RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES

CANADA
[2012]

NATIONAL NUCLEAR ENERGY CONTEXT

The Government of Canada supports nuclear energy as an important component of a diversified energy mix to ensure a secure and sustainable energy future for Canadians. The federal government develops and implements nuclear policies. The federal government also regulates the development and application of nuclear energy. Decision-making responsibility for planning, construction, and operation of nuclear power plants resides with the provinces and provincial electric power utilities.

The Canadian nuclear industry covers most of the nuclear energy fuel cycle: research and development, uranium mining and processing, fuel fabrication, nuclear plant construction and operation, servicing and maintenance, waste management and decommissioning.

The federal government provides funding for Atomic Energy of Canada Limited's (AECL) nuclear research and development program. In 2011, the Government of Canada restructured AECL by selling its Candu Reactor Division to Candu Energy Inc., a wholly-owned subsidiary of SNC-Lavalin.

Currently, there are around 150 firms benefitting from Canada's nuclear technology and the industry contributes to creating several thousand high-tech and well-paid jobs for Canadians.

There are 22 CANDU nuclear reactors in Canada which 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 are currently in full commercial operation which generate on average 15% of Canada's electricity. In the province of Ontario, over 55% of the electricity comes from nuclear energy while in New Brunswick it represents around 25% and in Quebec it is estimated at 3%.

Canada is the world's 2nd largest producer of uranium, accounting for about 18% 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 of approximately 468 600 tonnes of uranium are estimated to be 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 and intermediate level radioactive waste, and uranium mine and mill tailings.

Nuclear fuel waste

In Canada, nuclear fuel waste is defined under the *Nuclear Fuel Waste Act* (*NFWA*) as "irradiated fuel bundles removed from a commercial or research nuclear fission reactor". It, therefore, includes CANDU fuel bundles discharged from power and prototype reactors, as well as the bundles from the shutdown of the WR-1 research reactor at Whiteshell Laboratories.

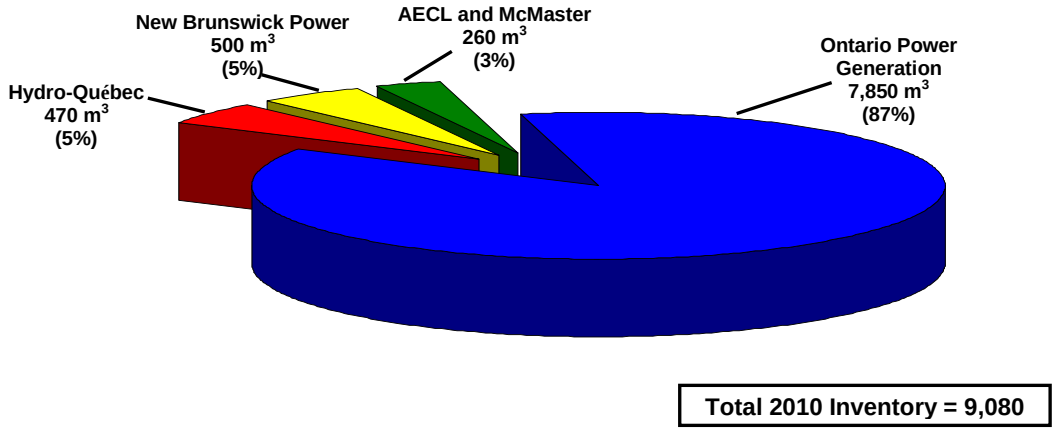
Although not specifically covered under the *NFWA*, other forms of nuclear fuel waste include AECL's fuel rods which are discharged from its research reactors, and a small amount of waste that is generated by AECL's research and radioisotope reactors, including waste that is produced by research reactors in operation at a number of universities.

