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Spent Fuel Repository

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Spent nuclear fuel is highly radioactive. In order not to cause harm, the fuel must be kept isolated from man and the environment for a very long time. The solution is a final repository at a depth of nearly 500 metres, where three different barriers prevent the radioactive substances (radio-nuclides) in the fuel from reaching the ground surface.

The operation of the Swedish nuclear power plants over the past fifty years or so has given rise to spent nuclear fuel. At present the spent fuel is being stored in water-filled pools in Clab, a facility outside Oskarshamn, awaiting disposal in a final repository. The fuel is stored for at least 30 years to allow most of the radioactivity to decay. That makes the fuel easier to handle during deposition in the final repository.

Today Clab contains around 6,500 tonnes of spent fuel. Each year an additional 200 tonnes is stored there. By the time all the original twelve reactors in the Swedish nuclear power programme have been taken out of service, they will have given rise to 12,000 tonnes of spent fuel. This is the amount which the Spent Fuel Repository has been designed and built for. The Spent Fuel Repository is not intended to receive spent fuel from possible future reactor types, nor spent fuel from other countries.

What makes the question of final disposal of spent nuclear fuel so complicated is the mind-boggling time perspective. The fuel will be radioactive for a longer time than mankind has existed up to now. To prevent it from causing harm – today or in the future – it must be isolated from man and the environment for a very long time. The Spent Fuel Repository is therefore based on a method where three barriers (the canister, the buffer and the rock) together prevent the radionuclides in the spent fuel from reaching the ground surface and causing harm to man and the environment.

In the spring of 2011, Swedish Nuclear Fuel and Waste Management Company (SKB) applied for a licence to build the Spent Fuel Repository in Forsmark in Östhammar and an encapsulation plant next to Clab in Oskarshamn. The regulatory authorities have examined the applications for many years. Now the applications is with the government for continued handling. SKB hopes to be able to start work on the construction in the early 2020s and reckons that the Spent Fuel Repository can then be ready to start operations

Facts about the Spent Fuel Repository

Number of deposited canisters: 6,000

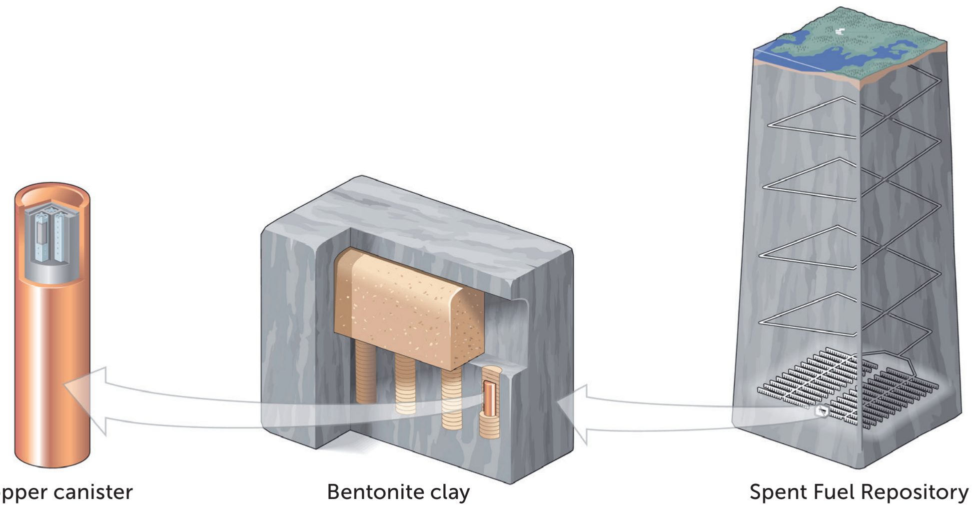
Excavated rock volume: 2,300,000 m^3

Tunnel length: about 60 km

Surface area underground: 3–4 km^2

Depth: 500 metres

The final repository for spent nuclear fuel is planned to be built in Forsmark. The surface facilities will be clustered at Söderviken near the cooling water channel to the nearby nuclear power plant.



Three barriers – the canister, the buffer and the rock – together prevent the radionuclides in the spent fuel from reaching the ground surface.

about ten years later. The reason why SKB selected Forsmark is that it is a site that offers good prospects for the long-term safety of the nuclear fuel repository. The rock is stable and homogeneous, with few fractures and low water flows at depth.

The Spent Fuel Repository consists of two parts: an operations area on the ground surface and a deposition area below ground. The canisters containing the spent nuclear fuel are handled in the surface facility. Buffer and backfill material are also produced there. A spiral-shaped ramp provides access to the central part of the underground facility.

300-metre-long tunnels

The underground facility consists of a number of tunnels located at a depth of about 500 metres. A large number of deposition tunnels branch off at right angles from the central transport and main tunnels. The deposition tunnels are up to 300 metres long and spaced at a distance of about 40 metres from each other. Eight-metre-deep deposition holes are bored at intervals of six metres in the tunnel floors. The canisters containing spent fuel will be deposited in these deposition holes surrounded by the bentonite buffer.

Construction of the tunnel system and deposition of canisters in the Spent Fuel Repository will proceed in parallel over a period of many years in separate operation areas. When all deposition holes in a deposition tunnel are full, the tunnel is back-filled with clay. Finally, when all canisters have been deposited, the entire repository is backfilled.

As construction of the Spent Fuel Repository proceeds, the facility will be adapted to local conditions in order to minimize the risks. For example, we will position the deposition tunnels in the most favourable direction in relation to the rock stresses encountered. This will reduce the risk of stability problems during construction. We will also make sure that the distance to large fracture zones in the rock is great enough and that the deposition holes are not intersected by long fractures. This reduces the risk that a canister will be damaged if an earthquake should occur nearby at some time in the future.

Barriers in the Spent Fuel Repository

The first barrier is the copper canister. The canister is nearly five metres long and has a diameter of over one metre. The outer shell is made of copper and is five centimetres thick. Inside the copper shell, an insert of nodular iron (a kind of cast iron) provides the necessary strength. The canister weighs between 25 and 27 tonnes when filled with spent nuclear fuel. Approximately two tonnes of the total weight is spent fuel. The canister is designed to isolate the spent fuel. As long as it is intact, no radionuclides can escape from it.

The copper canisters with the spent fuel are surrounded by 30-centimetre-thick rings and blocks of bentonite clay. The bentonite clay swells when it absorbs water and acts as a buffer between the canister and rock walls of the deposition holes. If a canister should start to leak, the bentonite buffer will capture and retard the spread of radionuclides from the canister. The buffer also prevents harmful substances dissolved in the groundwater from corroding the canister and protects the canister from small movements in the rock.

The third barrier that prevents the radionuclides from finding their way to the surface is the rock itself. Virtually all radionuclides are filtered out by the fracture-filling minerals and micropores in the rock. The rock also isolates the waste from everything that happens on the ground surface.

SKB is tasked with managing Swedish nuclear fuel and radioactive waste in a safe way. For more information see www.skb.se.