What is a geological disposal facility?

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A geological disposal facility (GDF) stores and manages waste from nuclear power generation. It is a highly sophisticated engineering operation, which involves placing solid radioactive waste in robust, multi-layered engineered containers (for example, copper and steel canisters), that are then placed in purpose-built tunnels in an underground facility and sealed into place.

Geological disposal via a multi-barrier system is a permanent, passive technique, removing the need for future generations to manage the waste.

Geological disposal has been adopted as national policy in many countries, including Belgium, Canada, Finland, France, Germany, Sweden, Switzerland, the United Kingdom, and the United States of America.

Used nuclear fuel disposal cannister

Geological disposal is viewed by expert scientists and governments around the world as the best available solution for managing used nuclear fuel over the long term.

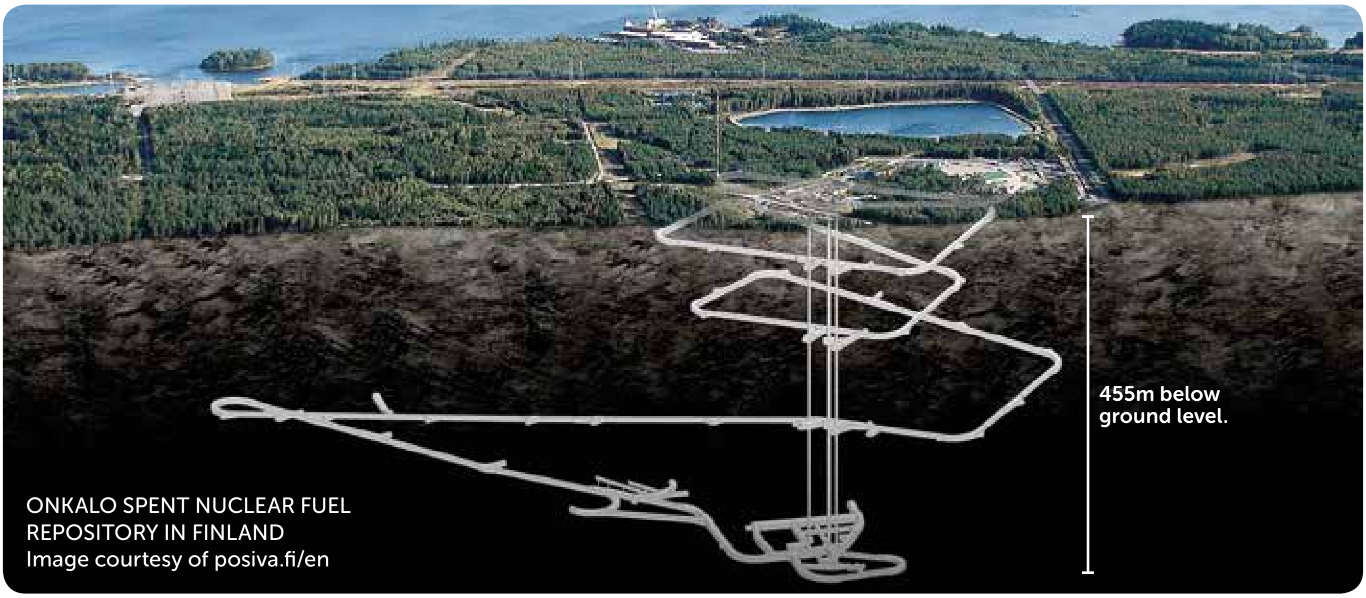
Is this happening anywhere else in the world?

There are GDF programs in development, or facilities scheduled to begin operation in the next few years, in Finland, Sweden and Switzerland. France has identified a site and has built an underground research laboratory to undertake detailed examinations of the host geology.

How is the waste stored?

Multiple barriers help to ensure that nuclear waste will not be released into the environment or accessible to humans while it remains hazardous.

In Finland, used nuclear fuel will be stored in cast iron and copper canisters inside the Olkiluoto bedrock in Finland, at a depth of about 455 metres.



