SFR

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Radioactive operational waste is disposed of in SFR, which is situated near the Forsmark Nuclear Power Plant.

This is where Sweden's radioactive operational waste is kept

SFR, the final repository for radioactive operational waste, was the first facility of its kind in the world when it was built. It contains waste from nuclear power plants as well as from other activities.

Sweden has been producing electricity by means of nuclear power for over 30 years. Operation of a nuclear power plant gives rise to different types of radioactive waste. The spent nuclear fuel accounts for by far most of the radioactivity in the waste. Spent nuclear fuel is both high-level (requires cooling) and long-lived.

Operational waste is also generated. It is low- or intermediate-level (does not require cooling) and also relatively short-lived. The operational waste may consist of filters used to collect the radioactive substances in the reactor water, tools and protective clothing. Radioactive substances may also adhere to the walls in pumps, pipes and valves. When these components are replaced, the old parts have to be disposed of.

The industry's responsibility

The nuclear power industry was given responsibility for management and disposal of all radioactive waste from its plants back in the 1970s. The owners of the nuclear power plants therefore formed Svensk Kärnbränslehantering AB (SKB, the Swedish Nuclear Fuel and Waste Management Company). A fund to finance the programme was also established.

SKB was given the task of organizing the work of disposing of the waste. We have a specially-built ship for shipping the waste, a final repository for different types of operational waste, and an interim storage facility for spent nuclear fuel. Construction of a final repository for the spent nuclear fuel is also on the agenda.

SFR is located 50 metres beneath the bottom of the Baltic Sea adjacent to the Forsmark Nuclear Power Plant.

Besides low- and intermediate-level waste from the nuclear power plants, other radioactive waste from medical care and industry is also taken there. These wastes are processed and packaged in Studsvik outside Nyköping. The activities at Studsvik also generate their own radioactive waste.

Expandable facility

The facility has the capacity to accommodate 63,000 cubic metres of waste and can be expanded if needed. So far nearly 31,000 cubic metres of the space has been utilized. Just under 1,000 cubic metres of waste is added every year. SFR is

owned by SKB, but operated by Forsmarks Kraftgrupp AB. Around ten people work in the facility.

The repository consists of four 160-metre-long rock vaults, plus a rock cavern with a 50-metre-high concrete silo. Two parallel kilometre-long access tunnels connect the facility to the ground surface.

The waste in the silo consists primarily of solidified filter resins used for purification of water from the reactors. The filter resins are classified as intermediate-level waste and contain most of the radioactivity in the facility. The space between the silo and the rock wall has been filled with bentonite clay. The clay prevents groundwater from entering the silo. All handling of waste in the silo is automated and remote-controlled.

Divided into shafts

The silo has an inside diameter of 26 metres and holds 18,000 cubic metres of waste. About 4,000 cubic metres of waste has been deposited so far.

Internally the silo is divided into deep shafts measuring 2.5 square metres . The shafts are separated by concrete walls. Six metres of waste are deposited at a time in each shaft. Then it has to be grouted with concrete before any more waste can be stacked on top of it.

Low-level waste from the nuclear power plants is deposited in one of the four rock vaults. It consists of such items as used protective clothing. The waste is transported to SFR in standard freight containers. Then the unopened containers are driven directly into the rock vault by an ordinary forklift truck. The radioactivity is so low that the waste can be handled without any radiation shielding.

SFR is located 50 metres beneath the bottom of the Baltic Sea.

Interior from SFR.

Radiation shielding required

The three remaining rock vaults are used to dispose of the intermediate-level waste. The radioactivity is so high that the radiation shielding is required. Dewatered filter resins in concrete tanks are kept in two of the vaults. These waste packages are handled by a radiation-shielded forklift truck. The last rock vault contains more hard-to-handle waste, which is emplaced in shafts. When the shafts have been filled they are sealed with concrete lids. The waste in this vault is handled with a remote-controlled overhead crane.

