

Decommissioning in Canada

CURRENT STATUS

Nuclear Power Reactor Sites

Eighteen of Canada's 22 commercial nuclear power reactors are operational, two are beginning refurbished and are scheduled to be restarted in 2009 and 2010, and the remaining two are being prepared for safe storage. Three prototype power reactors (NPD, Douglas Point and Gentilly-1) have been partially decommissioned and put into a safe storage-with-surveillance state pending final decommissioning. These three reactors are owned and managed by Atomic Energy of Canada Limited (AECL), under licences from the regulatory body, the Canadian Nuclear Safety Commission (CNSC). The Douglas Point and Gentilly-1 reactors are located at sites with operational, commercial nuclear power reactors.

Atomic Energy of Canada Limited (AECL) Research Facilities

AECL, which is a Government of Canada Crown Corporation, has conducted nuclear R&D on behalf of the federal government over the past 50 years, resulting in significant legacy waste and decommissioning liabilities at its two research laboratories: Chalk River Laboratories (CRL) in Chalk River, Ontario and Whiteshell Laboratories (WL) in Pinawa, Manitoba. These nuclear legacy liabilities include accumulated waste (buried and stored) and contaminated buildings and land. CRL is operational, whereas WL is shutdown and undergoing active decommissioning.

Regarding WL, the site-wide decommissioning plan was subjected to an environmental assessment under the *Canadian Environmental Assessment Act* (CEAA). The environmental assessment addressed the partially decommissioned WR-1 research reactor and all buildings, infrastructure, waste management areas and affected lands. It was completed in March 2002, and following public hearings in September and November 2002, the CNSC issued a decommissioning licence in December 2002 for a 6-year term. The licence was intended to cover Phase 1 of a three-phase decommissioning plan for the site, and AECL is on track to completing the work by the end of the licence term (December 2008).

At CRL, approximately 20 buildings are shutdown and in various states of decommissioning, including the former NRX research reactor. Some shutdown buildings have been decommissioned and dismantled, whereas other buildings have been decontaminated and made available for other uses. AECL is currently seeking the CNSC's approval to carry out decommissioning work on the former fuel bays associated with the NRX reactor, a heavy water upgrading plant, some facilities formerly associated with plutonium extraction, a wastewater processing plant and a small research reactor. AECL also submitted a site-wide preliminary decommissioning plan for CRL to the CNSC for approval. The plan was considered at public hearings on the renewal of AECL's operating licence for CRL in April 2006 and June 2006. In renewing the licence, the CNSC tribunal stated (in its reasons for decision dated September 2006) that the plan was acceptable, recognizing that the plan will continue to evolve throughout the operating life of the site, and that uncertainties will diminish with each revision to the plan.

In 2006, the Government of Canada reviewed its long-term strategy for dealing with its nuclear legacy liabilities at AECL sites, specifically CRL, WL and the three prototype reactors. A 70-year strategy has been developed that is estimated to cost about \$7 billion (2005 Canadian dollars), with a net present value of about \$3 billion. On June 2, 2006, the Minister of Natural Resources announced that the Government of Canada had committed \$520 million to fund the 5-year, start-up phase of the long-term strategy. The funds will be used to address health, safety and environmental priorities at the sites, including the construction of new, replacement storage facilities for high-hazard wastes and a fourth groundwater treatment facility, accelerate the decommissioning of shutdown buildings and affected lands, and continue required care and maintenance activities. Also, activities to lay the groundwork for future phases of the strategy will be completed, such as the construction of waste characterization facilities and siting and design studies for the necessary waste management facilities. Natural Resources Canada (NRCan), the lead government department for the development and implementation of Government of Canada policy on radioactive waste management, will oversee AECL's implementation of the 5-year plan.

The Minister also announced that public consultations would be carried out, starting in 2007, on the further development of the long-term, 70 year strategy. NRCan and AECL will jointly conduct the public consultations, with NRCan taking the lead role.