ONKALO SPENT NUCLEAR FUEL REPOSITORY IN FINLAND
Image courtesy of posiva.fi/en

Breakdown of each layer of the multi-barrier system to be used in Finland and Sweden:

Used fuel pellet.

Used fuel, when discharged from a nuclear reactor, is a solid ceramic that remains sealed in its metal cladding.

Fuel rod and fuel assembly.

An engineered bundle of fuel rods (long, sealed metal tubes) that contain used fuel pellets.

Canister insert.

The interior of the final disposal canister is made of cast iron and is strong enough to resist the mechanical stress that the canister is subjected to from the host bedrock. The canister has been manufactured to endure extreme conditions, such as earthquakes, or the pressure exerted by a continental glacier.

Copper overpack.

Disposal canisters are large metal casks which are about 5 metres high and 1 metre wide. Their interior is made of nodular graphite cast iron, with a copper exterior.

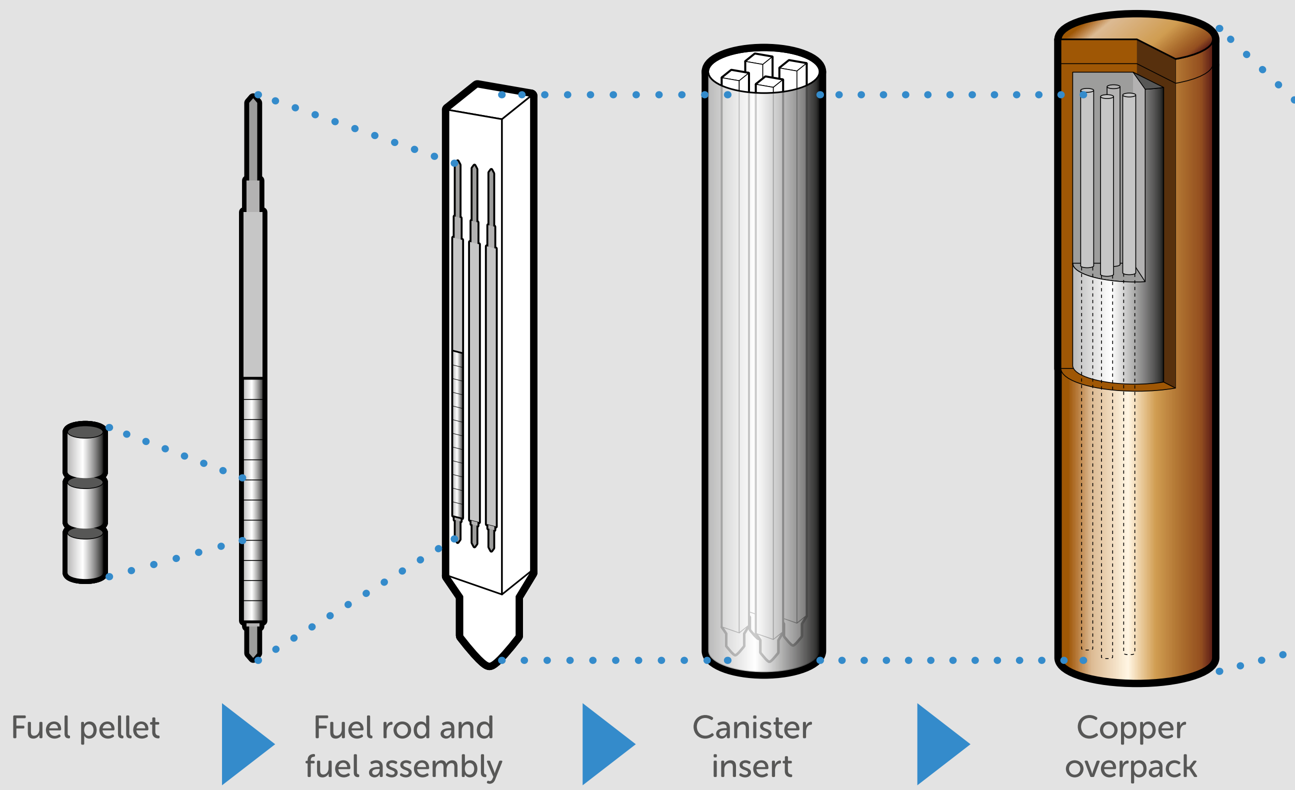
The copper exterior is 5cm thick. Its purpose is to protect the insert and the fuel assemblies from corrosion.

