

RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES

CANADA [2005]

NATIONAL NUCLEAR ENERGY CONTEXT

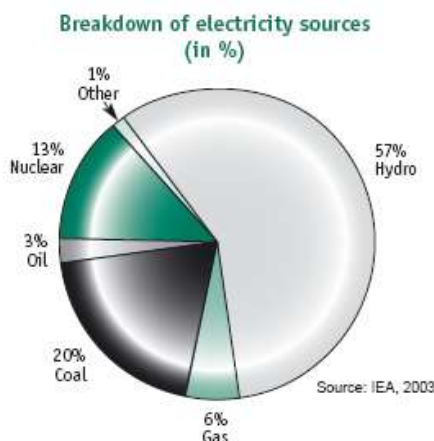
A total of 22 CANDU reactors are operated by public utilities and private companies in the provinces of Ontario (20), Quebec (1) and New Brunswick (1). Of the 22 reactors installed, 17 reactors are currently in full commercial operation, and they generate on average around 12.5% of Canada's electricity, mostly in Ontario where 40% of the electricity produced in the province comes from nuclear energy.

Also in 2002, the capacity for nuclear fuel fabrication was 2 750 tonnes heavy metal per year (HM/year) of uranium fuel for heavy water reactors.

In Canada the nuclear fuel cycle comprises uranium mining and processing, nuclear fuel fabrication and production of nuclear power, based on Canadian CANDU technology.

Canada is the world's leading producer of uranium, accounting for about 30% of global production. It has the world's third largest resource of uranium, including the two largest high-grade deposits.

The currently identified economic resources, about 439 000 tonnes of uranium, are sufficient for nearly 40 years of production at present rates of extraction.



SOURCES, TYPES AND QUANTITIES OF WASTE

In Canada, radioactive waste is generated from uranium mining and processing, nuclear fuel fabrication, operation of nuclear reactors, and radioisotope manufacture and use. These radioactive wastes are divided into three categories: nuclear fuel waste, low-level radioactive waste, and uranium mine and mill tailings.

Nuclear fuel waste (NFW)

In Canada, nuclear fuel waste refers to the nuclear fuel bundles discharged from CANDU power reactors, the prototype and demonstration power reactors, and research and isotope production reactors. There are no plans to reprocess and recycle the spent fuel removed from nuclear reactors. It is therefore described as nuclear fuel waste and current plans are based on its long-term management as a waste. Ontario Power Generation (OPG) is the largest nuclear utility with 12 reactors, 9 of which are presently in operation. Bruce Power, which leased the Bruce nuclear generating station from OPG in 2001 for a period of 18 years, has 6 of the 8 reactors at that site in operation. New Brunswick Power and Hydro-Québec each operate one reactor, at Point Lepreau and Gentilly respectively. Together, the four nuclear utilities generate, on an annual basis, a few hundred cubic metres (~ 250 m³ in 2002) of nuclear fuel waste from the operation of these reactors. To the end of 2002, the inventory of nuclear fuel waste stored on site by the utilities in wet and dry storage was 5 568 m³ and 990 m³ respectively. In addition, a small amount of nuclear fuel waste comes from the research and radioisotope production reactors of Atomic Energy of Canada Ltd (AECL), a federal Crown corporation, and research reactors in operation at universities. The estimated volume of these wastes to the end of 2002 was 208 m³.

Low-level radioactive waste (LLRW)

Low-level radioactive waste is defined by exception. It comprises all forms of radioactive waste except for nuclear fuel waste and uranium mine and mill tailings. LLRW is divided into two broad categories:

- Waste from ongoing activities where an owner or producer remains responsible for its management.
- Waste from historic activities where no owner or producer exists to take responsibility for it, leaving government as the manager of last resort.

Ongoing LLRW is currently being produced from Canada's nuclear reactors, nuclear fuel processing and fabrication facilities, and from medical research and industrial uses of radioisotopes. Operational wastes constitute most of such waste, and this trend will continue until the start of significant decommissioning of nuclear facilities. At the end of 2001, there was an estimated inventory of 186 000 m³ of ongoing LLRW in storage. Historic LLRW consists primarily of process residues and contaminated materials mixed with soil. It is generally of low or very low activity. The volume of historic waste is approximately 1 430 000 m³, representing the bulk of Canada's total LLRW inventory. Over 90% of the historic waste results from past operations of a radium and uranium refinery and is located at interim waste management sites in the Port Hope area of southern Ontario. In addition, there are some 83 000 m³ of contaminated soil stored at the AECL Chalk River Laboratories, which were produced by nuclear activities during the early years of nuclear research and development and by associated cleanup activities.