Uranium Mining Facilities

Canadian uranium mining companies use environmentally sustainable mining practices, have developed new technologies to manage uranium mill tailings and have successfully decommissioned a number of closed uranium mine sites. For example, Cameco Corporation has developed state-of-the-art, high-tech methods to safely mine the large, high-grade uranium deposits at McArthur River and Cigar Lake. The McClean Lake Mill, operated by Areva Resources Canada, is a state-of-the-art facility that is setting new standards for the entire spectrum of mine waste management, in particular the treatment and underground disposal of uranium mill tailings. In addition to the new technologies employed to improve safety and reduce environmental impacts, the volumes of tailings generated are significantly less than from past mining operations in Canada due to the high grades of the ore bodies.

Uranium mining facility owners are responsible for decommissioning and restoring their mine and mill sites after operations cease. In this regard, Rio Algom and Denison Mines have successfully decommissioned and remediated the extensive Elliot Lake, Ontario uranium-mining facilities that were the centre of Canada's uranium mining industry from the 1950s through to the early 1980s. The mines are licensed and are under active management. Other, smaller historic mine sites in Ontario, Saskatchewan and the Northwest Territories have also been decommissioned. All sites remain under the regulatory control of the CNSC.

All operating uranium mines in Canada are located in Northern Saskatchewan, and are licensed by the CNSC. The Cluff Lake mine site is the first of the current generation to move into decommissioning. Areva Resources Canada received a decommissioning licence for the site from the CNSC in July 2004, and plans to complete active decommissioning work in 2006.

In instances where remedial actions are required at uranium-mine and mill-tailings facilities where the owner no longer exists, the Government of Canada and provincial governments ensure that the sites are safely decommissioned. In Ontario, home of the former Elliot Lake uranium mining complex, the governments of Canada and Ontario have entered into a Memorandum of Agreement outlining their roles in the management of “abandoned” uranium mine and mill tailings. Best efforts are made to identify the uranium producer or property owner of the site. Where such an owner cannot be identified, the governments have agreed to share costs, including a 50/50 sharing of costs associated with any necessary remediation. To date, these arrangements have not been necessary as all Ontario sites have owners that are complying with their responsibilities.

In June 2005, the Government of Canada announced that it would share the costs of remediating certain cold war era uranium mine sites, principally Gunnar and Lorado, in northern Saskatchewan with the Government of Saskatchewan. The companies that operated these mines in the 1950s and 1960s no longer exist, and the regulatory framework in place at the time they were closed was not sufficient to ensure adequate treatment and containment of the waste. The project will be carried out in three phases. Phase 1 will last a minimum of two years and consists of an environmental assessment under the CEAA and an application to the CNSC for a project licence. Phase 2, which will last at least three years, involves the actual site clean-up. Phase 3 consists of monitoring the site to ensure the waste produced as a result of the mining activity is properly treated and managed.

A Memorandum of Agreement is being developed between the two governments to define roles and responsibilities in the remediation of these legacy uranium mining and milling sites. Although the private sector companies that operated the mines no longer exist, a private land owner of a portion of the Lorado site will contribute to the clean-up costs.

Other Facilities

A former research laboratory at Tunney’s Pasture in Ottawa has been decommissioned, and the site has been released for unrestricted use. The University of Toronto has completed decommissioning of its sub-critical assembly, and the facility is no longer licensed. In addition, the University’s SLOWPOKE II research reactor has been decommissioned, and the building that housed the reactor has been decontaminated to levels permitting unrestricted use.

There are five SLOWPOKE reactors in operation in Canada. During the past year, the operator of the Dalhousie University (Nova Scotia) SLOWPOKE reactor approached the CNSC to discuss the process for decommissioning the facility. However, the formal process for decommissioning, including an environmental assessment under the CEAA and a licence application, has not yet been initiated.

The Bruce Heavy Water Plant was demolished by Ontario Power Generation between 2004 and early 2006. It was subjected to a comprehensive environmental assessment under the CEAA, and the work was performed under a CNSC Decommissioning Licence and a Detailed Decommissioning Plan. Approximately 97% of the materials arising from the demolition were

metals sent for recycling. Pre-demolition and demolition-phase environmental monitoring indicated no adverse environmental impacts from the decommissioning project.

