

**“Considerations on nuclear waste management in Sweden”,  
presentation of Dr. Johan Swahn, Director, The Swedish NGO  
Office for Nuclear Waste Review, MKG, at the European  
Parliament’s Committee on Industry, Research and Energy  
public hearing on management of nuclear waste, December 1,  
2010**

[Slide 1]

My name is Dr. Johan Swahn. I work as the director of the Swedish NGO Office for Nuclear Waste Review, MKG. I have been asked to give present some considerations on the management of nuclear waste in Sweden. I thank the Committee on Industry, Research and Energy for this possibility.

[Slide 2]

The Swedish NGO Office for Nuclear Waste Review, MKG, is an environmental organisation created by the largest Swedish environmental NGO, the Swedish Society for Nature Conservation, to work with nuclear waste issues. MKG receives funding from the Swedish Nuclear Waste Fund. The funding allows the organisation to participate in the consultation process for the development of the Environmental Impact Assessment for a Swedish repository for spent nuclear fuel.

The Swedish nuclear industry, via their special company created to be responsible for waste management SKB, have stated that they in March 2011 will apply for a permit to construct a Swedish repository for spent nuclear fuel. This is after a development and siting process of over thirty years. The repository is proposed to be sited adjacent to the Forsmark nuclear power plant on the Baltic Sea coast some hundred kilometres North of Stockholm.

During the consultation process that has taken place before the application a number of issues have been raised. Some of these are of quite grave concern when considering the long-term environmental safety of the Swedish repository project. All the issues will be addressed in the licensing process that starts after the license application has been handed in.

[Slide 3]

It is a big challenge to find a way of managing the most long-lived and dangerous waste from the production of electricity from nuclear power. The waste is highly radioactive and has therefore to be isolated from man and environment for hundreds of thousands of years. If the nuclear waste is the direct disposal of spent nuclear fuel, the plutonium remaining in the waste is possible to use for the production of nuclear explosive devices. As the most important plutonium isotope has a half-life of 24 000

years the nuclear proliferation risk, and the need for surveillance and safeguards, also exists for a timespan of over one hundred thousand years. Finally the repository will be a chemical risk for all future time as it will contain heavy metals and other elements that are chemically hazardous.

[Slide 4]

According to the Swedish Nuclear Act the nuclear industry is responsible for the management of the Swedish nuclear waste. They have to find a sustainable method for final disposal of the nuclear waste that meets stringent criteria for long-term safety, as set by the regulator. An economic system has been set up to guarantee that the polluter-pays-principle is upheld. For every kWh of nuclear electricity produced the nuclear electricity production companies have to pay a fee to the Swedish Nuclear Waste Fund. The nuclear industry has set up a special company and given it the task to meet the requirements of the Nuclear Act. The company is called the Swedish Nuclear Fuel and Waste Management Company, SKB. In Sweden the spent nuclear fuel is to be directly disposed of in a geologic repository. Early plans for reprocessing the spent fuel were abandoned already in the early 1980's. The nuclear waste company SKB has been working for over 30 years on developing a method for a repository and finding a site for the

disposal of Swedish spent nuclear fuel. The method they have developed is called the KBS method. It is this method that the Finnish repository planners now also want to use. It is important to understand that Finland relies entirely of the safety analysis developed in Sweden and can not proceed with their repository work if the Swedish repository is not given a final go-ahead after forthcoming license application has been reviewed.

I will come back to a discussion of the KBS method for a repository for final disposal for spent nuclear fuel and the environmental concerns about the method that will have to be dealt with in the licensing process. But first I want to give a brief overview of the Swedish system for management of nuclear waste.

[Slide 5]

For the Swedish low-level nuclear operational waste produced in the nuclear power plants as well as waste from hospitals and other industry, a repository for low-level nuclear waste called SFR has been built near the Forsmark nuclear power plant. Much of the transportation is done with a special ship called Sigyn.