Uranium mine and mill tailings

Uranium mine and mill tailings are a specific type of radioactive waste generated during the mining and milling of uranium to produce uranium concentrate, which is used in fabrication of nuclear fuel. These wastes are generally held in containment areas close to the milling sites. Because of their large volumes, the tailings are usually decommissioned where deposited. This is typically in mined-out, open pits that have been engineered to create tailings management facilities, or in above-ground tailings ponds. Most of the existing uranium mine and mill tailings are located in the provinces of Ontario and Saskatchewan. Of the total of twenty-four tailings sites in Canada, only three in Saskatchewan continue to receive such waste. At the end of 2003, the inventory of uranium mine and mill tailings at operational mine sites was 12.7 million tonnes dry mass. The total quantity of all Canadian uranium mine and mill tailings, from both operational and inactive or shutdown mines, is about 225 million tonnes. These figures are summarised in the table below.

Radioactive waste type	Description	Quantity
Nuclear fuel waste	In wet storage	5 568 m ³
	In dry storage	990 m ³
	From research and radioisotope production reactors	208 m ³
Low-level radioactive waste	From ongoing activities	About 186 000 m ³ *
	From historic activities	About 1 430 000 m ³ *
Uranium mine and mill tailings	At operating and inactive or shutdown mines	About 225 million tonnes

* Estimated inventory.

RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES

Waste management policies

In July 1996, the Government of Canada announced its Policy Framework for Radioactive Waste. This set the stage for further development of the institutional and financial arrangements required for implementation of long-term management of radioactive waste in a safe, environmentally sound, comprehensive, cost-effective and integrated manner. The federal government has responsibility to develop policy, to regulate, and to oversee the activities of radioactive waste producers and owners to ensure that they meet their operational and funding responsibilities, in accordance with approved long-term waste management plans. It is recognised, however, that there will be variations in the general approach to management of the different types of waste.

Health, safety, security and environmental aspects of the management of all radioactive wastes, whether ongoing or historic, are regulated under the Nuclear Safety and Control Act by the federal regulatory body, the Canadian Nuclear Safety Commission (CNSC).

Programmes and projects

Nuclear fuel waste

As required by the federal government, a deep geological disposal concept for nuclear fuel waste was developed by AECL and Ontario Hydro, the precursor of OPG. In October 1988, this was referred for review to an independent, federal Environmental Assessment Panel. Guidelines for preparing an Environmental Impact Statement (EIS) were published in 1992, and the EIS was duly submitted by AECL in 1994. In March 1998, the Panel published a report with conclusions and recommendations on the acceptability of the proposed concept. They found that, on balance, the concept was technically sound but not socially acceptable, and the Panel proposed further steps to remedy the situation.

In 1998, the Government of Canada responded to the Panel recommendations, in line with the 1996 Policy Framework for Radioactive Waste, and set the stage for developing institutional and financial arrangements for implementing long-term nuclear fuel waste management. The challenge was to ensure that the public would be confident that long-term management of nuclear fuel waste would be carried out in the best interest of Canadians. An important part of the answer to this challenge was the development of the Nuclear Fuel Waste Act (NFW Act), which came into force on 15 November 2002.

The NFW Act requires nuclear utilities to create and maintain a waste management organisation with a mandate to propose to the Government of Canada alternative approaches for the long-term management of nuclear fuel waste, and to implement the approach that is selected by Government. The NFW Act also requires the utilities and AECL to establish trust funds to finance the implementation of the selected long-term nuclear fuel waste management approach.

