

Developing the first ever facility for the safe disposal of spent fuel

By Nathalie Mikhailova

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— Jussi Heinonen, Director, Nuclear Waste Regulation and Safeguards Department, Finland's Radiation and Nuclear Safety Authority

Following several decades of committed implementation of disposal strategies in Finland and Sweden, as well as cooperation in the development of a safe disposal solution based on a Swedish design, the first ever deep geological repository for spent fuel is being constructed in Olkiluoto, Finland. Sweden, along with other countries, is also working towards building such a facility.

After spent fuel is removed from nuclear power reactors, it continues to generate significant heat for several decades. It is therefore placed in water pools or in dry storage facilities to cool down. Storage pools and containers ensure that spent fuel maintains its integrity and no radiation or radioactive materials are released, thereby protecting people and the environment from exposure. However, spent fuel remains highly radioactive for several thousands of years and needs to be isolated for several hundred thousand years.

One way to dispose of spent fuel — when declared as waste — once the heat has decayed is to bury it in engineered facilities several hundred metres below ground level, in deep geological disposal facilities. The objective is to contain its radioactivity by encapsulating the spent fuel in robust and leak-tight containers and isolating it by burying it. Such facilities consist of a system of tunnels or chambers, built at a site geologically suitable for ensuring the long-term safety of the buried material (see the Science box).

The facility being built in Finland is based on the ‘KBS-3’ disposal concept, which was developed by the Swedish Nuclear Fuel and Waste Management Company (SKB), in close cooperation with Posiva, the Finnish company responsible for the disposal of spent nuclear fuel. The KBS-3 method consists of encapsulating spent fuel in corrosion-resistant copper canisters and embedding the canisters in swelling clay inside the repository’s tunnels up to 500 metres below ground level.

“Not only are we both opting for the direct disposal of spent fuel, but Finland and Sweden also have similar reactors,

which means that we have similar spent fuel. Expanding direct cooperation for various research and development activities made sense for both of us,” said Magnus Westerlind, Senior Advisor at the SKB. “For example, we have done basically everything related to the copper canisters as a joint development project.”

In both countries, government decisions in the late 1970s and early 1980s led to the introduction of policies requiring the producers of nuclear waste to also be responsible for its management. In Finland, spent fuel from the Loviisa nuclear power plant was transported to the Soviet Union, and later Russia, for reprocessing until 1996. When the Finnish government issued the operating license for the Olkiluoto nuclear power plant in 1978, it requested that the licensee develop a waste management plan, including for spent nuclear fuel, which had to be disposed of in Finland.

In Sweden, power plant owners came together in the late 1970s to form the SKB with a view to jointly manage spent fuel. This initiated research and development activities for the development of a disposal concept, which ultimately led to the KBS-3 method. This concept was selected as an appropriate means of waste disposal in 1983 and has since been developed further. A site for the implementation of this concept has been selected and plans for construction are under way.

“An important element in actually implementing the disposal strategy in practice is the review process, which takes place every three years,” said Westerlind. “As part of this process, numerous parties — universities, government agencies, non-governmental organizations and municipalities — are invited to comment on our strategy. This has made a significant contribution to not only the technical review of our programme, but also to making sure that the programme is in line with Swedish policies.” Furthermore, extensive work has been done, and is ongoing, to gain and maintain public acceptance for siting and construction of the spent fuel disposal facility, he added.

Constructing the first ever disposal facility in Finland

Before construction of a disposal facility can begin, the company in charge of implementing the concept needs to obtain a construction licence. In Finland, the licence was issued in 2015, marking the first time a construction licence for a geological disposal facility was received anywhere in the world.

The site was chosen following several years of screening a number of potential sites. After surveying the country's land mass based on geological information, Posiva continued site characterization through site-specific studies, which included drilling, to find a geologically suitable environment. During this process, Posiva also started discussions with several municipalities about hosting a facility.

“Social acceptance and social factors play a crucial role in site selection,” said Jussi Heinonen, Director of the Nuclear Waste Regulation and Safeguards Department at Finland's Radiation and Nuclear Safety Authority (STUK). “Social acceptance relates to trust for the implementer, regulator and decision makers. This trust has to be built and maintained.”

Posiva is in the middle of the construction of the ONKALO disposal facility, at a depth of over 400 metres below ground level and is set to begin the excavation of the disposal tunnels soon. The disposal process is planned to start in 2024.



Progress in other countries

In 2011, the SKB submitted its licence application for the construction of a disposal facility in Forsmark, 150 kilometres north of Stockholm, which was reviewed by the Swedish Radiation Safety Authority (SSM) and the Land and Environmental Court. These authorities have since submitted their review statements to the government for a final decision on the licence.

Finland and Sweden are not the only countries making progress in this area. In France, the radioactive waste management agency Andra is currently preparing its licence application. In Canada and Switzerland, national waste management agencies are investigating appropriate sites through site characterization.

The Onkalo disposal facility for spent fuel being constructed in Olkiluoto, Finland, consists of an engineered system of tunnels. Onkalo is also used to characterize the host rock to support safety case development.

(Photo: Posiva Oy)

THE SCIENCE

Deep geological disposal facilities

Intensive research has identified the suitability of various rock types to host deep geological disposal facilities to isolate radioactive waste. These disposal facilities are constructed in suitable geological formations at a depth of several hundred metres and designed to contain high-level waste for hundreds of thousands of years.

A key characteristic of deep geological disposal facilities is that they provide passive safety, meaning that once the disposal facility has been closed, no further human action is required.

Building these disposal facilities several hundred metres below ground level, at a depth that effectively isolates waste from potential surface perturbations for hundreds of thousands of years, involves placing the waste in a non-dynamic environment, as opposed to a more dynamic, near-surface geological environment, where conditions tend to be less stable.