[Slide 6]

The SFR repository is situated 50 m under the Baltic Sea and the safety case for the repository has to be proven for the a time-span of 500 years. The waste canisters are placed in tunnels or in a

central silo. The repository is present planned for expansion (the blue part) to allow for disposal of decommission wastes from the dismantling of phased-out Swedish nuclear reactors.

[Slide 7]

The spent nuclear fuel from the Swedish nuclear power plants is similarly shipped to a central interim storage facility called CLAB near the Oskarshamn nuclear power plant on the Southeast coast of Sweden.

[Slide 8]

The CLAB facility is placed 75 metres down in the bedrock. The spent fuel is stored in two large pools. All the spent fuel from the operating lives of all the Swedish reactors is in this facility.

[Slide 9]

The Swedish nuclear waste company SKB is now planning to try and go ahead with the next step for the management of the Swedish spent nuclear fuel. SKB is preparing an application for the license to construct a final repository for spent nuclear fuel. The license will also be for an encapsulation plant to put the fuel rods in copper canisters. The copper canisters are an important part of the safety case for the KBS method.

[Slide 10]

The Swedish project to find a method and site for a repository for high-level nuclear waste dates back to the mid-1970s. Thus, already over thirty years ago the so-called KBS repository method was developed. The present version of the method (KBS-3) came in 1983 (the orange report in the slide). The basic idea behind the KBS method is to construct a geologic repository about 500 m down in the Swedish bedrock. At this depth tunnels are excavated and the spent fuel is put in holes in the floor of the tunnels.

The fundamental safety system of the KBS project is the artificial barriers of copper and clay that enclose the spent fuel in the repository. The copper canister is the most important barrier and the idea is that the canister will only be very slightly affected by corrosion for over a hundred thousand years. The clay barriers most important function is to prevent ground corrosive water from reaching the copper.

The observant listener will of course see that the Finnish project for a repository described in the previous presentation is a copy of the Swedish repository project. I would like to repeat that the Finnish repository project for spent nuclear fuel is entirely dependent on the approval of the Swedish project in the forthcoming license review.

[Slide 11]

Before concluding with a discussion of the environmental issues that will be raised in the licensing review a few words about siting. After a long history of siting failures, the nuclear company SKB has since the turn of the century been carrying out site investigations at two sites, both right adjacent to a nuclear power plant (Oskarshamn, where also CLAB is situated and Forsmark where also SFR is situated). In June 2009 the Forsmark nuclear power plant site was chosen by the nuclear waste company SKB for a repository, with an encapsulation plant to be built at Oskarshamn.

[Slide 12]

The nuclear waste company SKB has stated it plans to submit an application for licensing of a KBS repository in Forsmark on March 16<sup>th</sup> 2011. The application will be submitted to the regulator (the Swedish Nuclear Safety Authority) according to the Nuclear Act and to the Environmental Court according to the Environmental Act. The license application will give the regulator the legal grounds to act fully on the issues of concern that it has, including the possibility to demand all the results from copper corrosion research carried out by SKB, some of which are now withheld by the company. A preliminary statement on the completeness of the application is expected after about three months. The whole

license review process will likely take three years or more. The regulator and the court will only give recommendations to the Government. It is the Government that finally decides if a permit is to be given or not. Such a decision is likely to come not earlier than in 2014.

[Slide 13]

There are a number of environmental concerns that will have to be handled in the licensing review process. A final repository for spent nuclear fuel cannot be allowed to release harmful radioactivity for a period of over 100,000 years. A geologic repository in Swedish bedrock at a depth of 500 m has corrosive groundwater flowing through the repository.

A repository using the KBS method therefore has to rely on man-made barriers (clay and copper) to isolate the nuclear waste from the environment. The chemical and biological environment will in the long term threaten the artificial barriers of copper and clay in ways that are difficult to foresee. The KBS concept is basically a model and whether the model is complete enough is now hotly debated.

