Final repository for spent nuclear fuel

SKB

We manage and dispose of the spent nuclear fuel

Manufacture of nuclear fuel.

SKB manages and disposes of the spent nuclear fuel so as it does not cause any harm to humans or the environment – now or in the future.

Every type of energy has its advantages and disadvantages. Nuclear power has given us electricity at reasonable prices. And it does not create any major emissions that influence the climate. A disadvantage is that it creates radioactive residual products that are harmful to humans and the environment. SKB's remit is to manage and dispose of the radioactive waste in a manner safe for humans and the environment – both in the short and the long term.

Important component missing

In recent decades we have built up a system of plants for managing and disposing of various types of waste, but an important part is still missing – a final repository for the spent nuclear fuel.

When the fuel can no longer be used in the reactor is it stored for a year in the nuclear power station's own pool. It is then transferred to the central interim storage facility for spent nuclear fuel (Clab) near Oskarshamn Nuclear Power Station.

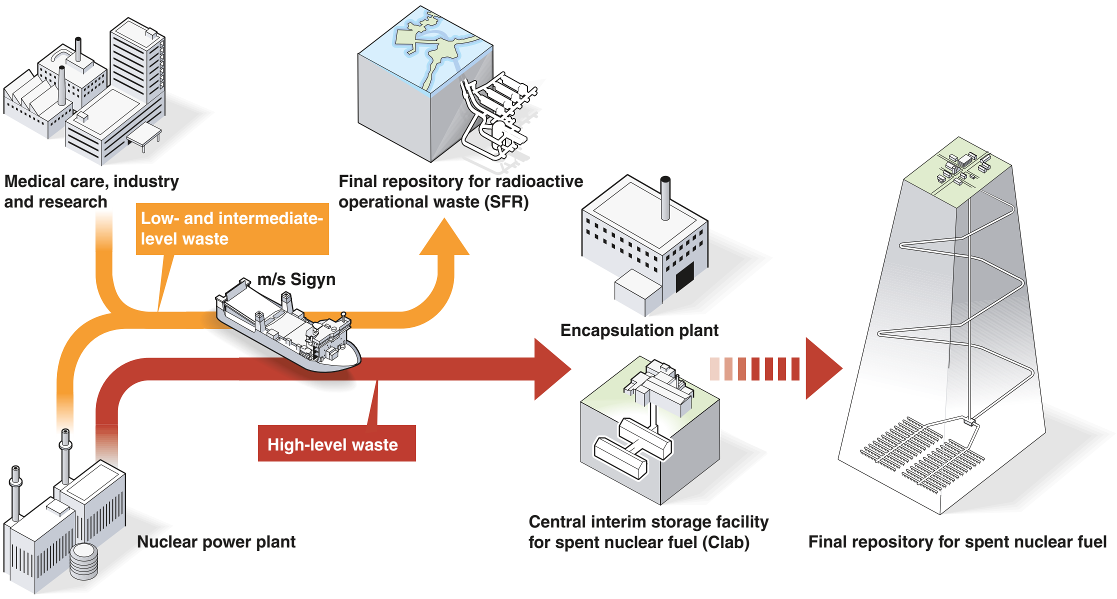
The fuel must be stored there for about 30 years before it is encapsulated and deposited in a final repository. Clab is authorised to store 8,000 tonnes of fuel. There is currently about 5,000 tonnes there.

Less hazardous as time passes

There is currently no commercially available technology for rendering spent nuclear fuel harmless, though it becomes less hazardous in the course of time. To reduce the risk of personal injury or harm – now or in the future – we must make sure nobody comes into contact with the fuel for as long as it remains hazardous.

Our method means that the spent fuel is encapsulated in copper and is embedded in clay about 500 metres deep in the bedrock.

Over a billion years have passed since the Swedish crystalline basement was formed. It is the most stable environment we know and the most suitable end location for the spent nuclear fuel.