Ontario Power Generation (OPG) is the largest nuclear power producer in Canada. It owns 20 reactors in the province of Ontario. Bruce Power, leases 8 of these reactors from OPG and 6 of the 8 are currently in operation. Of the remaining 12 reactors, OPG currently has 10 in operation. OPG is responsible for the management of the nuclear fuel waste produced by all of these reactors. In the provinces of New Brunswick and Quebec, the nuclear energy corporations, New Brunswick Power (NB Power) and Hydro-Québec (HQ) each operate one reactor, Point Lepreau and Gentilly, respectively. In total, the four nuclear energy corporations generate a few hundred cubic metres (~ 297 m^3 in 2010) of nuclear fuel waste from the operation of these reactors each year.

At the present time, there are no plans to reprocess the fuel bundles from nuclear power reactors. Current plans are to manage them as a waste product over the long term in a deep geologic repository, when it becomes available.

Figure 1 below, shows the distribution of nuclear fuel waste inventory by the waste owners as of 2010. The distribution of nuclear fuel waste was as follows: OPG, 87%; HQ, 5%, NB Power, 5%; and other, mostly AECL, 3%.

Figure 1 – Nuclear Fuel Waste Inventory, 2010



Low and intermediate level radioactive waste (LILRW)

Low and intermediate level radioactive waste (LILRW) includes all non-fuel waste arising from the activities associated with nuclear electricity generation, from nuclear research and development, uranium refining and conversion, fuel fabrication, and from the production and use of radioisotopes in medicine, education, research, agriculture and industry.

LILRW is divided into three broad categories:

- **Ongoing waste –** refers to the waste that is generated by nuclear facilities currently in operation.[1]
- **Nuclear Legacy Liabilities –** refers to waste at AECL sites that was generated prior to April 1, 2006, and dating back to the birth of nuclear technologies in Canada**.**[1]
- **Historic Waste –** refers to waste that was managed, in the past, in a manner that is no longer considered acceptable and for which the current waste owner cannot be reasonably held responsible. At the end of 2010, the volume of historic waste, much of which is contaminated soil, was 1,721,000 m^3.

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. 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 engineered above-ground tailings management facilities.

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 2010, the inventory of uranium mine and mill tailings at operational mine sites was 13.3 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 214 million tonnes.

RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES

Waste management policies

The Government of Canada has well-defined policies, legislation and responsible organizations that govern the management of radioactive waste in Canada. The Government's 1996 *Policy Framework for Radioactive Waste* provides the national context for radioactive waste management. The framework lays out a set of principles to ensure that the management of radioactive waste is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.

The *Framework* states that the federal government has the responsibility to develop policy, regulate, and oversee the activities of radioactive waste owners to ensure that they comply with legal requirements and meet their funding and operational responsibilities in accordance with approved waste management

[1] At the end of 2010, there was an estimated inventory of 616,590 m^3 of ongoing and nuclear legacy LILRW in storage. Source: Inventory of Radioactive Waste in Canada, 2012.

plans. Waste owners are responsible, in accordance with the "polluter pays" principle, for the funding, organization, management, and operation of long-term waste management facilities and other facilities required for their wastes.

The *Policy Framework* recognizes that arrangements may be different for the three broad categories of radioactive waste in Canada: nuclear fuel waste, low and intermediate level radioactive waste, and uranium mine and mill tailings.

Health, safety, security and environmental aspects of the management of all radioactive wastes are regulated under the *Nuclear Safety and Control Act* (*NSCA*) by Canada's independent federal nuclear regulator, the Canadian Nuclear Safety Commission (CNSC).

Programmes and projects

Nuclear fuel waste

In 2002, the Government of Canada brought into force the *NFWA*. The legislation required the nuclear energy corporations (i.e., OPG, HQ, and NB Power) to establish a waste management organization to assume responsibility for the long-term management of nuclear fuel waste.

In 2002, the Nuclear Waste Management Organization (NWMO) was established and it was required to submit a study of options to the Government of Canada, along with a recommendation on the most appropriate approach to be adopted for the safe and secure long-term management of nuclear fuel waste. The *NFWA* required that the analysis include feedback from comprehensive public consultations, including Aboriginal peoples, and be evaluated in terms of social and ethical considerations. Following extensive studies and public consultations on the possible options, the NWMO submitted its study to the Government on November 3, 2005 for review. In its study, the NWMO recommended Adaptive Phased Management (APM) as its preferred approach for the long-term management of nuclear fuel waste in Canada.