The waste has not been transported to SFR at the pace originally assumed when the facility was built. The main reason for this is that the technology for treating and compacting the waste at the nuclear power plants is constantly being improved, reducing the waste volumes.

So there is plenty of room in SFR. However, some of this space will be used when the nuclear power plants get older. The need for modernization and maintenance increases then. The work of replacing various items of equipment gives rise to what is known as “odd waste”. Odd waste consists mainly of large components such as pipes and turbine parts. Today reactor vessel heads from Studsvik already have been emplaced in SFR.

One day when the nuclear power plants are decommissioned and dismantled, 150,000 cubic metres of low- and intermediate-level decommissioning waste will also arise. This waste is planned to be disposed of in SFR. To make room for all this waste, we will have to expand the facility with a number of additional rock caverns. Doing this takes about seven years and requires a special permit. Today the repository is only intended for operational waste, as its name indicates.

Prior to decommissioning of the nuclear power plants, SKB will apply for a permit to expand SFR and dispose of decommissioning waste there. According to SKB’s and the power plants’ plans, this expansion will be finished in around 2020.

The Facility

SFR consists of four rock vaults and a silo. The facility is located 50 metres beneath the bottom of the Baltic Sea. Operational waste from the nuclear power plants and low- and intermediate-level waste from other waste producers are brought here.

❷ Casks with intermediate-level waste are carried to the top of the silo by overhead crane. The silo is divided into shafts into which the casks are lowered.

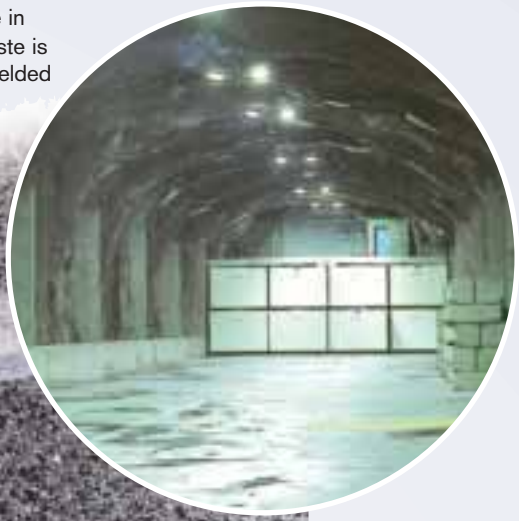
❶ The transport cask is unloaded in an unloading niche by means of remote-controlled equipment.

Facts about SFR

Location	Forsmark
Start of construction	1983
Start of operation	1988
Capacity	63,000 m³
Reception	About 1,000 m³/year
Surface facility	Office and workshop building, terminal building and ventilation building.
Underground facility	Four rock vaults, one silo and one operations centre.
Personnel	About ten people

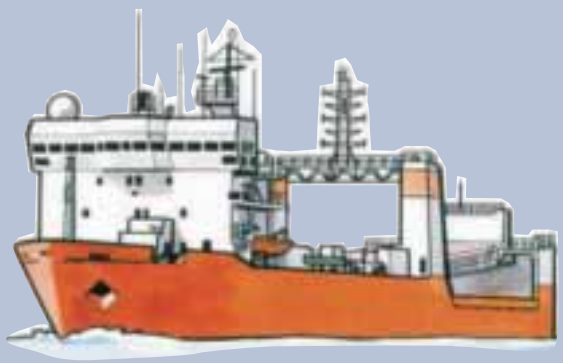
3 Unloading of waste is done by remote control from a control room.

4 Intermediate-level waste in concrete tanks. The waste is handled by radiation-shielded forklift trucks.



5 Low-level waste is deposited in standard freight containers.

6 A rock vault fitted with shafts. Intermediate-level waste in drums or moulds is deposited in the shafts. When a shaft is full a concrete lid is placed on top of it.



