NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

May 2020

Programs around the world for managing used nuclear fuel

Canada's plan for the long-term management of used nuclear fuel calls for it to be contained and isolated in a deep geological repository. Canada's approach is consistent with best practices around the world. Most countries with commercial nuclear power production are planning to isolate the waste by-product of their nuclear fuel cycle in a deep geological repository.

Deep geological repositories use a combination of engineered and natural barriers to safely contain and isolate used nuclear fuel from people and the environment. There is a consensus among major nuclear regulatory and monitoring organizations that repositories are the responsible way forward for long-term management of these materials.

A small number of countries partly recycle their used nuclear fuel in existing reactors. Some countries are planning advanced reactors that would also recycle used nuclear fuel. These advanced fuel cycles generate high-level waste, a by-product with characteristics similar to used nuclear fuel. Studies conducted around the world have concluded that high-level waste from reprocessing should also be contained and isolated in a deep geological repository.

CONSTRUCTION UNDERWAY

Country	Status
Finland	Construction is in progress. Application for a license to operate is expected to be submitted in 2020.

SUBMITTED A LICENSING APPLICATION TO BUILD A REPOSITORY

Country	Status
Sweden	An application for licence to construct was submitted in 2011. The nuclear regulator approved the construction licence application in early 2018, while the federal Environmental Court, though positive on many aspects, requested more information. SKB provided further information in 2019, and the decision is presently with the Swedish government. SKB hopes to begin construction in the early 2020s.

SITE SELECTED

Country	Status
France	An application for a repository construction licence is expected to be submitted in 2020, with construction expected to start in 2025.
Russia	Construction will occur after a period of research using an Underground Research Laboratory, which is currently under construction at the site.

ACTIVE SITE SELECTION

Country	Status
Canada	Two sites are under investigation, with site selection expected by 2023.
China	A site was selected to host an Underground Research Laboratory in 2019. It has strong potential to become the eventual site of the repository.
Germany	Siting criteria are being developed. The site selection process will be accompanied by extensive public participation.
Hungary	The site selection process is expected to be complete by 2032.
India	Siting activities are focused in the northwest region of Rajasthan.
Japan	The site selection process is expected to be completed by 2025, with repository operation from about 2035.
Slovakia	Two sites are undergoing detailed site investigations, which are expected to be complete in 2023.
Switzerland	Potential sites are being evaluated. Test drilling began at several potential sites in 2017. Site selection is expected in 2022. Nagra expects to submit a construction license application by 2024.
United Kingdom	A new siting process was launched in 2018, beginning with community consultations. The initial consultation period ended in 2019, with the results integrated into Site Evaluation documents, published in early 2020, which describes the planned approaches to find a site in England and Wales.

International Co-Operation and Research

The NWMO has co-operation agreements with our counterparts in Belgium, Finland, France, Japan, South Korea, Sweden, Switzerland, and the United Kingdom. We also have a memorandum of understanding with our counterpart in Taiwan. Partnering with other radioactive waste management organizations allows us to:

- Foster international co-operation on the development and demonstration of technology;
- Learn from other countries' experience; and
- Keep abreast of developments in repository design and safety case development for various host rock formations.

As part of our commitment to international collaboration, the NWMO is working on joint projects with other countries to bolster our knowledge and inform the design and engineering of Canada's plan. Some of these projects are underway at underground research laboratories. The NWMO has participated in experiments at the Mont Terri Laboratory and the Grimsel Test Site in Switzerland, the ONKALO facility in Finland, and the Äspö Hard Rock Laboratory in Sweden.



NWMO scientists host Taiwanese counterparts on a visit to a corrosion/electrochemistry lab at Western University.



NWMO scientists travel to Finland.



The NWMO renews c-operation agreement with South Korean counterpart.

Country	Examples of international collaboration
Belgium National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)	The NWMO and ONDRAF/NIRAS are collaborating to measure extremely low rates of corrosion to verify the stability of copper and steel in a deep geological repository.
Finland Posiva	The NWMO is learning from Posiva's used fuel container and engineered barrier emplacement trials at their ONKALO Underground Rock Characterization Facility.
France French National Agency for Radioactive Waste Management (ANDRA)	The NWMO and ANDRA share learnings and research.
Japan Nuclear Waste Management Organization of Japan (NUMO)	The NWMO is collaborating with NUMO to develop copper coating for used fuel containers.
South Korea Korea Radioactive Waste Agency (KORAD)	The NWMO and KORAD have supported student exchange.
Sweden Swedish Nuclear Fuel and Waste Management Company (SKB)	The NWMO, SKB and Posiva are working together to understand the mechanical behaviour of rock, including tests at a surface laboratory in Sweden. The NWMO, SKB, RWM and COVRA are also collaborating on a study of permafrost hydrology.
Switzerland National Cooperative for the Disposal of Radioactive Waste (NAGRA)	The NWMO is conducting joint research with NAGRA at their Mont Terri Underground Research Laboratory and Grimsel Test Site, where we test our understanding of the behaviour of engineered barriers and rock formations under deep geological conditions.
Taiwan Institute of Nuclear Energy Research (INER)	The NWMO and INER are developing areas for collaboration. This may include opportunities for its team members to work as visiting scientists at some of our partner research facilities.
United Kingdom Radioactive Waste Management (RWM)	The NWMO and the RWM share learnings. Recent cooperation has included staff from RWM working at NWMO. The NWMO, SKB and RWM are collaborating on a study of permafrost hydrology.