Extensive experimental and theoretical studies of the copper overpack have been undertaken to assess and demonstrate its corrosion resistance for hundreds of thousands of years, under a range of conditions.

Reserves of natural copper and discoveries of ancient man-made copper tools show that copper has high corrosion-resistant properties.

How it will be permanently stored - Multiple barriers help to ens

The concept for the disposal of used fuel to be used in Finland and Sweden.



Bentonite buffer and tunnel backfill.

Bentonite is a naturally occurring type of clay that expands when it comes into contact with water, and conducts almost no water at all. The expanding bentonite fills the space surrounding the final disposal canisters.

The bentonite clay prevents water from coming into contact with the copper canisters. In the event that a canister corrodes, the clay also stops the radioactive substances from moving far beyond the canister.

The bentonite barrier protects against mechanical wear, due to possible movements of the bedrock. Bentonite behaves somewhat like modelling clay: it buckles when necessary, but can also recover its shape because of its elasticity. It quickly seals any cracks that occur if the bedrock moves.

400–500 metres of carefully selected bedrock.

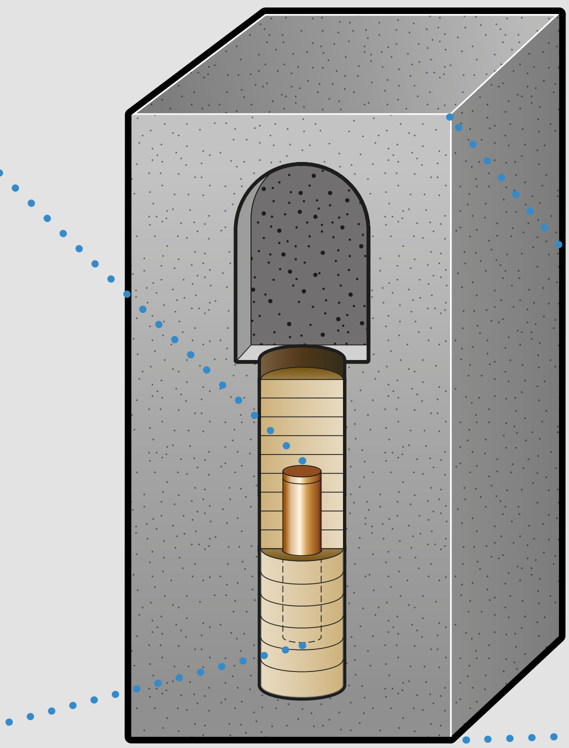
The bedrock protects the canisters against external impacts, creates mechanically and chemically stable conditions for the repository, and limits the amount of groundwater coming into contact with the final disposal canisters. The bedrock in Finland is stable, and the possibility for any large-scale movements inside the bedrock is minimal.

Research indicates that hundreds of metres down in the bedrock, groundwater is virtually void of oxygen and flows very slowly, which is why its corroding effect on the canisters and used nuclear fuel is very small.

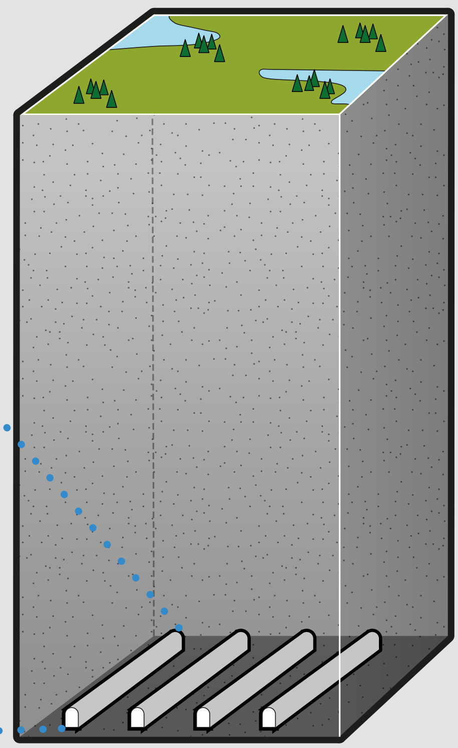
The bedrock also effectively stops direct radiation emanating from the canisters, because rock two metres thick alone is sufficient to diffuse the radiation to natural background levels.