The *NFWA* required the Governor in Council, on the recommendation of the Minister of Natural Resources, to select one of the options from among those set out in the NWMO study. Following a careful and thorough examination of the NWMO study, the Government announced its decision on June 14, 2007, to select the NWMO's APM approach as the most appropriate option to safeguard both the public and the environment. The APM approach offers centralized containment and isolation of nuclear fuel waste in a deep geologic repository, with the option of an interim shallow-underground storage facility located at a site in an informed and willing host community. A key element of the APM approach is that it is sufficiently flexible to adjust to changing social and emerging technological developments.

Following the Government's decision, the NWMO is responsible for implementing the APM approach in accordance with the *NFWA*. Its activities are set out in a rolling five-year implementation plan that is developed through public dialogue. Pursuant to the *NFWA*, the NWMO is also required to report annually on its activities towards implementing the APM approach to the federal Minister of Natural Resources.

Through public dialogue and consultation, the NWMO has developed a site selection process for the proposed geologic repository which was initiated in May 2010. This process is aimed at identifying a willing and informed community with a suitable site to host a deep geologic repository for the long-term management of nuclear fuel waste.

Since its launch, a number of communities have agreed to participate in the NWMO's siting process and learn about the APM approach. These communities, while in the early stages of the process, first agree to undergo an initial screening exercise and may further decide to undergo preliminary feasibility studies to determine if they have a suitable site. Following feasibility studies, one or more of the communities may decide to undergo more detailed characterization and evaluation work. This is a gradual process and it is likely to take a decade or more from now before a suitable site in a willing community is identified to host a long-term waste management facility.

The NWMO is also advancing work on the development of repository designs and safety cases, including governance and capacity building to provide the necessary, skills, expertise, and capabilities required to implement Adaptive Phased Management. For information about the NWMO's implementation of the government-selected plan visit its website at www.nwmo.ca

Implementation of the APM approach will be regulated at all stages, with the CNSC responsible for regulatory matters pursuant to the *NSCA*. The NWMO will be required to obtain licences from the CNSC for site preparation, construction, operation and decommissioning of the repository facilities.

Low and intermediate level radioactive waste (LILRW)

Ongoing waste

Canada currently produces approximately 5100 m^3 of ongoing LILRW per year. OPG, which owns 20 of Canada's 22 CANDU reactors, is responsible for about 77% of this amount. AECL generates approximately 17% of the annual volume, and accepts waste from a number of small waste producers for long-term management, which amounts to a further 3% of Canada's annual volume. The remaining 3% is largely generated by NB Power and HQ, which own and operate the other 2 CANDU reactors in Canada.

All ongoing LILRW waste from nuclear power production is presently stored at reactor sites. OPG, HQ, and NB Power all operate on-site storage facilities. AECL manages its ongoing production of LILRW on site at its Chalk River Laboratories and provides a waste storage service at Chalk River for smaller producers on a fee-for-service basis.

Long-term management of LILRW

Canada's two major waste owners, OPG and AECL, are pursuing initiatives to develop and implement long-term waste management solutions. OPG produces the bulk of Canada's LILRW on an annual basis. Its LILRW is safely stored at the Western Waste Management Facility (WWMF) at the Bruce nuclear site, which is located in the Municipality of Kincardine, Ontario.

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 WWMF. A consulting firm was engaged to conduct an Independent Assessment Study (IAS) of three options: enhanced processing and storage; a covered above-ground concrete vault; and a deep geologic repository (DGR). The IAS concluded that each of the options was feasible, could be constructed to meet international and Canadian safety standards with a considerable margin of safety, would not have significant residual environmental effects, and would not have a negative effect on tourism. The geology of the Bruce site was considered ideal for the DGR option.

In April 2004, Kincardine Council passed a resolution to select the "Deep Rock Vault option as the preferred course of study" for the management of LILRW because it had the highest margin of safety and

is consistent with international best practice. Other noteworthy considerations in the choice of the preferred option are outlined below.