Perhaps most importantly there has been much discussion in Sweden and internationally the last few years concerning the fundamental SKB understanding that copper is essentially

inert/immune to corrosion in the repository environment. The controversy remains unresolved but copper corrosion research results points to major problems.

[Slide 14]

In Sweden it is expected that there will several ice ages during the next 100 000 years. Glaciation will lead to extreme variations in the chemical and biological environment in ways that will affect the man-made barriers of copper and clay. Glaciation during ice ages will also physically affect a repository (lateral movement, major earthquakes, permafrost). The uncertainties of long-term physical, chemical and biochemical impact on a KBS repository means that there are still a number of unanswered questions in the safety analysis.

It is also important not to forget that spent nuclear fuel contains plutonium that poses a long-term nuclear weapons proliferation risk for over 100 000 years. This means there will be monitoring and surveillance demands for an extended future.

[Slide 15]

The regulator, the Swedish Radiation Safety Authority, and the Environmental Court will have to deal with a number of important issues as they review the forthcoming license application. First there are basic legal issues such as if the consultation process has

been properly carried out or if the environmental impact statement conforms to legal standards?

Then there is the issue of whether the complex model for the long-term safety analysis will hold up to scrutiny? The model has to show long-term safety for hundreds of thousands of years.

Are ice age scenarios covered in an appropriate way for example regarding permafrost or earthquakes? Are scenarios for future release of radioactivity and impact on the biosphere covered in an appropriate way? Can SKB show that the clay will not erode too fast during glaciation?

Then there is the issue of whether the “input data” to the model can be verified or at least made plausible? This concerns foremost what happens in the repository for the first 1 000 years. It is important to understand that there is extremely weak experimental support for the fundamental idea that copper does not corrode in the repository environment. The problems will be worse in the beginning when the spent fuel is hot. During this period it is also questioned whether the clay will swell and behave as predicted, which is also a necessity. As stated previously SKB has major problems with the results of research on copper and clay in a repository environment. Will the copper corrode very fast during the hot first thousands of years as some researchers claim?

[Slide 16]

Other licensing issues relate to intrusion scenarios, risks with retrievability and the need for long-term monitoring/information transfer to the future. The risks for unintentional or intentional intrusion have to be balanced with positive aspects of retrievability. The nuclear weapon proliferation risks with plutonium and the resulting need for long-term monitoring have to be considered. Finally there are issues regarding alternative siting and methods, which are important in the implementation of Swedish environmental law. SKB has to show that the site has been chosen in an appropriate way and that it is “the best site”. SKB also has to show that it has dealt with alternative methods in an appropriate way. Are there better alternatives “around the corner”? One method that has been much discussed is deep borehole disposal. The use of deep boreholes could give a higher long-term environmental safety and be less problematic for unintentional or intentional intrusions.

[Slide 17]

Even though the exact developments during the licensing process are very difficult to predict it is certainly possible that major problems for the Swedish nuclear waste company SKB will appear

in the review process. The licensing of the KBS method in Sweden is not a certainty.

If the issues regarding copper corrosion of the canister are found to be too serious to give a go-ahead, a question is if it is at all possible for SKB to modify the KBS method and come back. Or will the concept of using man-made barriers to achieve long-term safety have to be abandoned?

The KBS system, with its reliance on man-made engineered barriers for long-term safety has allowed repository siting in “almost any bedrock”. This makes it easier to site in “nuclear communities” that may be more positive to a repository. Siting may be more difficult without the availability of the KBS method.

Problems for the KBS method will affect the nuclear waste management systems in Finland, Canada, the UK, and elsewhere where the use of KBS method is planned or considered.

[Slide 18]

For those interested in more information the web site of the Swedish NGO Office for Nuclear Waste Review, MKG, is <http://www.mkg.se>. The site of the Swedish regulator, the Swedish Radiation Safety Authority is <http://www.ssm.se>. The site of SKB is <http://www.skb.se>.

With this I end my presentation. I thank you very much for your attention.