



nwmo

NUCLEAR WASTE
MANAGEMENT
ORGANIZATION

SOCIÉTÉ DE GESTION
DES DÉCHETS
NUCLÉAIRES

**SAFETY IS
EVERYTHING**

Protecting people and the environment

The Nuclear Waste Management Organization (NWMO) is a not-for-profit organization tasked with the safe, long-term management of Canada's used nuclear fuel. The project will contain and isolate used nuclear fuel inside a deep geological repository, in a manner that protects people and the environment for generations to come.

Our voluntary site selection process began in 2010, with 22 communities initially expressing interest in exploring their potential to host the project. Today, two areas remain in our site selection process: the Wabigoon Lake Ojibway Nation-Ignace area in northwestern Ontario and the Saugeen Ojibway Nation-South Bruce area in southern Ontario.

After more than a decade of detailed studies led by our science and engineering teams, the NWMO is confident that both potential sites could safely contain and isolate Canada's used nuclear fuel. Further studies will be needed to confirm these results.

This brochure provides an overview of the safety factors for both sites. For a detailed summary of the findings to date in each siting area, demonstrating why we are confident that either site can meet the project's requirements, please review the *Confidence in Safety* reports at www.nwmo.ca.



Safety factors

Our confidence that the proposed sites could safely host the repository is built on our understanding of several key factors, supported by international scientific consensus and best practices for managing used nuclear fuel. These factors include:

Regulatory
The facility will meet all regulatory requirements.



Transportation
Used fuel can be safely transported to the site.



Construction, operation and closing
The repository can be safely constructed, operated and closed.



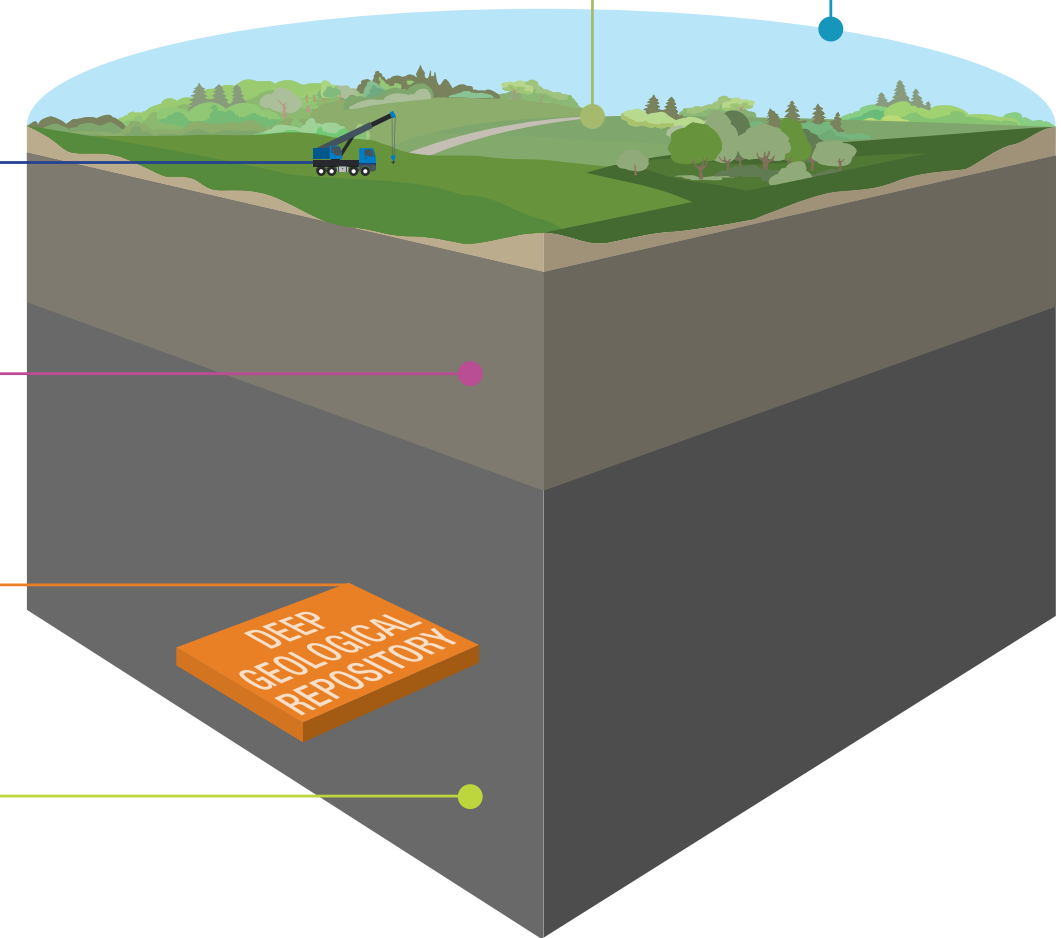
Human intrusion
The risk of future human intrusion is low.



