

Nuclear Fuel Management

How is Used Nuclear Fuel Managed?

The fuel for nuclear power reactors is in bundled tubes containing pellets of uranium oxide. Initially, unused CANDU fuel bundles are so slightly radioactive that they can be carried by hand. However, when the fuel is discharged from the reactor it can not be handled directly due to radioactivity. The bundles are inserted into and removed from the reactor by remotely operated fuelling machines. Typically a bundle will reside in the reactor for about two years.

Used fuel is sometimes referred to as “high-level nuclear waste”. This is something of a misnomer since only a

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very small portion of the used fuel is radioactive byproducts of the fission process.

Used nuclear fuel is perceived by some to be uniquely hazardous. However, like many non-radioactive but toxic materials that require permanent isolation, the potential hazard can be eliminated by careful isolation and management.

How Do We Currently Manage Used Fuel?

Used fuel from nuclear generating stations in Canada is stored onsite. When the fuel first exits the reactor, it is placed in water-filled bays. Water cools the fuel and shields the radiation. After several years in the bays, when the radioactive fission products have largely decayed and the associated heat generation has diminished, the used fuel can be transferred to dry storage onsite, typically large concrete cylinders.

There is enough space at each nuclear generating station to store all its used fuel for the operating life of the station. A 600MW CANDU nuclear reactor produces only 20 cubic metres of used fuel bundles per year.

Who Pays for Used Fuel Management?

The cost of onsite storage of used fuel is included in the total operating costs of the station, reflected in the electricity rate. The *Nuclear Waste Fuel Act* requires the utilities operating nuclear power plants to form a Waste Management Organization to deal with the long-term management and also to establish a trust fund to cover all future costs.



Fuel Bundles are used to generate electricity in Candu Reactors.

What are the Alternatives to Onsite Storage?

There are a number of alternatives to onsite storage for the long-term management of used nuclear fuel. One method would be to gather all used fuel in a central place and store it in concrete canisters on or near the surface. To ensure the continuing security of this method, the canisters would need to be monitored on an ongoing basis as they are now at reactor sites.

Permanent isolation is another method considered by nations with nuclear power programs. This method would not rely on long-term human supervision but on passive safety. A number of such options are being examined in several countries. These options include isolation in granite, in salt domes and other solid rock formations. Finland and Sweden are proceeding with the development of geologic disposal facilities for their used nuclear fuel.

What is an Isolation Vault?

Extensive research and testing was carried out by Atomic Energy of Canada Limited (AECL) on the potential for a permanent disposal location for used fuel. This concept would locate the used fuel in a vault deep in stable granitic rock in the Canadian Shield. Many of the rock formations in the Canadian Shield have been in place for two billion years.

As part of this research, AECL constructed its Underground Research Laboratory (URL) near the town of Lac du Bonnet in Manitoba, to demonstrate the conceptual designs for isolation

and storage of spent fuel. A single vault could hold all the used fuel arising from 100 years of operation of all existing Canadian nuclear generating stations. Many sites can be found in the Canadian Shield that would meet the geological requirements established by Canadian and international scientists for the safe isolation of high-level nuclear waste.

Is Permanent Isolation Safe?

A federal Environment Assessment Panel examined the concept for an isolation vault described above. In its report, the Panel found the safety of the concept had been adequately demonstrated from a technical perspective.

A number of uranium ore bodies in the world provide valuable evidence about geological containment. The Oklo deposit in Gabon, the Koongara in Australia, and Cigar Lake deposit in Saskatchewan are some of the best known examples. The Cigar Lake deposit has been buried under porous, wet sandstone for more than a billion years, yet has retained its radioactive components so well there is no trace of them at the surface.

What about the Long-term Care of Canada's Used Nuclear Fuel?

The Nuclear Waste Management Organization (NWMO) was established in 2002 to develop with Canadians a management approach for the long term care of Canada's used nuclear fuel. An Adaptive Phased Management approach has since been selected and the NWMO is now responsible for collaboratively implementing the plan with Canadians.

Adaptive Phased Management features:

- Centralized containment and isolation of used nuclear fuel in a deep geological repository in a suitable rock formation.
- Continuous monitoring with the potential for retrieval for an extended period of time.
- An informed and willing host community.
- Ongoing public engagement.

Used nuclear fuel will remain safely stored at Canadian nuclear reactor sites until the design, siting, environmental assessments, licensing, site-specific R&D, transportation systems, confirmation of site suitability, final design, safety analysis and decision to construct are complete.

Citizens will be engaged in decision making at every step of implementation.

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Courtesy of Canadian Nuclear Association

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