The Nuclear Waste Management Organisation (NWMO) was established by the nuclear utilities in late 2002. The NFW Act requires it to submit to the Government, by 15 November 2005, a study setting

out alternative approaches for the long-term management of nuclear fuel waste, and its recommendation on which approach should be adopted. The NWMO study is required to include approaches based on on-site storage, centralised storage and on disposal. In carrying out this study, the NWMO must consult the general public on each of the alternative approaches. It must also create an Advisory Council whose role is to examine and provide written comments on the NWMO programme activities. The Advisory Council membership must reflect technical and social sciences expertise and, when the Government of Canada has selected the general approach, it must include representatives from relevant local and regional governments and aboriginal organisations.

Low-level radioactive waste

All ongoing low-level radioactive waste from nuclear power production is presently stored at reactor sites. OPG, Hydro-Québec, New Brunswick Power and AECL all operate on-site storage facilities. AECL also provides a waste storage facility for smaller producers on a fee-for-service basis. To date there has been no pressing need for early disposal of LLRW as waste volumes are small and the interim storage is judged to be safe.

The major nuclear utility in Canada, OPG, and AECL together produce about 70% of the annual volume of low-level radioactive waste in Canada. OPG's low-level radioactive waste is safely stored on an interim basis at the Western Waste Management Facility at Bruce Nuclear Power Development (BNPD). In April 2002, OPG and the Municipality of Kincardine signed a Memorandum of Understanding to jointly study options for the long-term management of the wastes at the BNPD site. The year 2015 is considered an achievable target date for bringing a long-term management facility into service.

The other major ongoing producer of low-level radioactive waste, AECL, stores the waste it generates in in-ground and above-ground structures. Natural Resources Canada and AECL are assessing organisational approaches and long-term waste management strategies for dealing with the AECL inventory of low-level radioactive waste, in support of future government decisions about management of those wastes.

The bulk of historic LLRW in Canada is located in the area of Port Hope in Ontario. In March 2001, the Government of Canada entered into an agreement with the municipalities in whose localities the historic wastes are located. This agreement, termed the Port Hope Area Initiative (PHAI), addresses the cleanup and long-term management of these wastes. The Government proponent for the PHAI is the Low-Level Radioactive Waste Management Office (LLRWMO). This body was established in 1982 as the Government of Canada agent for the management of historic waste and is responsible for implementation of the PHAI.

The PHAI will involve long-term management of these historic wastes in newly constructed, above-ground mounds in the local communities. The \$ 260 million project will take about ten years to complete. The first phase of the Initiative involves environmental assessment and regulatory review and is expected to be complete in 2007. Ongoing public consultation remains a priority and municipal consent will be necessary to move into the next phase. Cleanup, waste facility construction and waste emplacement would take place in the following five years, after which the facilities would continue to be monitored and maintained for the long-term.

Uranium mine and mill tailings

All currently active uranium mining sites are situated in northern Saskatchewan. Most of the inactive sites are in the Elliot Lake area of northern Ontario, which was the major uranium-mining centre in Canada

for over 40 years. Since the last facility closure in 1996, uranium mining companies have committed over \$ 75 million for decommissioning of all mines, mills and waste management areas.

The CNSC has recently embarked on a programme to bring all inactive sites in Canada under regulatory control where appropriate and necessary.

Research and development

AECL maintains a comprehensive R&D programme of underlying research in support of existing and ongoing CANDU reactor designs, with the specific objectives to ensure the continuing safe and effective operation of CANDU reactors, including radioactive waste management; to develop new products and services to enhance AECL business opportunities; to provide the basis for specific enhancements to AECL's CANDU 6, CANDU 9 and MAPLE reactor designs; to support the pre-commercial development of advanced CANDU designs; and to support Canadian government policy.

Regarding R&D related to uranium mine and mill tailings, the mining industry, in co-operation with provincial and federal governments, has funded a comprehensive research programme over the past two decades on acid rock drainage and the stability of engineered barriers. Technologies developed under this program have been successfully applied to the decommissioning of uranium tailings in Ontario and Saskatchewan and at other sites across Canada.

Decommissioning and dismantling policies and projects

The *Nuclear Safety and Control Act*, together with supporting Regulations, explicitly addresses the decommissioning of nuclear facilities. Amongst other things, the Act requires that the shutdown and decommissioning of facilities licensed by the CNSC must be carried out according to plans approved by the CNSC. It also includes provisions for ensuring that applicants provide such financial guarantees for funding the decommissioning of their facilities as CNSC may require.

