Nuclear Waste Management Organization

Integrated Strategy for Radioactive Waste

Report on Technical Options

Layperson's Summary

Original Report on Technical Options Prepared By:

HATCH, Golder, Calian

Executive Summary

This document is a summary of the Nuclear Waste Management Organization's Integrated Strategy for Radioactive Waste (ISRW) Initial Plan Development Characterization and Options Project Report (the 'Report on Technical Options'). It is written for the layperson. The full report is publicly available and can be found here.

The Report on Technical Options was prepared as a study to support the initial planning of the Integrated Strategy for Radioactive Waste (ISRW), a long-term management strategy for Canada's low- and intermediate-level radioactive waste (L&ILW). A video explainer on radioactive waste can be found here, and an infographic showing the types of radioactive waste can be found here.

The purpose of this study is to evaluate Canada's low- and intermediate-level radioactive waste inventory at a summary level to categorize and group the radioactive waste, and to identify suitable long-term management options for each radioactive waste category. Six (6) potential options for the long-term management of Canada's low- and intermediate-level radioactive waste have been identified by the NWMO. The six potential long-term management options for low- and intermediate-level radioactive waste are:

- Engineered Containment Mound,
- Concrete Vault,
- Shallow Rock Cavern,
- Deep Geological Repository,
- Deep Borehole, and
- Rolling Stewardship.

For the purposes of this initial plan, a summary level of detail was gathered about the current and projected future inventories from the current Canadian waste owners. This report identifies existing and future Canadian low- and intermediate-level radioactive waste with no current long-term management plans and presents an integrated assessment for the long-term management of this waste. Overall, the evaluation presented in this report provides observations and recommendations for further investigation on the Integrated Strategy for Radioactive Waste.

Given the summary level of detail gathered for this initial plan, there is an opportunity to further engage each waste owner and investigate the characterization of the waste in future studies.

Table of Contents

Introduction

The Nuclear Waste Management Organization (NWMO) was tasked by Canada's Minister of Natural Resources to share its extensive engagement expertise and lead the development of a strategy for the safe, long-term management of all of Canada's low- and intermediate-level radioactive waste (L&ILW).

While low- and intermediate-level radioactive waste is safely managed today on an interim basis facilities operated by the waste owners, a long-term, integrated strategy for Canada's low- and intermediate-level radioactive waste needs to be developed. To support this strategy, Hatch has been retained to analyze Canada's low- and intermediate-level radioactive waste and identify suitable long-term management options for the waste.

Based on international benchmarking, the NWMO has identified six (6) potential options for the long-term management of Canada's low- and intermediate-level radioactive waste, which are presented in further detail on the Integrated Strategy for Radioactive Waste (ISRW) website. These six potential technical options are summarized in the next section, with their main features. Each has a link to a more detailed factsheet.

The Report on Technical Options discusses the volume and radiological, physical, and chemical characteristics of low- and intermediate-level radioactive waste reported by waste owners in Canada and their fit with the six potential long-term management options.

Assumptions

The Report on Technical Options makes the following assumptions:

1. All liquid waste is assumed to be solidified.

2. Unless quantified by the waste owner, additional decontamination and volume reduction practices were not assumed in this study.

3. Projected operational waste is assumed to be packaged in the same physical configuration as an existing operational waste of the same source.

4. All long-term management options can accept nuclear waste with non-nuclear hazardous properties because non-nuclear hazardous waste facilities employ engineered containment measures similar to those present in near-surface nuclear waste disposal facilities