Transportation

Transportation of low- and intermediate-level waste takes place by sea. The ship m/s Sigyn is specially designed for transporting various types of radioactive waste. Sigyn is 90 metres long, 18 metres wide and can transport 1,400 tonnes of waste.

SFR is located 50 metres beneath the bottom of the Baltic Sea. Below the seabed the groundwater pressure is uniform and the water in the bedrock is virtually immobile.

In safe-keeping

SFR has performed very well. No radioactivity is released, and the radiation dose to the personnel is low. Multiple barriers prevent the radionuclides from escaping into the environment.

Why is SFR located in Forsmark? The answer is simple. It is a good location from a safety viewpoint. The facility is located 50 metres beneath the seabed, which is in turn covered by five metres of water.

The only way radionuclides could be transported from the repository into the surrounding environment is with the groundwater. The groundwater pressure beneath the seabed is uniform. As a result, the groundwater in the surrounding rock is virtually immobile. It is therefore not surprising that the groundwater in SFR is 7,000 years old.

Most of the radioactivity in the facility is present in the silo.

When SFR is eventually closed and sealed, the radionuclides will be contained in various types of waste packages, which will in turn be surrounded by multiple barriers. The repository will gradually fill with groundwater from the surrounding rock. And as noted above, only the groundwater can transport radionuclides out into the surrounding environment.

Retard transport

The purpose of the barriers is to prevent – or at least retard – this transport of radionuclides. They will be transported so slowly that the radioactivity will decay before the toxic substances reach the environment. Some of the barriers are engineered, such as the bentonite clay around the silo. And some are natural, such as the rock itself.

Most of the radionuclides are contained in the silo. They are sealed in the waste packages, which are in turn immobilized in containers of steel or concrete. In the shafts in the silo, the containers are embedded in concrete. The next barrier is the silo's concrete wall, which is nearly one metre thick.

Between the outer wall of the silo and the rock is a thick layer of bentonite clay. The impervious clay prevents groundwater from flowing through the silo. It also acts as a filter and captures any radionuclides that might escape from the silo. Moreover it protects the silo from movements in the rock.

The outermost barrier is the rock in which the repository is built. The rock also has a retarding effect on radionuclide transport, since the radionuclides tend to adhere to the surface of fractures and cavities. Radionuclide transport in the rock is therefore much slower than the transport of groundwater.

Safe operation

The radioactivity in the final repository's rock vaults is considerably lower. More than adequate protection is provided by a combination of barriers such as the waste packages, the concrete backfill, the rock vault's concrete structure and the surrounding rock.

In normal operation, no radioactivity can be released from the repository, since the radionuclides are isolated in the waste packages. The facility will soon have been in operation for two decades, and so far we have not had any serious incidents. Radiation doses to the personnel and releases to the environment have remained well below the legal limits.