- The DGR will permanently isolate LILRW, much of which is already stored on site.
- The project will provide significant economic benefit to the residents of the municipality.
- No high level waste or nuclear fuel waste would be allowed in the facility.
- The project will undergo a rigorous environmental assessment and the CNSC regulatory process will include opportunities for public input before construction is approved.

In October 2004, Kincardine and OPG signed the Kincardine Hosting Agreement, which sets out the terms under which the DGR project would proceed. The DGR involves the construction of rock vaults within stable, low-permeability bedrock using conventional mining techniques. The rock vaults would be positioned at a depth of approximately 678 meters in relatively flat-lying sedimentary rock formations that have remained tectonically stable and undeformed for hundreds of millions of years. Support buildings would be located on ground surface above the underground workings. Access to the repository would be through a vertical, concrete-lined shaft. A second shaft would be constructed for ventilation and emergency egress purposes. The DGR will be designed to hold OPG's current and future LILRW from the operation and refurbishment of its 20 CANDU reactors.

OPG's DGR project is now proceeding through the regulatory review phase. On April 14, 2011, OPG submitted its Environmental Impact Statement, Preliminary Safety Report and other documentation to the CNSC. A Joint Review Panel (JRP) was established, in January 2012, under the *Canadian Environmental Assessment Act* and the *NSCA* to review the environmental aspects of the proposed project and to gather the information necessary for the consideration of a licence application for the construction of a DGR. Public hearings are expected to take place in late 2012 or early 2013. Should a construction and operation licence be granted by the CNSC, the DGR could begin to receive LILRW around 2020.

AECL, the other major ongoing producer of LILRW, stores its waste in-ground and in above-ground structures. Although not the largest producer of LILRW, AECL has the largest amount currently in storage as a result of its previous nuclear R&D work. Natural Resources Canada and AECL are assessing organizational approaches and long-term waste management strategies for dealing with this waste.

Nuclear legacy liabilities

The Government of Canada's nuclear legacy liabilities have resulted from 60 years of nuclear research and development (R&D) carried out on behalf of Canada by the National Research Council (1944 to 1952) and AECL (1952 to present). These liabilities are largely located at AECL research sites, and consist of shutdown research buildings (including several prototype and research reactors), a wide variety of buried and stored wastes, and contaminated lands. The shutdown buildings and contaminated lands need to be safely decommissioned to meet federal regulatory requirements, and long-term solutions need to be developed and implemented for the wastes.

About 70 percent of the liabilities are located at AECL's Chalk River Laboratories (CRL) in Ontario, and a further 20 percent are located at AECL's shutdown Whiteshell Laboratories in Manitoba. The remaining 10 percent relate largely to three shutdown prototype reactors in Ontario and Quebec, which were key to the developmental stage of Canada's CANDU reactor technology.

The inventory of legacy waste includes spent fuel, intermediate-level and low-level solid and liquid radioactive waste, and wastes (largely contaminated soils) from site cleanup work across Canada. Most of the wastes are in an untreated form, and limited characterization information is available for the wastes

generated in past decades. In many cases, unique and potentially costly solutions will be required to recover, handle and process the wastes.

In 2006, the Government of Canada adopted a new long-term strategy to deal with the nuclear legacy liabilities over a 70-year period. The overall objective of the long-term strategy is to safely and cost-effectively reduce the liabilities and associated risks based on sound waste management and environmental principles in the best interests of Canadians.

Also in 2006, the Government of Canada established the Nuclear Legacy Liabilities Program (NLLP) to implement the long-term strategy to address the legacy waste, redundant infrastructure and contaminated land liabilities at AECL sites. The Program was launched with a five-year, $520-million start-up phase, and the Government renewed the Program in 2011 with a $439-million three-year second phase that runs from April 2011 to March 2014. Under the NLLP, liabilities and risks have been reduced through the decontamination and dismantling of shutdown buildings, the recovery of buried waste and the treatment of contaminated groundwater. New facilities have been established to characterize, process and store radioactive waste.