Decommissioning projects are under way on the AECL research facilities at Whiteshell and Chalk River, and on the AECL demonstration/prototype power reactor sites at Douglas Point and Rolphton in Ontario, and at Gentilly in Québec. These reactors, and the NRX reactor at Chalk River and the WR-1 reactor at Whiteshell, are now partially decommissioned and are in a state of "storage-with-surveillance". This surveillance period is to allow for the decay of radioactivity in the reactors, thus reducing the radiation dose to workers involved in their final dismantling. AECL is continuing to submit preliminary and detailed decommissioning plans for components of its research facilities.

Monitoring the decommissioned uranium mining facilities in the Elliot Lake area of Ontario is continuing. These facilities include the Stanrock and Denison facilities of Denison Mines Limited and the Quirke, Panel and Stanleigh facilities of Rio Algom Limited. On 16 August 2002, the CNSC issued a Radioactive Waste Facility Operating Licence to Rio Algom Limited for the remaining other idle uranium mining facilities in the Elliot Lake area (Spanish American, Milliken, Lacnor, Nordic/Buckles, and Pronto). These mine sites have not been operational for almost 40 years, and were not previously licensed.

Indian and Northern Affairs Canada is conducting decommissioning work, under CNSC licence, at the idle Rayrock mine site in the Northwest Territories.

The University of Toronto has completed the decommissioning of its sub-critical assembly and its Slowpoke research reactor.

TRANSPORT

In Canada, radioactive material is routinely transported by road, rail, sea and air. The CNSC regulates the safe transport of nuclear substances under the *NSC Act* and cooperates with the federal department, Transport Canada, under the *Transportation of Dangerous Goods Act*. The requirements for transport of such materials are based largely on the *Regulations for Safe Transport of Radioactive Material* developed by the International Atomic Energy Agency.

Most shipments are of radioactive materials destined for use in medicine, science and industry and they generally involve routine deliveries of materials with very low levels of activity, but other more radioactive materials, such as spent fuel from nuclear reactors, are also transported within Canada.

COMPETENT AUTHORITIES

Regulation and licensing

The Government of Canada recognises the important contribution of the nuclear industry as well as the need to ensure safety, security, public health and the protection of the environment. Against this background, policies, legislation and regulations have been put in place in order to provide appropriate direction and oversight of radioactive waste management in Canada. The Canadian Nuclear Safety Commission (CNSC) is the leading federal body for regulation and oversight of operations conducted by the nuclear industry. Natural Resources Canada also provides oversight, particularly through its Nuclear Fuel Waste Bureau, which administers the Nuclear Fuel Waste Act. Health Canada, Transport Canada and the Canadian Environmental Assessment Agency also contribute to federal oversight.

Public bodies

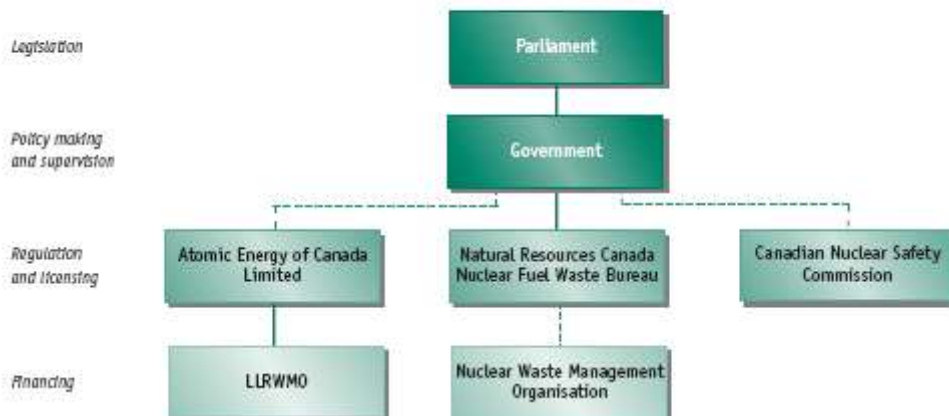
AECL is a federal Crown corporation and is responsible for CANDU design, engineering and marketing as well as nuclear research and development. It has both a public and commercial mandate and is a radioactive waste producer in its own right.