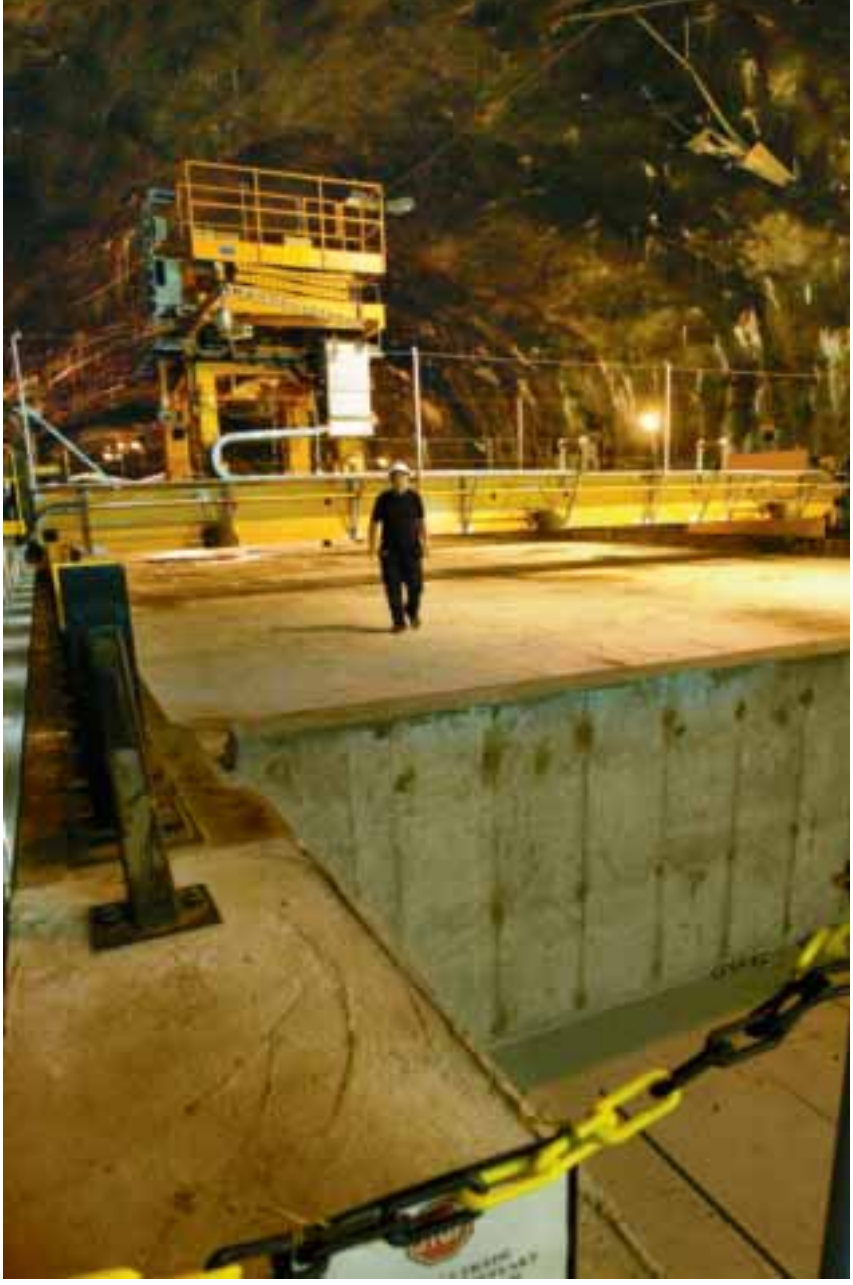
In the event of a fire or a transport accident, however, the possibility of a release cannot be ruled out. The handling equipment has therefore been specially designed to reduce the risk of mishaps. There is also extensive fire protection and emergency plans for various accidents.

Furthermore, we conduct regular assessments of safety in the facility. They show that even the worst scenario – a fire that takes a long time to extinguish – has very little impact on the surrounding environment.

Long-term safety

Most of the safety assessment is devoted to the facility's long-term safety, however. The calculations show that SFR is a safe facility. Not even under the worst possible conditions do the releases exceed the regulatory limits.

We will also carry out extensive monitoring throughout SFR's operating lifetime. We measure groundwater flows, groundwater chemistry, rock movements, the performance of the bentonite clay and the properties of the waste. Beyond this there is an extensive programme for monitoring conditions in the surrounding environment. The information obtained from all of these measurements provides valuable input data to the calculations in our safety assessments.



Throughout SFR's operation, radiation doses to the personnel and releases to the environment have remained below the legal limits.

Different types of waste containers for low- and intermediate-level waste.

Our way of life gives rise to hazardous waste.
Some of it is radioactive.
The waste must not be passed on to future generations,
but rather be managed and disposed of today.
Svensk Kärnbränslehantering AB
(the Swedish Nuclear Fuel and Waste Management Co.)
has been assigned the task of managing and disposing
of the radioactive waste from the nuclear power plants.
We have developed a system for disposing
of this waste safely and permanently.

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