5. Waste owner inventory volumes have been rounded, given the level of uncertainty present at this time.

Potential Technical Options Considered

Engineered Containment Mound Engineered containment mounds are used in Canada for some low-level waste, specifically near Port Hope, Ontario, and there are similar facilities around the world.	∉ Suitable for low-level waste which will not reduce in volume or compact over time, contaminated soil or concrete. ∉ ∉ Uses layers of natural materials in combination with synthetic materials. ∉ May be constructed in several types of soil. ∉ Similar to the design of a landfill for domestic waste. ∉ In operation in Canada, France, Sweden, and the U.S.
Concrete Vault Concrete vaults are widely used around the world for the disposal of low-level radioactive waste (LLW). A concrete vault repository is easy to construct and operate. It is also modular in its design, which means that additional vaults can be added to increase its capacity as needed.	∉ Simple, modular design. ∉ Expandable according to need. ∉ Suitable for low-level waste in various packages, including waste that may become compacted over time, such as clothing and paper products. ∉ May be constructed in several types of soil. ∉ In operation in the Czech Republic, France, Japan, Slovakia, Spain, and the UK. ∉
Shallow Rock Cavern Shallow rock caverns could potentially be suitable for the disposal of low-level waste. A series of rock caverns are excavated at a nominal depth of 50 to 100 meters below the surface in low permeability rock. They are accessed from the surface by a small system of ramps and tunnels.	∉ Suitable for low-level waste, including waste that may reduce in volume or compact over time, such as paper products. ∉ Requires suitable geology. ∉ Makes use of natural barriers. ∉ Buildings on the surface are relatively small. ∉ In operation in Finland and Sweden.
Deep Geological Repository Recognized as one of the best-practice methods to dispose of waste that requires isolation for more than a few hundred years, such as intermediate-level waste (ILW) or high-level waste (HLW).	∉ International best practice for intermediate- and high-level waste requiring isolation for more than a few hundred years. ∉ Requires suitable geology. ∉ Makes use of natural and engineered barriers. ∉ In operation in Hungary and the U.S.
Deep Borehole This emerging technology could potentially be beneficial for smaller quantities of intermediate-level waste. The method would require drilling a series of narrow boreholes to a depth of about 500 to 1000 meters into which waste packages would be lowered, creating a stack deep underground.	∉ Relatively simple to construct and operate, compared to larger facilities. ∉ May be suitable for small volumes of intermediate-level waste. ∉ Requires suitable geology. ∉ Makes use of natural barriers. ∉ Limited in size.
Rolling Stewardship Rolling stewardship for the long-term storage of low and intermediate-level waste (LLW) would involve multi-generational intervention. Although there are advocates of this approach for the long-term management of nuclear waste, rolling stewardship is not recognized internationally as a preferred method for the disposal of nuclear wastes.	∉ A way to manage waste indefinitely, not to dispose of it. Keeps options open for the future. ∉ Assumes future technology will present a permanent disposal option. ∉ Requires continuous monitoring, inspection, and renewal of waste packages and storage facilities for many years. ∉ Requires work and investment by future generations. ∉ Not recognized internationally as a method for the disposal of radioactive waste.

Waste Inventory

Data is reported in this section for each waste owner by waste types and lifecycle waste volumes. For the purpose of the study undertaken to develop the Report on Technical Options, a summary level of detail was provided by each waste owner. As such, the level of detail available is different between waste owners. For instance, some owners reported only their current waste inventory while others reported their lifecycle waste volumes (i.e., including their projections of future waste generation). The study made adjustments such that lifecycle waste volumes were estimated and used in the analysis for all waste owners.

Low-Level Waste (LLW)

Waste Owners	LLW Volume m^3	Percentage of Total LLW
OPG	270,000	91.83%
Hydro Québec	18,000	6.12%
NB Power	2,270	0.77%
Cameco	2,000	0.68%
Other	1,740	0.59%

Canadian Low-Level Waste (LLW) with no current long-term management plans
Reference: Report on Technical Options Figure 3.2

Intermediate-Level Waste (ILW)

Waste Owners	ILW Volume m^3	Percentage of Total ILW
OPG	40,000	78.46 %
AECL / CNL	8,200	16.08 %
Hydro Québec	1,000	1.96 %
Other	1,000	1.96 %
NB Power	780	1.53 %

Canadian Intermediate-Level Waste (ILW) with no current long-term management plans
Reference: Report on Technical Options Figure 3.2

Low- and intermediate-level waste that has existing long-term management plans that are either under regulatory approval or in operation are not included, and out of scope. Because nearly 90% of the total low- and intermediate-level waste in Canada currently has long-term management plans, the total waste volume that is included as part of the Integrated Strategy for Radioactive Waste study (the Report on Technical Options) is reduced from 3,350,000m^3 to 345,000m^3. The low- and intermediate-level waste with existing long-term management plans consists predominantly of contaminated soils and other bulk material and is planned for disposal at various near-surface facilities.

The reduced ISRW inventory consists of approximately 294,000m^3 of low-level waste and 51,000m^3 of intermediate-level waste.

Evaluation Summary

The Canadian waste inventory was organized into categories to support the assignment of long-term waste management options based on the following characteristics which include the following, as described below:

- Radioactive classification,
- Physical configuration/packaging characteristics,
- Non-nuclear hazardous characteristics.

Radioactive Classification

The radioactive waste was classified using CNSC definitions of low-level radioactive waste and intermediate-level radioactive waste. In general, low-level waste requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near-surface facilities, and Intermediate-level waste requires a higher level of containment and isolation for periods ranging from hundreds to thousands of years. Due to its long-lived radionuclides, intermediate-level waste generally requires a higher level of containment and isolation than can be provided in near-surface repositories. The study found that 15% of the ISRW waste inventory is intermediate-level waste, and 85% is a low-level waste.