Multiple-barrier system
The strength of the multiple-barrier system will ensure that the used fuel can be isolated within the rock and engineered-barrier system.



Geology
The characteristics of the rock and surrounding area will ensure that the site can safely contain and isolate the used nuclear fuel.





Martin Sykes, Senior Geoscientist at the NWMO, examines a core sample from the Cobourg formation in the Saugeen Ojibway Nation-South Bruce area.



SAFETY FACTOR Geology

“ We are confident that the geology at both potential sites will support the overall safety of the project. The rock at each site has the depth, breadth and volume necessary to isolate the repository from any disturbances on the surface, whether caused by human activities or natural events. The sites are also located in stable, seismically quiet settings, with no indication that factors like erosion could significantly alter the rock over the next million years. ”



Sarah Hirschorn, Director of Geoscience at the NWMO



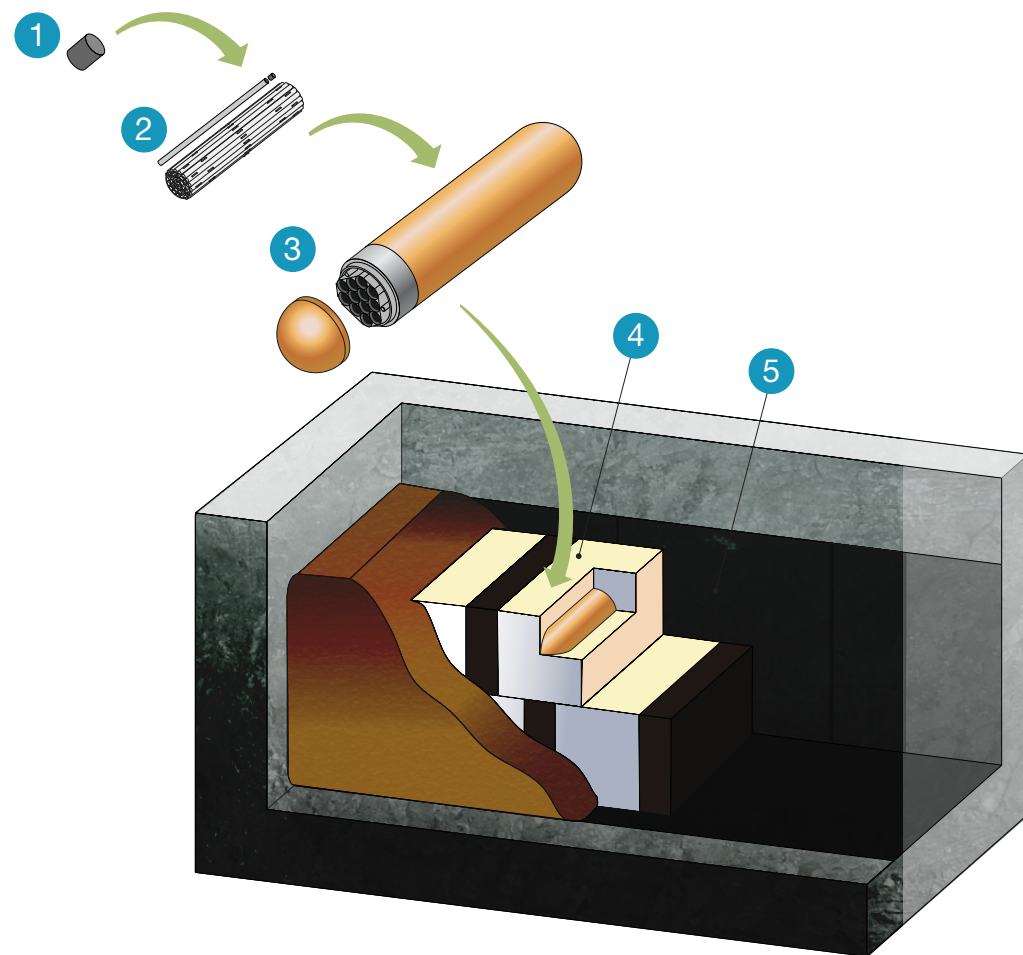
SAFETY FACTOR

Multiple-barrier system

“ People and the environment will be kept safe by a series of natural and engineered barriers that work together to contain and isolate the used nuclear fuel over the very long term. ”

