NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

April 2023

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 byproduct 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 around the world that deep geological 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 fuel cycles and advanced reactors generate high-level waste, a byproduct with thermal and radiological characteristics similar to used nuclear fuel. Studies conducted around the world have concluded that high-level waste from reprocessing and advanced reactors should also be contained and isolated in a deep geological repository.

CONSTRUCTION UNDERWAY	
Finland	The repository and surface facilities are well under construction. Application for a licence to operate was submitted in 2021 and the repository is expected to begin operations in 2024 or 2025.

SUBMITTED A LICENSING APPLICATION TO BUILD A REPOSITORY	
Sweden	In January 2022, the Swedish government approved SKB's proposed final repository system. The next step in the licensing process is for the Swedish Land and Environment Court to establish conditions for the facilities. The Swedish Radiation Safety Authority will also decide on permit conditions under the *Nuclear Activities Act*. After all licences are in place, it will take about 10 years to build the used fuel repository.
France	In January 2023, Andra submitted a licence application for the construction of a deep geological repository. Construction is expected to start in 2025.

SITE SELECTED	
Russia	Construction will occur after a period of research using an underground research laboratory, which is currently under construction at the selected site.
Switzerland	In September 2022, Nagra announced Switzerland's used nuclear fuel will be stored at Nördlich Lägern. Nagra expects to submit a construction licence application by 2024.

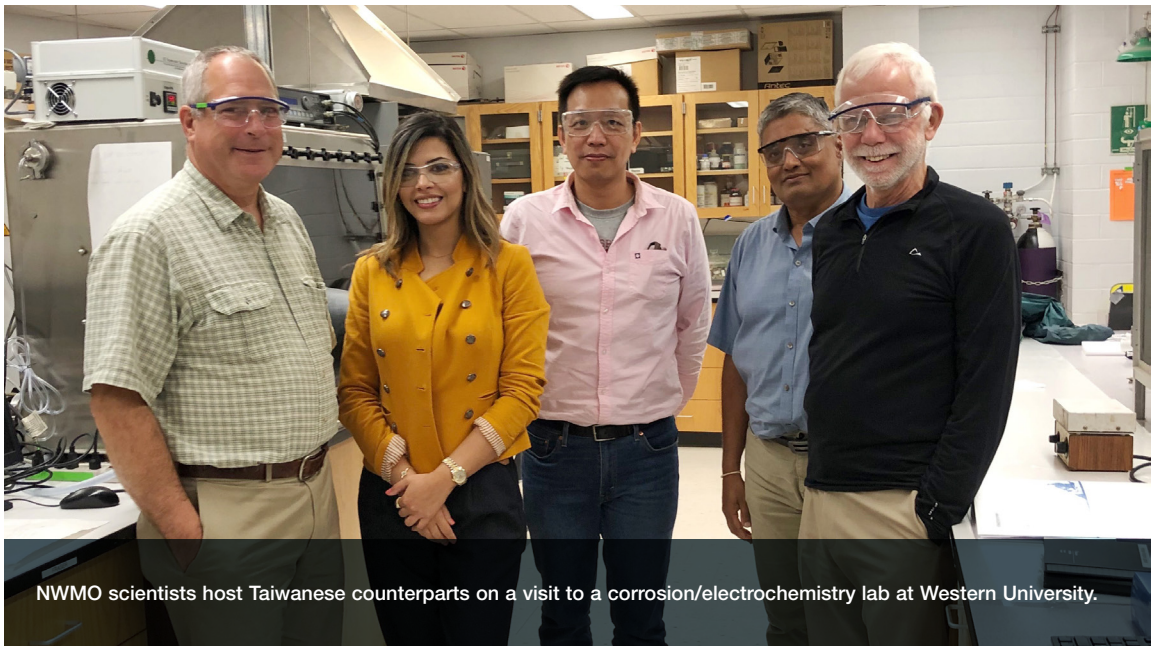
ACTIVE SITE SELECTION	
Canada	Two sites are under investigation, with site selection expected by 2024.
China	A site was selected to host an underground research laboratory in 2019. It has strong potential to become the eventual site of the repository.
Czech Republic	Technical evaluation is underway at four potential sites. Final site selection is expected by the end of the 2030s, followed by further geological tests to confirm the choice, with the submission of permit applications expected by the late 2040s.
Hungary	The site selection process is expected to be complete by 2032.
India	Siting activities are focused in the northwestern 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.
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 describe the planned approaches to find a site in England or Wales. Since 2021, several community partnerships have formed to advance discussions around siting a geological disposal facility for high-level radioactive waste.

International co-operation and research

The NWMO is co-operating on joint projects with our counterparts in other countries, including Sweden, Finland, Switzerland and the United Kingdom. Partnering with other radioactive waste management organizations allows us to:

- Learn from other countries' experience;
- Conduct studies using facilities not available in Canada; and
- Ensure our siting, repository design and safety case are aligned with international best practices.

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 co-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 repository site.
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 Hydro and Nuclear Power Company (KHNP)	The NWMO and KHNP are supporting studies on the long-term integrity of CANDU fuel bundles.
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, NWS, COVRA and BGE 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.
United Kingdom Nuclear Waste Services (NWS)	The NWMO, SKB, NWS, COVRA and BGE are collaborating on a study of permafrost hydrology.