PURPOSE/OBJECTIVES OF D&D

Under the *Nuclear Safety and Control Act*, licensees are required to develop decommissioning plans for their nuclear facilities. The licensee proposes when decommissioning should start and end, and the planned end state after the completion of decommissioning activities. The CNSC has the authority to either accept these proposals, or require their modification prior to licensing, subject to the requirements for environmental assessment under the CEEA. Depending on the licensee's proposal and supporting comprehensive safety case, the strategies that could be permitted by the CNSC include immediate dismantling, deferred dismantling, safe enclosure, or any combination of these. The time scales for planned safe storage intervals at nuclear facilities in Canada are generally in the range of a few decades.

The proposed end state of decommissioning varies from site to site. Some sites, notably most uranium mine sites and some other waste management sites, will be under permanent institutional control. That is, it will never be possible to release these sites for unrestricted use, and they may be regarded as indefinite safe storage sites. The projected decommissioning plans for many other large nuclear facilities are based on a planned end state of use for conventional industrial purposes. Some smaller facilities, including research reactors at locations such as universities, have been or will be cleared for unrestricted use.

SOCIAL AND ENVIRONMENTAL IMPACTS

The social and environmental issues that are of most interest to communities in the locality of decommissioning sites can vary considerably. Nevertheless, there are several issues that are common to a variety of such situations.

Among the issues of common concern are health impacts of releases and effluents, both during and subsequent to the decommissioning activity. In addition to such routine releases, the risks from possible accidents, both during and after decommissioning, are also of great interest to the community. Environmental impacts of interest include effects on water quality and effects on wildlife, such as fish in water bodies that might receive runoff from the decommissioned site.

Communities where nuclear facilities are located may be willing to accept that wastes and other remnants of the former facility remain in the community after the facility ceases to operate, but they are often unwilling to accept wastes from other locations. In some cases communities have expressed concern about the perceived stigma associated with the storage of radioactive waste near their communities, and any residual contamination from past operations and activities, and the potential impacts on property values. In some communities, ways are sought to make positive use of the sites of former facilities, for example for recreational purposes. An example of this might be the proposed use of the former head frame from a mine as a tourist attraction.

Employment is another issue, both in terms of the loss of employment after the original facility shuts down, and employment opportunities during the decommissioning work.

COMPETENT BODIES AND ROLES

The nuclear fuel cycle industry is primarily composed of four utilities (Hydro-Québec, Bruce Power, Ontario Power Generation, New Brunswick Power), the Nuclear Waste Management Organization, and uranium processing companies including uranium mining and milling (Cameco Corporation and Areva Resources Canada), refining (Cameco Corporation) and fuel fabrication (Canada General Electric and Zircotec Precision Industries). Atomic Energy of Canada Limited (AECL) is a Crown Corporation that designs, markets, sells and builds Canadian-designed CANDU power reactors, MAPLE research reactors, and MACSTOR waste storage modules. In addition, AECL has ongoing research and development programs that support operating CANDU stations.

With the exception of some legacy sites whose use predated the current regulatory system and for which an owner no longer exists, the organization responsible for decommissioning is the operator/owner of the facility. In cases of deferred decommissioning, the original operator, or a successor organization, continues to hold a licence for the facility and be responsible for meeting regulatory requirements, including those for financial guarantees. In the event that an operator becomes unable to meet its financial commitments for decommissioning, the regulator may draw upon a financial guarantee established by the operator to maintain safety and to complete the decommissioning process.

The Government of Canada recognizes 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 decommissioning and radioactive waste management in Canada. Natural Resources Canada is responsible for the development and implementation of Canadian government policy on uranium, nuclear energy and radioactive waste management issues. The CNSC is the federal body for the regulation and oversight of all life-cycle stages of nuclear facilities, including decommissioning, as well as for other uses of radioactive materials. Natural Resources Canada also provides oversight, particularly through its Nuclear Fuel Waste Bureau, which administers the *Nuclear Fuel Waste Act*. Environment Canada, Health Canada, and Transport Canada also contribute to federal oversight. The federal agent charged to carry out clean-up operations for historic waste is the Low-Level Radioactive Waste Management Office (LLRWMO).