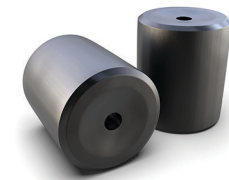


Chris Boyle, Vice-President and Chief Engineer at the NWMO



Safe materials in action

Uranium oxide



The uranium dioxide that the fuel pellets are made from is known to be durable in deep geological conditions over long time frames. For example, the Cigar Lake uranium ore body in Saskatchewan is a natural analogue for the used uranium dioxide fuel. The Cigar Lake uranium ore remained stable under geological conditions for over 1.3 billion years. In combination with the natural clay surrounding the ore, the uranium was so effectively contained that there was no indication of the ore deposit at the ground level.

1 Nuclear fuel pellet

The first barrier is the fuel pellet. Fuel pellets are made from uranium dioxide powder, baked in a furnace to produce a hard, high-density ceramic that is durable and practically insoluble. The fuel pellets do not readily dissolve if exposed to groundwater.

2 Fuel element and fuel bundle

Each fuel bundle is composed of a number of sealed tubes called fuel elements. Fuel elements contain the fuel pellets and are made of a strong, corrosion-resistant metal called Zircaloy. The function of each fuel element is to contain the fuel pellets.

3 Used nuclear fuel container

Used nuclear fuel bundles will be placed into large, durable containers that are optimized for the used fuel produced by Canadian nuclear power reactors. The container prevents radioactivity from escaping into the underground environment. It is engineered to remain intact and keep the used nuclear fuel completely isolated until the fuel's radioactivity has decreased to the same levels as natural uranium.

Each used nuclear fuel container is made from thick steel and is welded closed. The container has the mechanical strength to withstand pressure from the rock overhead and three-kilometre-thick glaciers during a future ice age. The container is protected by a corrosion-resistant copper coating.

Safe materials in action

Copper



The stability of copper is demonstrated by the existence of natural copper deposits such as the natural copper plates found in the Keweenaw Peninsula in northern Michigan and in the Permian Littleham Mudstone in southwest England. The existence of these long-lived deposits shows that copper can remain stable for long periods, under conditions not very different to those expected in a repository.

Safe materials in action

Bentonite clay



Bentonite clay is a durable natural material, with large deposits formed millions of years ago. The ability of clay to provide a long-term seal is illustrated in Italy's Dunarobba fossil forest, where tree stumps have been preserved in clay for more than 2 million years.

4 Bentonite clay

During placement in the repository, each used nuclear fuel container will be encased in a bentonite clay buffer box. Bentonite clay is a natural material proven to be a powerful barrier to water flow. It swells when exposed to water, making it an excellent sealing material.

Bentonite is also very stable, as seen in natural formations from millions to hundreds of millions of years ago. The chemical properties of the bentonite clay would help absorb any radioactivity in the unlikely event it was released from the container.

After the used nuclear fuel containers are placed in the repository, all open spaces in each underground chamber will also be filled with bentonite clay. A highly compacted bentonite clay seal and thick concrete wall will be used to seal the entrance to each placement room.

Before closing the repository, the tunnels and shafts will be backfilled and sealed, isolating the repository from the environment. The performance of the repository will be monitored as the used fuel containers are placed within it and during an extended period after the facility is closed.

While it will still be many decades before the host communities and regulatory authorities decide together how long this monitoring period will last, for planning purposes, we have assumed a 70-year extended monitoring period and another 30 years for decommissioning and closure of the facility.

5 The geosphere

The geosphere forms a natural barrier of rock that will protect the repository from disruptive natural events, water flow and human intrusion. The repository will be more than 500 metres underground – the exact depth will depend on the site. It will be built in a sedimentary or crystalline rock formation that meets the safety and technical requirements of the project.

The rock formation selected will have low permeability, which means there will be little groundwater movement. The traces of water that exist at the repository depth, known as porewater, can take millennia to move short distances.



SAFETY FACTOR

Human intrusion



“
At both sites, there are no known resources that people in the future might want to exploit such as economically exploitable minerals, gas or salt. That means that even if knowledge of the repository is lost in the distant future, the risk of human intrusion into the repository is low.
”

Paul Gierszewski, Director of Safety and Technical Research at the NWMO



SAFETY FACTOR

Construction, operation and closing

“ *As the repository is being constructed, environmental and geological conditions will be monitored to confirm our expectations based on prior surface-based measurements, ensuring construction proceeds safely.*

Over the repository’s decades of operations and through to its closure, ongoing monitoring will confirm that the repository is performing as expected, protecting people and the environment, including water.