The Low-Level Radioactive Waste Management Office (LLRWMO) is the federal body charged with carrying out cleanup operations for historic waste. The LLRWMO is operated as a separate division of AECL, but receives its funding and policy direction from Natural Resources Canada.

Operators

The key companies currently responsible for operating elements of the nuclear fuel cycle are the power-producing utilities, Hydro-Québec, Ontario Power Generation, Bruce Power and New Brunswick Power, together with their Nuclear Waste Management Organisation, the companies involved in uranium mining, milling, processing or refining, Cameco Corporation and Cogema Resources Inc, and the nuclear fuel fabrication companies, Canada General Electric and Zircotec Precision Industries.

Main bodies involved in radioactive waste management in Canada



FINANCING

In general, regarding financial responsibility for radioactive waste management, the CNSC requires existing operators to provide financial guarantees designed to ensure that operations take place in a responsible and orderly manner, in both the short and long term. Where a producer or owner cannot be identified, cannot be located, or is unable to pay, responsibility rests with the federal and/or provincial governments, as managers of last resort. Specific provisions are as follows.

Nuclear fuel waste

The requirements for financial guarantees set out in the Nuclear Safety and Control Act take into account the related requirements of the Nuclear Fuel Waste Act. This requires a specific guarantee in the form of trust funds into which nuclear utilities and AECL deposit money annually to cover the costs of long-term nuclear fuel waste management operations. Money in these funds can only be withdrawn by the Nuclear Waste Management Organisation, and only after a construction or operating licence for a long-term waste management facility has been granted by the CNSC. To date a total of \$ 660 million has been deposited into the trust funds.

Low-level radioactive waste

Financial guarantee requirements under the *Nuclear Safety and Control Act* apply to the ongoing production of low-level radioactive waste. Financial guarantees sufficient to cover the full costs of radio-active waste management are now being put into place for all nuclear facilities in Canada, including nuclear power reactors, research reactors, fuel fabrication facilities, uranium processing facilities, isotope processing facilities, and waste management facilities. With respect to the management of historic low-level radioactive waste, the LLRWMO receives its policy direction and funding from Natural Resources Canada.

Uranium mine and mill tailings

The CNSC requires the owners of uranium mine sites to post financial guarantees to cover the costs of decommissioning. Where an owner cannot be identified, cannot be located, or is unable to pay, responsibility for decommissioning rests with the federal and provincial governments. The 1996 Canada-Ontario Memorandum of Agreement (MoA) on costsharing for the long-term management of abandoned uranium mine sites recognises that present and past owners are responsible for all financial aspects of the decommissioning, and long-term maintenance of uranium mine sites, including the tailings. In the case of abandoned sites, however, the MoA outlines how both levels of government will share the long-term management responsibilities and associated costs. A similar agreement with the Government of Saskatchewan is under consideration.

PUBLIC INFORMATION

In Canada, public participation in decision making is of high priority and all major organisations carry out public information programs. This increasing public role is recognised in various pieces of federal legislation, which incorporate a mandatory requirement for public participation, especially in regard to social and ethical considerations.

For more information, the websites of the main government and industry organisations are listed below.

Government

Canadian Nuclear Safety Commission: www.cnscc.gc.ca

Nuclear Fuel Waste Bureau: www.nfwbureau.gc.ca

Natural Resources Canada: www.nrcan.gc.ca and <http://nuclear.nrcan.gc.ca>

Low-Level Radioactive Waste Management Office: www.llrwmo.org

Canadian Environmental Assessment Agency: www.ceaa.gc.ca

Transport Canada – Transport of Dangerous Goods Directorate: www.tc.gc.ca/tdg/menu.htm

Industry

Hydro-Québec: www.hydroquebec.com

Ontario Power Generation: www.opg.com

Bruce Power: www.brucepower.com

New Brunswick Power: www.nbpower.com

Atomic Energy of Canada Ltd: www.aec.ca

Nuclear Waste Management Organisation: www.nwmo.ca

Cameco Corporation: www.cameco.com

Cogema Resources Inc.: www.cogema.ca

General Electric Canada: www.ge.com/canada

Zircotec Precision Industries: www.zircotec.ca Canadian

Nuclear Association: www.cna.ca