Packaging/Physical Configuration

In addition to radioactive classification, the ISRW radioactive waste inventory was organized based on the existing physical configuration of the waste. The size and shape of each waste package is an important consideration to determine if the package can physically fit in a specific long-term management facility.

Non-Nuclear Hazardous Characteristics

The non-nuclear hazardous characteristics were considered in the long-term waste management options analysis. The level of detail available for non-nuclear hazardous characteristics of the waste inventory varied greatly depending on the waste owner. However, a number of notable non-nuclear hazardous characteristics were identified, in particular:

- **Heavy Metals** (depleted uranium, lead, cadmium, and mercury). Heavy metals require consideration because heavy metal toxicity will outlive the radioactivity of nuclear waste, most notably for low-level waste.

- **Organics** (plastics, rubbers, resins, bitumen, and various toxic organic compounds). Organics require consideration because of potential flammability and, in some cases, toxicity.

The disposal of non-nuclear hazardous waste is well established in Canada and is regulated at the provincial level.

Recommended Long-Term Waste Management Option

Repository Type	LLW Bulk Material	LLW Other	ILW General	ILW Small
Engineered Containment Mound	Y Most suitable for large volumes of bulk LLW	Y2	N	N
Concrete Vault	Y2	Y Internationally accepted practice for LLW disposal	N	N
Shallow Rock Cavern	Y2	Y Internationally accepted practice for LLW disposal. Large objects may require segmentation or volume reduction	N	N
Deep Geological Repository	Y3	Y2	Y Internationally recognized best practices for ILW disposal. Large objects may require volume reduction.	Y Internationally recognized best practices for ILW disposal.
Deep Borehole	N	N	N	Y2
Rolling Stewardship	Y3	Y3	N	N

Matrix of Applicability	
Y	Applicable and Recommended for the allocated waste group
Y2	May be Applicable to the waste group but is not preferred or requires further study
Y3	Conceptually feasible but, after considering risk factors, is impractical
N	Not suitable for the allocated waste group

Recommendation

The purpose of the study that resulted in the Report on Technical Options was to identify groups in Canada's low- and intermediate-level waste inventory and assign these groups to potential long-term management options.

In general, the waste was grouped based on radioactivity classification (i.e., low-level waste and intermediate-level waste) and physical configuration (i.e., bulk material, containers, etcetera). It was identified that all low-level waste might be disposed of at a near-surface facility, whereas all intermediate-level waste must be disposed of in a Deep Geological Repository (DGR) or a Deep Borehole.

Typically, low-level waste can be disposed of in a higher level of containment (i.e., deep underground), but intermediate-level waste cannot move to a lower level of containment. This fact presents a key consideration for the Integrated Strategy for Radioactive Waste: to consolidate long-term management facilities to the fewest number of types or to consider multiple long-term management facilities.

The Engineered Containment Mound (ECM) was determined to be the most suitable option for bulk low-level waste such as soils and demolished concrete, given the low concentrations of radionuclides and the large volume of waste.

The Concrete Vault and Shallow Rock Cavern were considered the most suitable option for non-bulk low-level waste, given the increased containment and structural integrity offered (concrete barrier or rock mass) compared to the Engineered Containment Mound . These long-term management options may also be suitable for bulk low-level waste, but the containment and isolation offered by these options are considered excessive for bulk material.

The Deep Geological Repository is internationally recognized as the preferred approach to intermediate-level waste long-term management and was therefore considered the most suitable option for all intermediate-level waste. Additionally, the co-disposal of non-bulk low-level waste was considered as an alternative.

Deep Boreholes are considered an alternative long-term management option for small dimensional intermediate-level waste such as incinerated waste and spent ion exchange resins. Deep Boreholes are best applied to a decentralized disposal approach (i.e., with multiple borehole locations across Canada) in order to reduce the need for radioactive waste transportation.

Rolling Stewardship is a potential near-term waste management solution but is not a practical solution for any low-level waste or intermediate-level waste in the long term. Rolling Stewardship may be feasible for certain types of low-level waste that decays quickly to allow its free release or conventional disposal of waste in several decades, but not for wastes that will remain radioactive for several hundred years or longer. Rolling Stewardship is not in line with international best practices for the long-term management of radioactive waste.

For additional information about the Integrated Strategy for Radioactive Waste, visit our Website
www.radwasteplanning.ca