The CNSC operates under the terms of the *Nuclear Safety and Control Act*. The Commission consists of a seven person Tribunal which conducts public hearings for applicants and licensees to present information to the Tribunal for consideration and decision-making. The Tribunal also receives recommendations and information from CNSC staff as well as submissions from external interveners.

The CNSC makes regulations and issues licences for the siting, construction, operation, decommissioning and abandonment of nuclear facilities. This licensing process is comprehensive and is based on the licensee making a safety case for its intended activities, including requirements to maintain resulting effects on the environment and humans as low as

reasonably achievable. The CNSC also coordinates the input of various other federal and provincial regulatory agencies with relevant/applicable requirements in establishing the licensing conditions for operations at and decommissioning of nuclear facilities.

The conditions for licence termination (licence to abandon) will be established by the CNSC on a licensee/site-specific basis. The CNSC has the responsibility to approve the conditions for release and/or continued control. The conditions for release may in some cases include arrangements for the establishment and funding of institutional controls under the auspices of a provincial or other level of government.

FUNDING ARRANGEMENTS

The responsibility for paying for the costs of construction, operation and decommissioning of any nuclear facility rests with the licensee (owner/operator). In order to ensure that the costs of decommissioning will be funded, the CNSC has the power to require financial guarantees of its licensees. The CNSC exercises this power for any licensed activities where the expected cost of decommissioning is considered high enough to warrant requiring a guarantee. A prerequisite to establishing a financial guarantee is establishment of the amount of that guarantee, which in turn is based on an estimate of decommissioning costs. This estimate is part of the preliminary decommissioning plan required in support of a licence application for any nuclear facility. As these plans are received, they are reviewed and cost estimates agreed upon. Subsequently, the licensee is requested to propose financial guarantee arrangements to cover the full amount of the accepted decommissioning cost estimates. Once these arrangements are acceptable to the Commission, they are referenced in the construction or operating licence.

CNSC regulations require information to be submitted on decommissioning plans and financial guarantees. The decommissioning plans need to clearly present the proposed decommissioning strategy and final end-state objectives. The CNSC's expectations on these matters are presented in Regulatory Guidance Documents. Two key documents, both issued in June 2000, are G-219, "Decommissioning Planning for Licensed Activities" and G-206, "Financial Guarantees for the Decommissioning of Licensed Activities". These guides as well as other regulatory documents and information can be found at the CNSC's web site: <http://www.nuclearsafety.gc.ca>.

The creation of a financial guarantee does not relieve the operator of its responsibility to pay for the entire cost of decommissioning its facility. The power of the regulator, to use the proceeds of a financial guarantee to pay for the cost of decommissioning by a third party, would be used only in the event that the licence holder became unable to meet its financial obligations.

DECOMMISSIONING TECHNIQUES AND INSPECTION

Prospective licensees for decommissioning projects in Canada are free to propose the techniques they consider to be most appropriate for their particular situation. Techniques and equipment used for decommissioning, decontamination and dismantlement are regulated in the same way as techniques and equipment used during operations. The use of new technologies could be permitted by a licensee after review and acceptance by the CNSC of the proposed technology in

the overall final safety/decommissioning plan. If the technology was not mentioned in the plan, the licensee would be required to make a safety case for its approval by the CNSC. A licence amendment might be required if the changes to approved activities were significant.

The CNSC has a comprehensive compliance program in place. This program includes, as appropriate, periodic inspections of all licensed activities. Such inspections are conducted and would be conducted during all periods/phases of the licensed process, including decommissioning and safe storage. The comprehensive CNSC inspection program and the various radiation protection, quality assurance and contingency programs implemented by the licensee and modified with approval by the CNSC as required, are intended to ensure that the risks associated with the decommissioning process are managed appropriately.