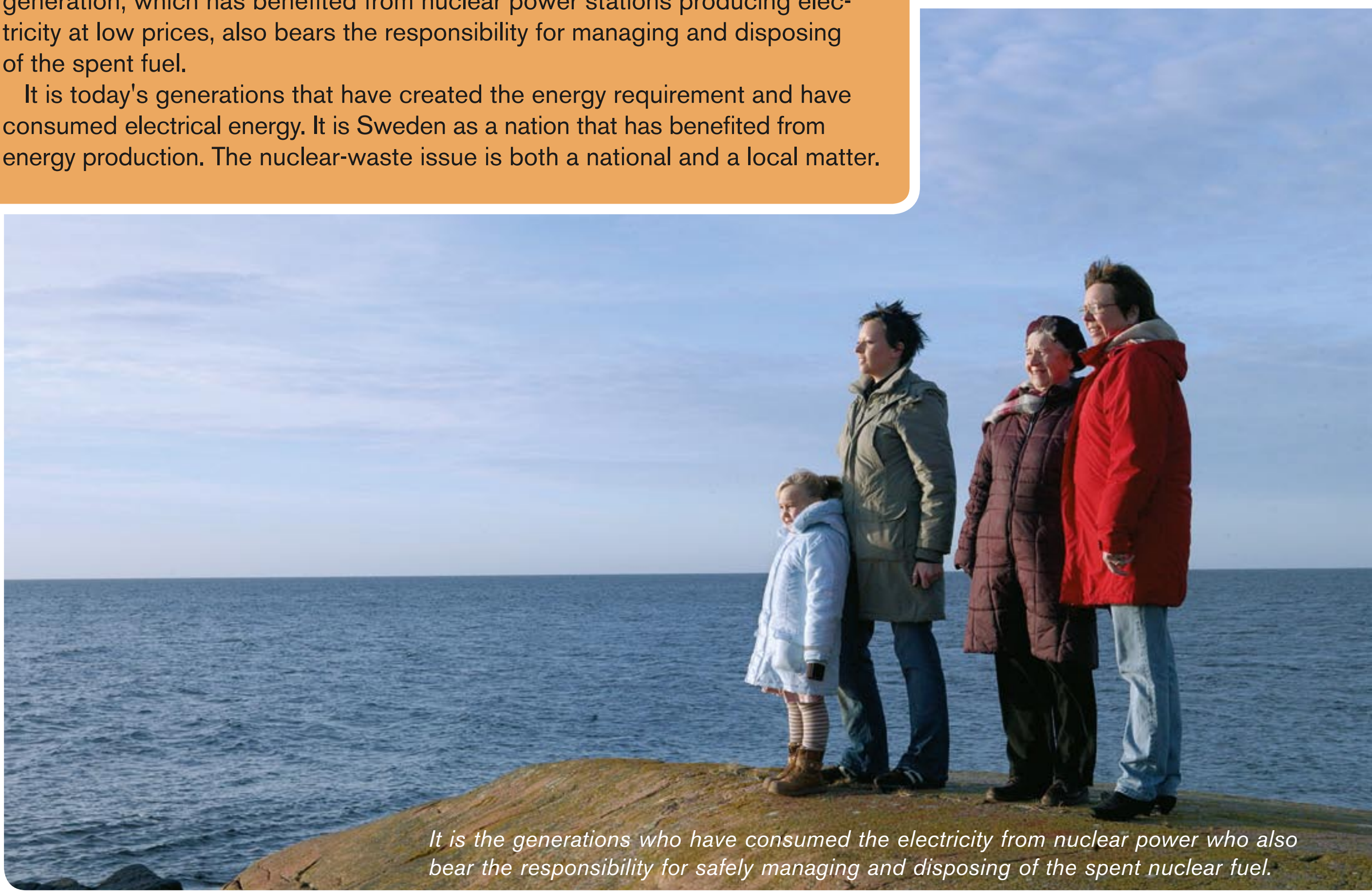


Sweden has a well-functioning system for managing and disposing of various types of radioactive waste.

A QUESTION OF RESPONSIBILITY

The question of nuclear waste is ultimately about responsibility – responsibility on the part of SKB, individuals and the nation. SKB's perception is that our generation, which has benefited from nuclear power stations producing electricity at low prices, also bears the responsibility for managing and disposing of the spent fuel.