A key ongoing initiative is the development of an Integrated Waste Plan that will assess the viable options for the treatment and long-term management of the legacy waste inventory. The results of the Plan will inform the identification of priorities and next steps, which will in turn be used to define the program of work for subsequent years. The advancement and refinement of the strategy will be informed by public consultations.

The current program of work is being implemented through a Memorandum of Understanding (MoU) between NRCan and AECL whereby NRCan is responsible for policy direction and oversight, including control of funding, and AECL is responsible for carrying out the work. A Joint NRCan-AECL Oversight Committee, chaired by NRCan, makes decisions on the planning, delivery, reporting and administration of the current plan. NRCan represents the interests of the Government, providing policy direction and oversight; and ensuring value for money, transparency and accountability. AECL implements the work; ensures regulatory compliance, safety and effectiveness; identifies priorities and develops annual plans; reports on approved activities; and holds and administers licences, facilities, lands, materials and other asset responsibilities related to the nuclear legacy liabilities.

Historic waste

The Government of Canada established the Low-Level Radioactive Waste Management Office (LLRWMO) within AECL in 1982 as the federal agent for the cleanup and management of historic low-level radioactive waste in Canada. NRCan provides policy direction and funding to the LLRWMO to carry out its work.

The bulk of Canada's historic low-level radioactive waste is located in the southern Ontario communities of Port Hope and Clarington. The majority of these wastes are contaminated soils that amount to a volume of roughly 1.7 million cubic meters. These materials relate to the historic operations of a radium and uranium refinery in the Municipality of Port Hope dating back to the 1930s.

In March 2001, the Government of Canada and the local municipalities entered into an agreement based on community-developed proposals to address the cleanup and long-term management of these wastes, thereby launching the Port Hope Area Initiative (PHAI). The PHAI Management Office (MO) is the proponent for the PHAI on behalf of the Government of Canada.

The PHAI will involve the long-term management of these historic wastes in two above-ground mounds to be constructed in the local communities of Port Hope and neighboring Clarington. The current

phase of the PHAI involves construction of new waste management facilities and remediation of contaminated lands, and is expected to be completed in fiscal year 2021/2022. Ongoing public consultation remains a priority.

Most of the remaining historic waste to be dealt with in Canada is located along the Northern Transportation Route between Port Radium, Northwest Territories and Fort McMurray, Alberta. The waste results from the past transport of radium and uranium bearing ore and concentrates from the Northwest Territories to Fort McMurray, Alberta. In 2003, the Government of Canada completed a cleanup of contaminated sites in Fort McMurray, and the resulting contaminated soils are safely stored in a long-term, above-ground mound at the local municipal landfill. Strategies are currently being developed for the cleanup of the remaining contamination along the Northern Transportation Route, which is estimated to consist of about 14,000 cubic metres of contaminated soils.

Uranium mine and mill tailings

All currently active uranium mining sites are situated in northern Saskatchewan. However, Elliot Lake, Ontario was the major uranium mining centre in Canada for over 40 years. Since the last Elliot Lake mining facility closed in 1996, uranium mining companies have committed well over $75 million to decommission all mines, mills, and waste management areas. Water treatment and minor engineering works continue to be the main activities at these locations. Water quality within the area watershed has improved dramatically since the closure and decommissioning of the mines and currently meets Ontario Drinking Water Standards.

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

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 the CNSC may require.

Decommissioning projects are underway at the AECL research facilities at Whiteshell and Chalk River, and at AECL demonstration/prototype power reactor sites at Douglas Point and Rolphton in Ontario, and at Gentilly in Quebec. 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". AECL is continuing to submit 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, Stanleigh, Spanish American, Milliken, Lacnor, Nordic/Buckles, and Pronto facilities of Rio Algom Limited. In Saskatchewan, decommissioning of the Cluff Lake uranium mine and mill began in 2002. AREVA Resources Canada Inc. completed decommissioning the mine and mill site in 2006 and is maintaining and monitoring the site under licence from the CNSC.