The CNSC establishes through an audit inspection by its own staff whether the site has met the agreed criteria and consequently whether it can be released for restricted or unrestricted use. After the release of the licensee from responsibility for the site/activity, the records required by the regulator would be kept using appropriate government archive mechanisms.

RADIOACTIVE WASTE MANAGEMENT

In July 1996, the Government of Canada announced its *Radioactive Waste Policy Framework*. The Framework sets the stage for the further development of institutional and financial arrangements to implement long-term management of radioactive waste in a safe, environmentally-sound, comprehensive, cost-effective and integrated manner. The federal government has the responsibility to develop policy, to regulate, and to oversee radioactive waste producers and owners in order that they meet their operational and funding responsibilities in accordance with approved long-term waste management plans. It is recognized that there will be variations in the general approach for the different waste types, i.e., nuclear fuel waste, low-level radioactive waste and uranium mine and mill tailings.

Health, safety, security and environment aspects of all radioactive waste, whether ongoing or historic, are regulated under the *Nuclear Safety and Control Act* as administered by the federal regulator, the Canadian Nuclear Safety Commission (CNSC). The CNSC's Regulatory Policy entitled *Managing Radioactive Waste* (July 2004) expresses the philosophy and principles used by the CNSC in regulating radioactive waste, and is fully consistent with the Government's *Radioactive Waste Policy Framework*. All radioactive wastes, except for those discharged to the environment under the terms of licence conditions relating to authorized releases, are stored and managed under conditions permitted by a licence issued by the CNSC. Waste materials resulting from decommissioning may also be released for unrestricted use, conventional disposal, recycling, etc.; in each case pursuant to licence conditions set by the CNSC.

The CNSC is currently developing an integrated approach to the assessment of proposals by licensees to release materials via all routes and pathways from licensed activities. This integrated approach will take into consideration current proposals and practices for clearance criteria under discussion internationally.

Nuclear Fuel Waste

In Canada, irradiated fuel taken out of nuclear reactors at the end of its useful life is considered as waste. There are no plans to reprocess and recycle this fuel, so current plans are based on direct long-term management of the nuclear fuel waste.

Nuclear fuel waste includes the irradiated fuel bundles that come from the 22 CANDU reactors in Canada: 20 owned by OPG, and the other two owned by Hydro-Québec and New Brunswick Power. In addition, AECL produces a small amount of waste from its prototype and research reactors. OPG owns about 90 % of the total amount of waste, the other two nuclear utilities about 4 % each, and AECL 2 %. Other waste owners, e.g., universities, produce a much smaller quantity of nuclear fuel waste.

In total, about 1.5 million bundles of nuclear fuel waste are currently in safe storage at the reactor sites, where it can be kept for decades, in pools or in dry concrete canisters. Canada's entire nuclear power program produces about 60 000 bundles annually.

In 2002, Parliament passed the *Nuclear Fuel Waste (NFW) Act* which established the legal framework for the long-term management of nuclear fuel waste in Canada. The Act requires nuclear utilities to form and maintain a Nuclear Waste Management Organization (NWMO) with a mandate to propose to the Government of Canada approaches for the long-term management of nuclear fuel waste, and to implement the approach that is selected by the 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 *NFW Act* requires the NWMO to submit to the Government by November 15, 2005 a study setting out its proposed approaches for the long-term management of nuclear fuel waste, and its recommendation on which proposed approach should be adopted. The *NFW Act* requires the NWMO to include in the study approaches based on both storage (on-site or centralized) and disposal. In carrying out the study, the NWMO must consult with the general public on each of the proposed approaches. The NWMO must also create an Advisory Council whose role is to examine and provide written comments on the NWMO's program activities. The Advisory Council's membership must reflect technical and social sciences expertise and, once the Government of Canada has selected the general approach, representation from affected local and regional governments and Aboriginal organizations.