It is today's generations that have created the energy requirement and have consumed electrical energy. It is Sweden as a nation that has benefited from energy production. The nuclear-waste issue is both a national and a local matter.



It is the generations who have consumed the electricity from nuclear power who also bear the responsibility for safely managing and disposing of the spent nuclear fuel.

Two candidates for final disposal: Forsmark and Laxemar

Drilled-out rock cores create knowledge about the rock.

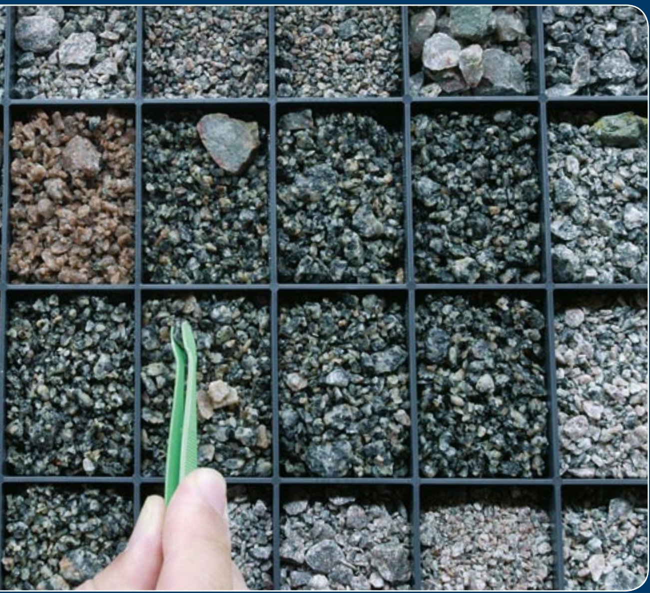
Two sites remain in the search for a suitable site for the final repository for spent nuclear fuel: Forsmark in northern Uppland and Laxemar in eastern Småland.

Site investigations have been in progress since 2002 at the sites in question, and are now largely completed. The main aim of a site investigation is to determine the location of major fracture zones in the rock and the properties of the rock between them. This means that we are drilling a number of holes in the bedrock and are as well thoroughly investigating the surface environment.

The investigations have generated an abundance of data on geology and hydrology and the conditions on the surface. The data from the sites in question constitutes information for the site descriptive model that is being developed. We are also creating a layout of what the facility would look like on each site. The description of the facility and the site descriptive model will then form the starting point for a safety analysis, which in turn will constitute part of the the application regarding the final repository.

Site selection in 2009

We are reckoning on being able to select a site in 2009. The site ultimately chosen must be suitable and must meet all the safety and radiation-protection requirements. It must also satisfy the technical requirements for construction of a final repository. Establishment of the facility and operations must



Rock cuttings from shallow drill holes.

The site investigations have meant thorough investigation of the environment on the surface.