International high-level radioactive waste management programs

Country | Agency

Type of geology

- Crystalline
- Sedimentary
- Salt
- Clay
- Other

- Co-operation agreement with the NWMO
- Construction underway
- Licensing process
- A site has been selected
- Active site selection process
- Early site selection process
- Decided to build a deep geological repository
- No decision

Type of waste stored

- Used fuel
- Intermediate level waste
- High-level waste

Sweden | SKB

Finland | Posiva

Germany | BGE

Czech Republic | SÚRAO

Russia | NO RAO

Slovakia | UJD SR

Netherlands | COVRA

Canada | NWMO

Hungary | PURAM

United Kingdom | RWM

Japan | NUMO

Ukraine | SAUEZM

Belgium | ONDRAF/ NIRAS

China | CNNC

France | ANDRA

Armenia

Iran

United States | DOE

Spain | ENRESA

Taiwan | INER

Switzerland | NAGRA

Romania | ANDR

South Korea | KORAD

Mexico

Italy

Pakistan

Slovenia | ARAO

Bulgaria

India | AEC

Croatia

Argentina

Brazil

South Africa | NRWDI

Australia

International high-level radioactive waste management programs

Country	Name of organization	What have they decided for their long-term management?	Where are they currently in the process	Type of geology?	Co-operation agreement
Argentina		No decision			
Armenia		No decision			
Belgium	National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/ NIRAS)	No decision	Decided to build a deep geological repository		Yes
Brazil		No decision			
Bulgaria		No decision			
Canada	Nuclear Waste Management Organization (NWMO)	Deep geological repository for used nuclear fuel	Active site selection process	Crystalline and sedimentary	
China	China National Nuclear Corporation (CNNC)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Crystalline	
Croatia		No decision			
Czech Republic	Radioactive Waste Repository Authority (SÚRAO)	Deep geological repository for used nuclear fuel and high-level waste	Early site selection process	Crystalline	
Finland	Posiva	Deep geological repository for used nuclear fuel	Construction underway	Crystalline	Yes
France	French National Agency for Radioactive Waste Management (ANDRA)	Deep geological repository for used nuclear fuel and high-leve waste	Site selected	Sedimentary	Yes
Germany	Bundesgesellschaft für Endlagerung (BGE)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Crystalline, sedimentary and salt	
Hungary	Public Limited Company for Radioactive Waste Management (PURAM)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Clay	
India	India Atomic Energy Commission (AEC)	Deep geological repository for high-level waste	Active site selection process	Crystalline, sedimentary and basalt	
Iran		No decision			
Italy		No decision			
Japan	Nuclear Waste Management Organization of Japan (NUMO)	Deep geological repository for high-level waste	Active site selection process	Crystalline and sedimentary	
Mexico		No decision			
Netherlands	Central Organisation for Radioactive Waste (COVRA)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	Salt and clay	
Pakistan		No decision			
Romania	Nuclear and Radioactive Waste Agency (ANDR)	Deep geological repository for used nuclear fuel and high-level waste	Early site selection process	Salt, clay, crystalline and green schists	
Russia	National Operator For Radioactive Waste Management (NO RAO)	Deep geological repository for high-level waste	Site Selected	Crystalline	

Country	Name of organization	What have they decided for their long-term management?	Where are they currently in the process	Type of geology?	Co-operation agreement
Slovakia	Nuclear Regulatory Authority of the Slovak Republic (UJD SR)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Crystalline and sedimentary	
Slovenia	Agency for Radwaste Management (ARAO)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	N/A	
South Africa	National Radioactive Waste Disposal Institute (NRWDI)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	N/A	
South Korea	Korea Radioactive Waste Agency (KORAD)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	N/A	Yes
Spain	National Company of Radioactive Waste (ENRESA)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	Crystalline, clay and salt	
Sweden	Swedish Nuclear Fuel and Waste Management Company (SKB)	Deep geological repository for used nuclear fuel	Submitted a licensing application to build a repository	Crystalline	Yes
Switzerland	National Cooperative for the Disposal of Radioactive Waste (NAGRA)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Clay	Yes
Taiwan	Institute of Nuclear Energy Research (INER)	Deep geological repository for used nuclear fuel	Early site selection process	Crystalline	
Ukraine	State Agency of Ukraine on Exclusion Zone Management (SAUEZM)	Deep geological repository for high and intermediate level waste	Decided to build a deep geological repository	Crystalline, Clay and Salt	
United Kingdom	Radioactive Waste Management Limited (RWM)	Deep geological repository for used nuclear fuel and high-level waste	Active site selection process	Crystalline, sedimentary and salt	Yes
United States	Department of Energy (DOE)	Deep geological repository for used nuclear fuel and high-level waste	Decided to build a deep geological repository	N/A	

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