On November 3, 2005, the NWMO submitted its study to the Minister of Natural Resources. The government is carefully reviewing the study of recommendations and expects to make a decision in the best interests of Canadians.

Low-Level Radioactive Waste

All low-level radioactive waste in Canada is presently stored. AECL provides a waste storage facility for small producers on a fee-for-service basis. To date there has been no pressing need for early disposal; volumes are small and the waste is being safely stored on an interim basis.

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 the Bruce Nuclear Power Development (BNPD). In April, 2002, OPG and the Municipality of Kincardine signed a Memorandum of Understanding (MoU) to jointly study options for the long-term management of the wastes at the BNPD site. The MoU led to a decision by the municipality to host, under the terms of an agreement with OPG, a deep geological repository for OPG's current and future low-level and intermediate-level radioactive waste from its 20 power reactors, including the waste that will be generated when those reactors are decommissioned. The proposal will undergo environmental assessment and regulatory reviews. OPG's targets are to commence construction of the deep geologic repository in 2013, with the first waste being emplaced in 2017.

The other major ongoing producer of low-level radioactive waste, AECL, stores the waste it generates in in-ground and above-ground structures. NRCAN and AECL have jointly compiled an inventory of radioactive waste and decommissioning liabilities and developed a comprehensive and proactive strategy to decommission and restore AECL's research sites over a 70 year period. The strategy includes the construction and operation of the infrastructure required to characterize, treat and manage over the long-term all of AECL's low-level radioactive waste. The Government of Canada has recognized the net present value (about \$3 billion) of the estimated cost of the strategy in the Public Accounts of Canada, and announced the initiation of the 5-year, \$520 million start-up phase on June 2, 2006.

The bulk of historic low-level radioactive waste in Canada is located in the area of Port Hope in Ontario. In March 2001, the Government of Canada and the local municipalities where the historic wastes are located entered into an agreement, the Port Hope Area Initiative (PHAI), for the clean-up and long-term management of these wastes. Canada's agent for the management of historic waste, the Low-Level Radioactive Waste Management Office (LLRWMO) which was established in 1982, is the proponent for environmental assessment and review of the PHAI and is responsible for its implementation.

The PHAI will involve the cleanup and consolidation of the wastes and long-term management in newly constructed above-ground mounds in the local communities. The project will take roughly twelve years to complete. The first phase of the PHAI is an environmental assessment and regulatory review that is expected to be completed in 2008. 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 over the long-term.

Uranium Mine and Mill Tailings

At present, all active uranium mining sites are situated in northern Saskatchewan. With respect to inactive sites, most are found in the Elliot Lake area of northern Ontario which was the major uranium mining center in Canada for over 40 years. Since the last facility closed in 1996, uranium mining companies have committed over \$75 million to decommission all mines, mills and waste management areas.

The CNSC continues to oversee a program to bring all inactive sites in Canada under regulatory control where appropriate and necessary.

PUBLIC INFORMATION

In Canada, public participation in decision-making processes continues to be a high priority. All major stakeholders carry out public affairs programs. Various pieces of legislation at the federal level incorporate mandatory public participation processes. The body of legislation is recognizing the increasing role of the public in decision-making processes, especially with respect to social and ethical considerations. For more information, Web sites of main stakeholders are listed below.

Uranium and Nuclear Industry:

Hydro-Québec: www.hydroquebec.com

Ontario Power Generation: www.opg.com

New Brunswick Power: www.nbpower.com

Bruce Power: www.brucepower.com

Atomic Energy of Canada Limited: www.aecl.ca

Nuclear Waste Management Organization: www.nwmo.ca

Cameco Corporation (uranium mining): www.cameco.com

Areva Resources Canada (uranium mining): www.cogema.ca

General Electric Canada: www.ge.com/canada

Zircotec Precision Industries: www.zircotec.ca

Canadian Nuclear Association: www.cna.ca

Federal Government Bodies:

Canadian Nuclear Safety Commission: <http://www.nuclearsafety.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

Environment Canada: www.ec.gc.ca

Health Canada: www.hc-sc.gc.ca

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