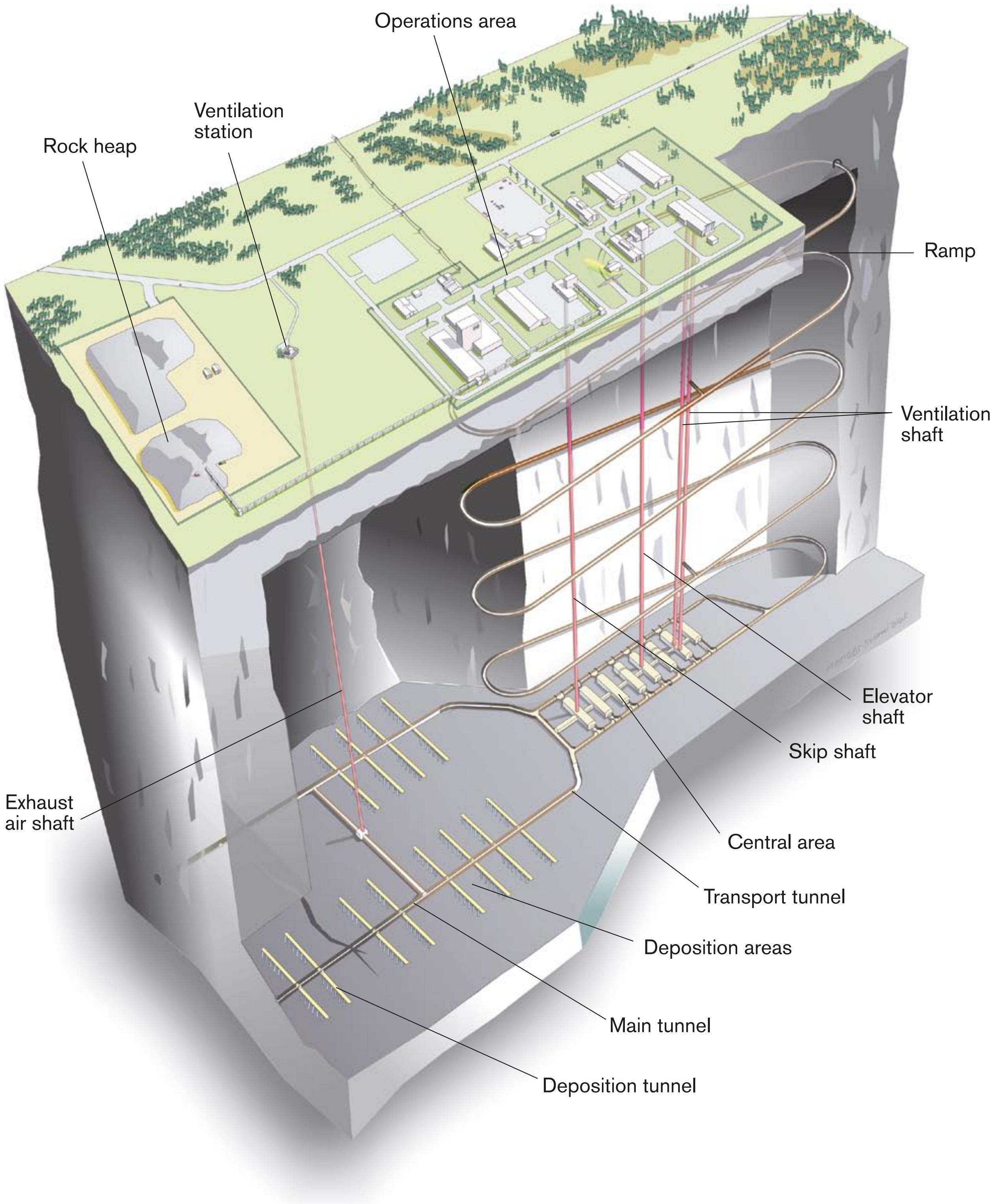
be possible with regard to other environmental factors. The site must also be accessible in physical terms, which in practice means that SKB must own the land. Furthermore, it must be viable in social terms, i.e. use of the site must be supported by local residents.

Two-stage evaluation

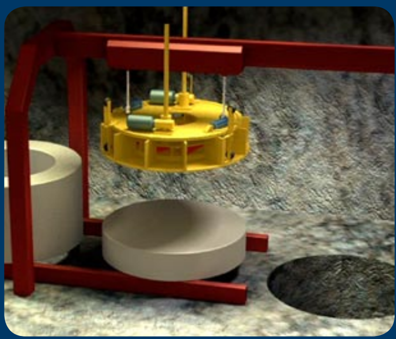
The two sites will first be evaluated individually. If the individual evaluations show that both sites are suitable they will be compared with each other.

The mutual evaluation will largely be performed in accordance with the same criteria as for the basic assessment. The aim is for the comparison to lead to a clear decision by SKB and a well-motivated choice.

The final repository above and below ground



The final repository will comprise two different parts – one surface facility and one underground facility.



A specially made tool will lift the buffer into position.

The canisters will be deposited using a depositing machine.

The Prototype repository in the Äspö Hard Rock Laboratory – a copy of the finalrepository.

