKB of the formal requirement of a systematic comparison between deep boreholes and KBS-3 that SSI imposed years earlier. No determination of BAT or the optimality of SKB's proposed solution can be made without it, SSI notes.

Reality check!

First of all, it should be noted that SKB AB started its biosphere research only a few years ago.

SSI points to four principal faults in the methodology applied:

- It leads to a 'dilution' of radiation dose estimates.
- Relevant natural nuclide transport processes are missing in the models presented.
- The empirical validation of the models is weak or non-existent.
- There is no analysis of uncertainties.

The report dwells on gaps between various models and the linking of models without specifying the underlying assumptions. Particularly the consequences of one or more glacial cycles are in dire need of further research. One might forgive a comparatively young research area for its inconsistencies. But the gaps in knowledge and understanding become potentially dangerous when coupled to a heavy reliance on numerical modeling.

Will SSI's comments reach the Government?

All in all, SSI's is an extremely critical assessment. Vital elements in the KBS-scheme have not been sufficiently penetrated, and SSI calls upon the Government to instruct SKB AB to fill in the gaps.

Two things are remarkable about the present situation. One is how a well-financed (and, ostensibly, closely regulated) company like SKB AB could find itself so far off base so close to the completion of a 30-some year old R&D project.

Secondly, one would think that when a nation's radiation protection authority expressed itself in such unequivocal terms, there would be some corrective action. In Sweden this cannot be taken for granted. The formal procedure for comment on the final repository project is that the Radiation Protection Authority (SSI) reports to the Reactor Safety Inspectorate (SKI), who in turn reports to the Government. (SKI will submit its report June 26.)

MKG, one of the environmentalist organizations involved in the EIS consultations, has undertaken a thorough reading of all comment filed in the past. They found that on at least one occasion SKI withheld criticism on the part of SSI from the Government. At a consultation May 28, MKG asked a representative of SKI whether SSI's critique and recommendations will be passed on to the Government. She declined to answer.

Notes

- (1) SSI. *Avd. för teknik och avfall. SSI:s yttrande över SKB:s Fud-program 2007* (Dnr 2007/2969-26). Available in Swedish at www.ssi.se.
- (2) 'FUD' stands for Research, Development and Demonstration.
- (3) Both the two umbrella organizations made up of environmental groups have the position that more information is needed on alternatives. For information on dry rock deposit and deep boreholes see www.nuwinfo.se - The Nuclear Waste Management in Sweden Document Archive.

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