On April 2, 2007, the Government of Canada and the Government of Saskatchewan announced the first phase of the cleanup of closed uranium mine and mill sites in northern Saskatchewan (principally the Gunnar and Lorado mines). These facilities were operated from the 1950s until the early 1960s by private sector companies which no longer exist. When the sites were closed, there was no regulatory framework in place to appropriately contain and treat the waste, which has led to environmental impacts on local soils

and lakes. Steady progress is being made on the decommissioning of these facilities by the Government of Saskatchewan.

Research and development

In 2007, the Nuclear Waste Management Organization (NWMO) assumed responsibility for directing and managing all aspects of the technical R&D program for Canada's nuclear fuel waste. (From 1996 to 2006, the technical R&D program was funded and managed by OPG. Previously, it was largely funded by the Government of Canada and managed by AECL.) The key goal of the NWMO's technical R&D program is to support implementation of Adaptive Phased Management, the approach selected by the Government of Canada in June 2007 for long-term nuclear fuel waste management. The R&D program focuses on long-term used fuel storage and repository engineering, geoscience, safety assessment as well as technical support to the collaborative siting process.

Cameco Corporation, AREVA Resources Canada Inc., the CNSC and the Government of Saskatchewan provide funding to support research related to uranium mine and mill tailings management. For example, both Cameco and AREVA Resources Canada support ongoing research at the University of Saskatchewan.

Both Cameco and AREVA conduct research to improve tailings management at their facilities. Cameco, in co-operation with universities and industry partners across North America, are researching methods to remove the trace metal selenium from the Key Lake mill effluent. This research will be shared with other mining companies experiencing similar concerns with tailings management. Research at AREVA has developed a method to contain arsenic as a relatively insoluble stable mineral in the Tailings Management Facility at McClean Lake, protecting nearby water resources.

The Canadian Nuclear Safety Commission funds an extramural research program to obtain knowledge and information needed to support its regulatory mission. The program provides the CNSC with access to independent advice, expertise, experience, information and other resources via contracts placed in the private sector, and with other agencies and organizations in Canada and elsewhere.

TRANSPORT

In Canada, nuclear materials are routinely transported by road, rail, sea and air. The responsibility to regulate the safe transport of nuclear substances, including radioactive waste, is jointly shared between the CNSC and Transport Canada.

Transport Canada's Transportation of Dangerous Goods (TDG) Regulations deal with the transport of all classes of dangerous goods, while the CNSC's Packaging and Transport of Nuclear Substances (PTNS) Regulations are primarily concerned with health, safety and security of the public, and protection of the environment related to the special characteristics of radioactive material. Both the TDG and PTNS Regulations apply to all persons who handle, offer for transport, transport or receive nuclear substances.

All nuclear substances are transported in packages that are selected based on the nature, form and quantity or activity of the substance. There are general design requirements that apply to all package types to ensure that they can be handled safely and easily, secured properly, and are able to withstand routine conditions of transport.

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, including spent fuel from nuclear reactors, are also transported within Canada.

COMPETENT AUTHORITIES

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.

Federal Policy Development

Natural Resources Canada is the lead federal department responsible for developing and implementing uranium, nuclear energy, and radioactive waste management policies. It administers the NFWA and has overall responsibility for the long-term management of historic waste and legacy waste.

Other federal departments have been assigned roles and responsibilities related to the safe management of radioactive waste, including Health Canada, Environment Canada, the Canadian Environmental Assessment Agency and Transport Canada.

Regulation and licensing

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, in particular through its Nuclear Fuel Waste Bureau, which administers the *NFWA*. Health Canada, Transport Canada and the Canadian Environmental Assessment Agency also contribute to federal oversight.

Implementing agencies

AECL is a federal Crown corporation and is responsible for operating Canada's Nuclear Laboratories which are primarily located and headquartered in Chalk River, Ontario. It is currently responsible for managing Canada's historic and legacy radioactive waste, producing medical isotopes, servicing the CANDU fleet, and conducting broader nuclear S&T.

The Low-Level Radioactive Waste Management Office (LLRWMO) is the federal body mandated to carry 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. The Port Hope Area Initiative Management Office is a fixed-term organization designated with specific responsibility to carry out the Port Hope Area Initiative.