MILESTONES FOR THE FINAL REPOSITORY

- Site selection
- Permit applications
- Linking up Clab and the encapsulation plant
- Application for trial operation
- Application for routine operation

In the final repository the canisters containing the spent nuclear fuel will be deposited at a depth of 500 metres, surrounded by bentonite clay.

On the surface there will be a medium-sized industrial plant. In addition to offices and staff areas there will also be a factory there to manufacture the bentonite blocks and bentonite rings that will be used for disposal. There will furthermore be a reception section there for transport containers bearing filled copper canisters.

Ramp and shaft provide links

From the part above ground a long ramp will lead to a system of transportation and deposition tunnels at a depth of about 500 metres. There will also be connections between the above-ground section and the underground section in the form of a shaft for lift transportation, ventilation etc. The canisters containing the spent nuclear fuel will come into the final repository in transport casks, which will also act as radiation screens. The casks will also afford protection in the event of any accidents.

Remote-controlled disposal

In each depositiontunnel there will be a number of deposition holes where the canisters containing the spent fuel must be deposited, surrounded by a buffer of bentonite clay. The canister will be transferred to a remote-controlled and radiation-screened deposition machine. It will drive up to the correct depositionhole and will lower the canister into the hole.

When all disposal sites in a tunnel have been used the tunnel will be filled in with blocks of swelling clay. All other underground areas and all access routes will be filled in when the last fuel has been deposited.

The barriers for final disposal

The main task of the rock is to protect the canister and the buffer.

The final repository must have several barriers and be made of materials that occur naturally in the earth's crust.

The final repository will be equipped with both belts and hangers. We will make it of materials occurring naturally in the earth's crust. As far as possible the idea is for storage to resemble natural conditions, thereby avoiding any undesirable effects resulting from use of foreign materials.

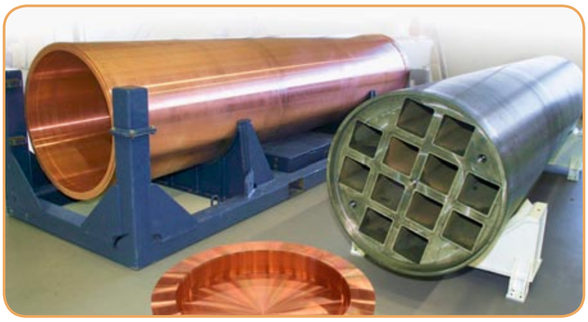
The final repository will be built in accordance with the multi-barrier principle. Three barriers (the canister, the buffer and the rock) will together prevent radioactive substances from the spent nuclear fuel from harming people or the environment.

The canister

The canister perhaps plays the most important role in final disposal. Provided the seal is tight no radioactive substances will escape into the environment.

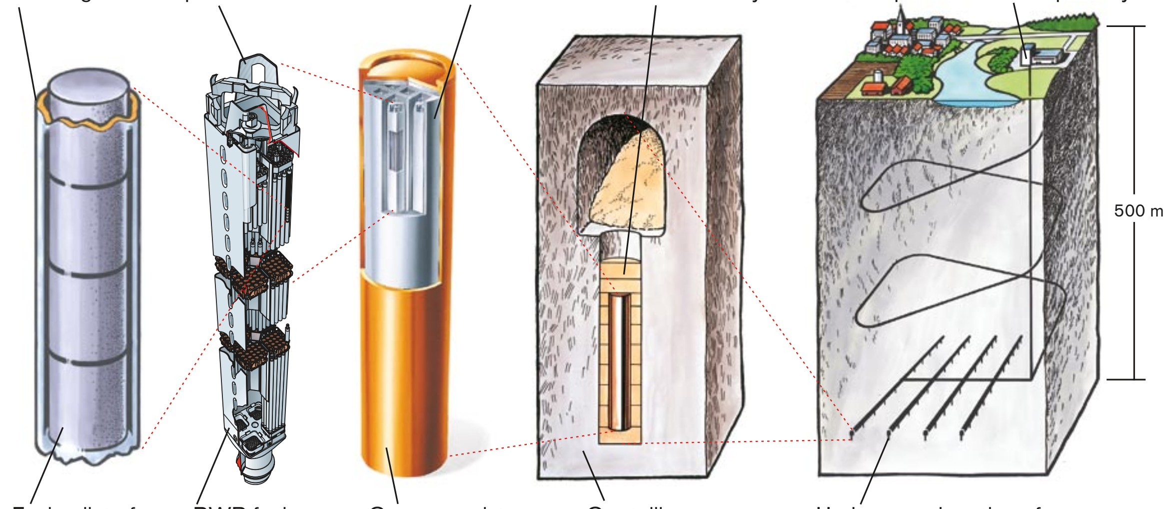
The outer sleeve is made of copper and is five centimetres thick. Copper is a material that is highly resistant to corrosion in the oxygen-free environment of a final repository.