If used fuel were to come into contact with groundwater, due to unforeseen circumstances, the radioactive materials would mainly remain in the bentonite and bedrock barriers surrounding the canisters.

sure that radioactive material isn't released into the environment.



Bentonite buffer and tunnel backfill



400–500 metres of bedrock

FINDINGS FROM THE NUCLEAR FUEL CYCLE ROYAL COMMISSION REPORT.

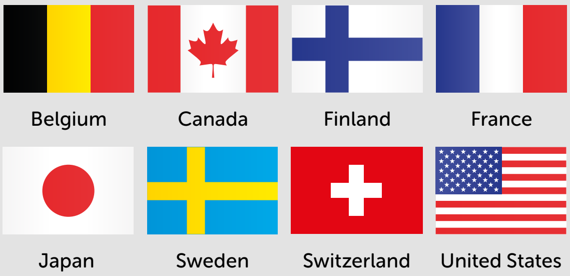
How is long-term safety determined?

Safety cases are used to provide evidence of the long-term safety of the design concept and the site suitability of a GDF.

They rely on mathematical modelling and extensive testing in underground research laboratories to explore scenarios that could lead to the release of radioactivity to the environment.

International experience.

Safety case analyses have been undertaken on GDF proposals at various stages of project development in Belgium, Canada, Finland, France, Japan, Sweden, Switzerland and the United States, and have been accepted by independent nuclear safety regulators in Finland, Sweden and the United States.



The safety requirements are set by the appropriate regulator and must be demonstrated to gain approval to construct and then operate a facility.

The Finnish regulator requires demonstration that radiation doses to a person in the most exposed group of people would remain below 0.1 millisievert per year (10% of the annual radiation dose limit for members of the public). This is more than 25 times lower than average background radiation in Australia.

FINDINGS FROM THE NUCLEAR FUEL CYCLE ROYAL COMMISSION REPORT.

The safety assessment of Finland's Onkalo GDF has involved an extensive program of research, development and demonstration, which has been conducted over more than 30 years.

This assessment showed that:

- Copper and cast iron canisters can remain intact over the period required for containment (10,000 years).
- The buffer of bentonite clay restricts corrosion of the canister and can limit the mobility of radionuclides over a very long timeframe.

Modelling has been undertaken to assess how GDF barriers would perform in the event of expected and unexpected changes in material properties (e.g. corrosion), site characteristics (geology), seismicity (earthquakes) and climate (e.g. glaciation or erosion). This modelling is informed by recent geological history, drilling, sampling and materials testing, as well as archaeological studies.

This modelling and testing shows if engineered barriers perform as expected, they would inhibit the movement of the harmful components in used fuel to the environment for at least 100,000 years.

If a component of all engineered containers throughout the GDF were to fail, the quantity of radionuclides that would pose a risk to humans and the environment would be well below the regulated limit set for the most exposed person in a given community. In another scenario, if a person in the most exposed group drilled into a waste container 1000 years after the facility was closed, they would be exposed to 0.003 millisievert per year, which is over 800 times below background radiation levels.

How safe are GDFs?

GDF safety cases require thorough scrutiny by a robust and independent regulator, and are often subject to international peer review. There is scientific consensus that an appropriately sited GDF that has received a licence to be constructed and operated provides more than the required level of protection for people and the environment far into the future.

Every South Australian has an opportunity to learn more about the nuclear fuel cycle by discovering the facts, understanding the choices, and providing their views on the Royal Commission's Report. This is a discussion about the state's future that all South Australians can have, and will help guide the Government's decision making on the next steps.

Visit **nuclear.sa.gov.au** to find out more.

Government of South Australia