The Nuclear Waste Management Organization (NWMO) – an industry led organization – was established in 2002 by the nuclear energy corporations in accordance with the *NFWA*, mandated with the long-term management of nuclear fuel waste. NWMO operates on a non-profit basis and reports annually to the Minister of Natural Resources.

Key organizations that play a role in the nuclear fuel cycle

In Canada, there are several key companies that play an important role in the nuclear fuel cycle. For example, the major mining companies in Canada involved in uranium mining, milling, processing or refining are Cameco Corporation and AREVA Resources Canada Inc. Nuclear fuel fabrication companies are General Electric and Cameco Fuel Manufacturing Inc.

The key Canadian companies currently responsible for nuclear power production are HQ, OPG, Bruce Power and NB Power.

The current waste management-specific organizations are the NWMO (nuclear fuel waste), AECL (legacy LILRW and LILRW management for small users), and AECL's LLRWMO and PHAI MO (historic LLRW owned by the federal government). The nuclear power utilities and other fuel cycle companies mentioned above are also involved in waste management activities for their respective wastes.

FINANCING

With respect to the 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, or cannot be located, or is unable to pay, responsibility rests with the federal and/or provincial governments, as managers of last resort.

Nuclear fuel waste

The requirements for financial guarantees set out in the *NSCA* take into account the related requirements of the *NFWA*. The *NFWA* requires that each of the nuclear energy corporations and AECL set aside funds in trust to pay for the full lifecycle costs (i.e., construction, operation, on-site transportation, handling, maintenance, monitoring and surveillance) of managing the nuclear fuel waste over the long term. Money in these funds can only be withdrawn by the Nuclear Waste Management Organization, and only after a construction or operating licence for a long-term waste management facility has been granted by the CNSC. As of December 2011, a total of approximately $2.5 billion has been set aside in trust.

Low and intermediate level radioactive waste

Financial guarantee requirements under the *NSCA* apply to the ongoing production of LILRW. Financial guarantees sufficient to cover the full costs of radioactive 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 long-term management of historic waste and nuclear legacy liabilities, these are financed directly by the Government of 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 may rest with the federal and/or provincial government, depending on the circumstances.

The 1996 Canada-Ontario Memorandum of Agreement (MoA) on cost-sharing 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.

On April 2, 2007, the Government of Canada and the Government of Saskatchewan announced the first phase of the cleanup of closed uranium mines in northern Saskatchewan (i.e. principally the Gunnar and Lorado mines). Under a MoA, the governments of Canada and Saskatchewan agreed to share the costs of the decommissioning. Although these mines were operated by the private sector from the 1950s until the early 1960s, the companies no longer exist. When the sites were closed, there was no regulatory framework in place to appropriately contain and treat the waste, which has led to environmental impacts on local soils and lakes.

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.

The data in this report is derived from the publication *Inventory of Radioactive Waste in Canada, 2012*.

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

Government
Canadian Nuclear Safety Commission: www.cnsc.gc.ca
Natural Resources Canada: www.nrcan.gc.ca and http://nuclear.nrcan.gc.ca
Nuclear Fuel Waste Bureau: www.nfwbureau.gc.ca
Low-Level Radioactive Waste Management Office: www.llrwmo.org
Port Hope Area Initiative Management Office: http://www.phai.ca/en/phai-home
Canadian Environmental Assessment Agency: ww.ceaa.gc.ca
Transport Canada – Transport of Dangerous Goods Directorate: www.tc.gc.ca/tdg/menu.htm

Industry
Nuclear Waste Management Organization: www.nwmo.ca
Ontario Power Generation: www.opg.com
Bruce Power: www.brucepower.com
Hydro-Québec: www.hydroquebec.com
New Brunswick Power: www.nbpower.com
Atomic Energy of Canada Ltd: www.aecl.ca

Cameco Corporation: www.cameco.com
AREVA Resources Canada Inc.: www.arevaresources.com
Canadian Nuclear Association: www.cna.ca