Inside the canister there is a cast-iron insert. This is to give the canister sufficient strength, so it will be capable of withstanding movements in the rock and the weight of inland ice.



The various parts of the canister.

During disposal, the radiation from the canister must be screened off.



In the final repository several barriers must ensure that the radioactive substances do not harm people or the environment.

The buffer is made of bentonite clay.

The buffer

Before the canister is lowered into the deposition hole the latter will be clad with blocks and rings made of bentonite clay so as to form a layer between the walls of the hole and the canister. The layer is called a buffer, as its purpose is to absorb small movements in the rock and chemical changes in the groundwater.

The bentonite clay swells when it comes into contact with water, and becomes extremely tight. Substances that may cause corrosion in the canister will then find it hard to get to it. The buffer simultaneously prevents radioactive substances emanating from an untight canister from escaping to the surface.

The rock

The main task of the rock in storage is to protect the canister and the buffer so that the waste remains isolated.

The secondary task of the rock is to delay transportation of radioactive substances up to the surface.

For the canister it is important that the groundwater in the rock be free of loose oxygen. A low renewal level of water in the rock is advantageous to all barriers.

How we will build and run the final repository

Drilling of deposition holes.

The final repository will be built and will be in operation for the greater part of this century. A total of 6,000 canisters will be deposited.

When all permits have been issued and all terms have been clarified the final repository will be constructed – both the underground part and the part at surface level. The underground construction will firstly comprise access routes to the repository level. When we have got down to repository level, transport tunnels, the central area and the first deposition tunnels will be built (see sketch on p. 6).

In parallel with this there will be investigations for detailed planning of the facility in accordance with the set requirements and restrictions. These investigations will also verify the assumptions that have formed the basis for the safety analysis regarding the final repository. Surface buildings and infrastructure needed for running of the facility will be constructed.

Will be commissioned gradually

The different parts and systems of the repository will be commissioned gradually, as they are put in place. The systems will be tested – first separately, then jointly within the plant and finally together with

All systems must be tested – first separately and then together.

The deposition tunnels will be filled with blocks and pellets made of bentonite clay.

The tunnels in the final repository must be backfilled.

This is what the sealing of a disposal tunnel might look like.

adjoining plants – i.e. including encapsulation and transportation. The aim is for the entire system to work on an industrial scale, both technically and organisationally. The fine-tuning of technology and organisation will conclude with joint-function testing of the entirefacility. As early as possible during commissioning we will renew the analyses for both long-term and operational safety. In conjunction with this we will submit an application for trial operation.

The commissioning will conclude when the authorities issue a permit for trial operation.

The operational stage will start with a period of trial operation, when for the first time canisters containing spent nuclear fuel will be coming into the plant. Disposal of canisters of spent nuclear fuel will commence, and the disposal capacity will gradually be built up. Trial operation will later move on to routine operation.

In addition to disposal, operation will also include ongoing investigations and analyses, planning, rock work and recurrent safety analyses. Operation of the final repository thus entails continuous planning, construction and disposal. Operation will continue until the final deposition tunnel has been sealed.

This leaflet is about how we will build the final repository for spent nuclear fuel in order to protect people and the environment in the short and long term.

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