”



Derek Wilson, Chief Operating Officer at the NWMO



SAFETY FACTOR

Transportation

“ *There is strong evidence that used nuclear fuel can be safely transported to the repository. In nearly 60 years, there have been more than 20,000 shipments of used nuclear fuel worldwide, and none have caused harm to people or the environment due to the release of radioactive materials.*

Used nuclear fuel is the most highly regulated material on our roads, and the NWMO’s transportation program must meet stringent safety and emergency management regulations set by Transport Canada and the Canadian Nuclear Safety Commission. These regulations ensure public safety during normal transport and accident conditions.

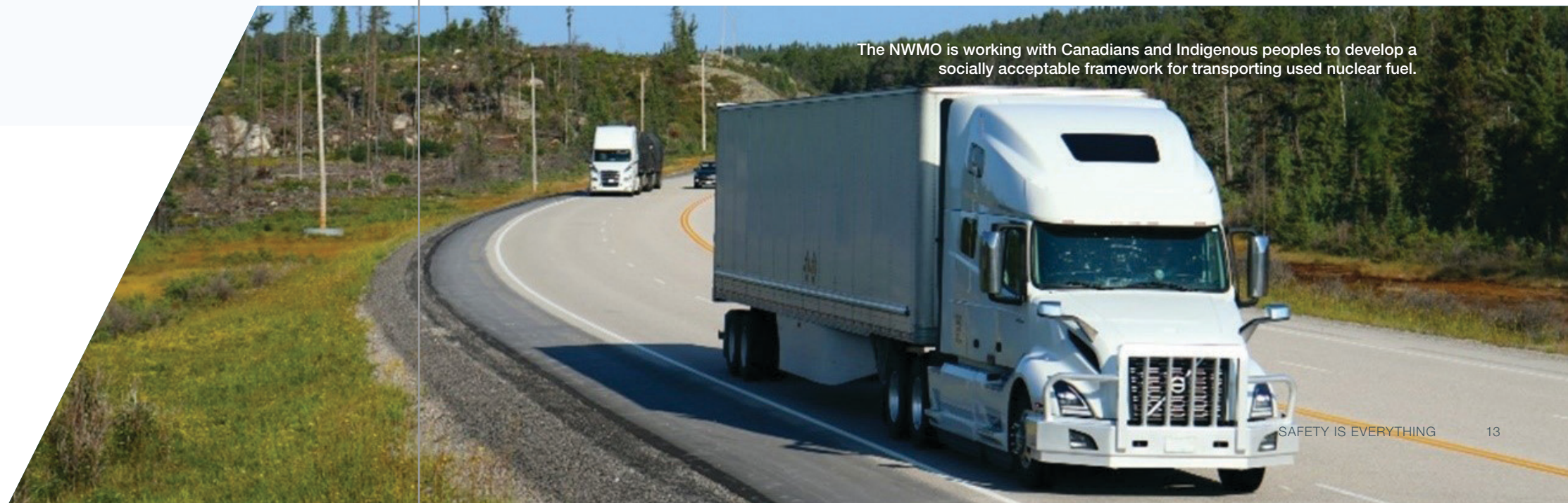
In particular, the transportation packages for used fuel must undergo extreme tests designed to demonstrate their ability to withstand severe impacts, fire and immersion in water.

”



Caitlin Burley, Manager of Transportation Engagement at the NWMO

The NWMO is working with Canadians and Indigenous peoples to develop a socially acceptable framework for transporting used nuclear fuel.





SAFETY FACTOR

Regulatory

“ *As part of the regulatory decision-making process, the NWMO will perform a safety assessment to demonstrate that the repository will meet all regulatory criteria, under both likely and unlikely conditions. This will be a careful and detailed process that will take about a decade to complete.*

Two safety assessments are required. One covers the operational period, during which the used fuel is received and placed in the repository. This assessment must show that workers and people living next door to the repository will receive less exposure to radiation than the regulatory limits.

The other safety assessment covers the period after the repository is closed and the used nuclear fuel is slowly becoming less hazardous. This post-closure safety assessment must show that under normal and accident scenarios, a family living on or near the top of the repository, using local well water and growing their own food, would not be exposed to unsafe levels of radiation.

The safety assessments will ultimately be evaluated by the Canadian Nuclear Safety Commission as part of the construction licensing process.

”



Allan Webster, Director of Regulatory Affairs and Environmental Assessment at the NWMO



The post-closure Safety Assessment team at the NWMO calculates repository performance in the long term.



Learn more about safety.
www.nwmo.ca/confidenceinsafety

For more information,
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