International used fuel and high-level waste management programs


Sweden | SKB
Finland | Posiva
Russia | NO RAO
| BGE
Czech Republic | SÚRAO
COVRA
Slovakia | JAVYS
Hungary | PURAM
Japan | NUMO
Ukraine | SAUEZM
China | CNNC
Armenia
Iran
Romania | ANDR
Taiwan | INER
South Korea | KORAD
Pakistan
Bulgaria
India | AEC
ARAO
Croatia
South Africa | NRWDI
Australia

International used fuel and high-level waste management programs

Country	Name of organization	Long-term management plan
Argentina	National Atomic Energy Commission (CNEA)	No decision (decision must be made by 2030 under Law No. 25018)
Armenia		No decision
Belgium	National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)	Deep geological repository for used nuclear fuel and high-level waste
Brazil	Brazilian Nuclear Energy Commission (CNEN)	No decision
Bulgaria	State Enterprise Radioactive Wastes (SE RAW)	No decision
Canada	Nuclear Waste Management Organization (NWMO)	Deep geological repository for used nuclear fuel
China	China National Nuclear Corporation (CNNC)	Deep geological repository for used nuclear fuel and high-level waste
Croatia		Deep geological repository for used nuclear fuel and high-level waste
Czech Republic	Radioactive Waste Repository Authority (SÚRAO)	Deep geological repository for used nuclear fuel and high-level waste
Finland	Posiva	Deep geological repository for used nuclear fuel
France	French National Agency for Radioactive Waste Management (Andra)	Deep geological repository for used nuclear fuel and high-level waste
Germany	Federal Company for Radioactive Waste Disposal (BGE)	Deep geological repository for used nuclear fuel and high-level waste
Hungary	Public Limited Company for Radioactive Waste Management (PURAM)	Deep geological repository for used nuclear fuel and high-level waste
India	Indian Atomic Energy Commission (AEC)	Deep geological repository for high-level waste
Iran	Iran Nuclear Waste Management Company (INWM Co.)	No decision

Status	Type of geology
Research underway to identify potential sites for deep geological repository for either used nuclear fuel or high-level waste	To be determined
Decided to build a deep geological repository	Focus is on clay (other geologies studied to a lesser degree)
Active site selection process	Crystalline and sedimentary
Active site selection process; underground research laboratory under construction at potential site	Crystalline
Site selection to begin approximately 2050 to find a site in Croatia or Slovenia (joint ownership of fuel)	To be determined
Active site selection process; technical evaluation underway at four potential sites	Crystalline
Construction underway; application for a licence to operate was submitted in 2021	Crystalline
Submitted a licensing application to build a repository; construction is expected to start in 2025	Sedimentary
Early site selection process	Crystalline, sedimentary and salt
Active site selection process	Clay
Active site selection process	Crystalline, sedimentary and basalt

Country	Name of organization	Long-term management plan
Italy	Nuclear Plant Management Company (Sogin)	Deep geological repository for high-level waste
Japan	Nuclear Waste Management Organization of Japan (NUMO)	Deep geological repository for high-level waste
Mexico		No decision
Netherlands	Central Organisation for Radioactive Waste (COVRA)	Deep geological repository for used nuclear fuel and high-level waste
Pakistan	Pakistan Atomic Energy Commission (PAEC)	No decision
Romania	Nuclear and Radioactive Waste Agency (ANDR)	Deep geological repository for used nuclear fuel and high-level waste
Russia	National Operator For Radioactive Waste Management (NO RAO)	Deep geological repository for high-level waste
Slovakia	Nuclear and Decommissioning Company (JAVYS)	Deep geological repository for used nuclear fuel and high-level waste
Slovenia	Agency for Radwaste Management (ARAO)	Deep geological repository for used nuclear fuel and high-level waste
South Africa	National Radioactive Waste Disposal Institute (NRWDI)	Deep geological repository for used nuclear fuel and high-level waste
South Korea	Korea Radioactive Waste Agency (KORAD)	Deep geological repository for used nuclear fuel and high-level waste
Spain	National Company of Radioactive Waste (Enresa)	Deep geological repository for used nuclear fuel and high-level waste
Sweden	Swedish Nuclear Fuel and Waste Management Company (SKB)	Deep geological repository for used nuclear fuel
Switzerland	National Cooperative for the Disposal of Radioactive Waste (Nagra)	Deep geological repository for used nuclear fuel and high-level waste
Taiwan	Institute of Nuclear Energy Research (INER)	Deep geological repository for used nuclear fuel
Ukraine	State Agency of Ukraine on Exclusion Zone Management (SAUEZM)	Deep geological repository for high-level waste
United Kingdom	Nuclear Waste Services (NWS)	Deep geological repository for used nuclear fuel and high-level waste
United States	United States Department of Energy (DOE)	Deep geological repository for used nuclear fuel and high-level waste

Status	Type of geology
Early site selection process	To be determined
Active site selection process	Crystalline and sedimentary
Decided to build a deep geological repository	Salt and clay
Early site selection process	Salt, clay, crystalline and green schists
Site selected; underground research laboratory under construction	Crystalline
Active site selection process	Crystalline and sedimentary
Site selection to begin approximately 2050 to find a site in Croatia or Slovenia (joint ownership of fuel)	To be determined
Decided to build a deep geological repository	To be determined
Decided to build a deep geological repository	To be determined
Decided to build a deep geological repository	Crystalline, clay and salt
Submitted a licensing application to build a repository	Crystalline
Site selected; Nagra expects to submit a construction licence application by 2024	Clay
Early site selection process	Crystalline
Decided to build a deep geological repository	Crystalline, clay and salt
Active site selection process	Crystalline, sedimentary and salt
Decided to build a deep geological repository	To be determined

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