RADIOACTIVE WASTE MANAGEMENT AND DECOMMISSIONING IN CANADA

March 2008

1. NATIONAL FRAMEWORK FOR MANAGEMENT AND REGULATION OF RADIOACTIVE WASTE AND DECOMMISSIONING

1.1 National framework

1.1.1 Overview of national policy

The Government of Canada has put in place a structure of 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 and 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 *Policy Framework* states that the federal government has the responsibility to develop policy, regulate, and oversee owners to ensure that they comply with legal requirements and meet their funding and operational responsibilities in accordance with approved waste management 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.

In terms of federal organizations, Natural Resources Canada (NRCan) is the lead government department for the development and implementation of Government of Canada policy on radioactive waste management and oversight to ensure obligations under the *Policy Framework* are met. The Canadian Nuclear Safety Commission (CNSC), established under the *Nuclear Safety and Control Act*, is Canada's independent nuclear regulator. The CNSC has developed a comprehensive and modern nuclear regulatory regime to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. Atomic Energy of Canada Limited (AECL), a Crown Corporation wholly owned by the Government of Canada, and its Low-Level Radioactive Waste Management Office (LLRWMO) manage federal legacy and historic waste obligations on behalf of the Government.

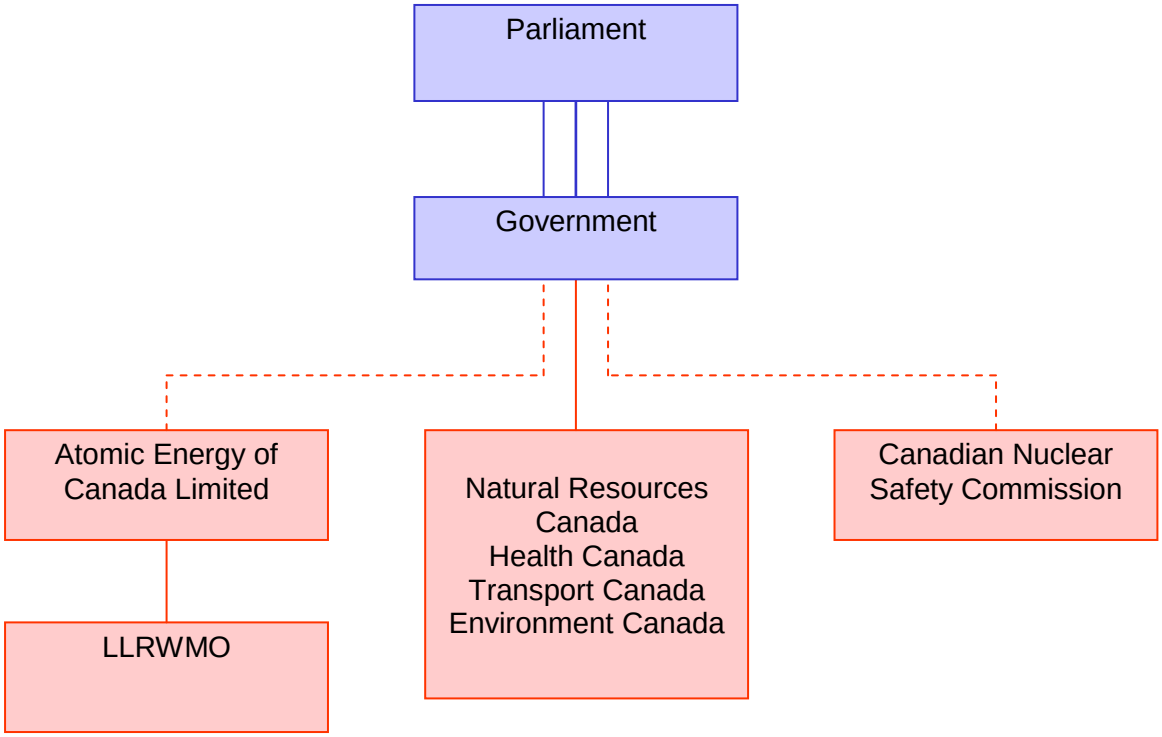
Waste owners are responsible for dealing with their radioactive wastes, and Canada's mature and skilled nuclear industry is well placed to develop and implement appropriate long-term solutions. The nuclear industry is safely managing its radioactive wastes, and initiatives are underway to develop and implement long-term radioactive waste management facilities. In the case of nuclear fuel waste, the Government of Canada determined that it would be in the best interests of Canadians to have a national long-term management approach. The *Nuclear Fuel Waste Act*, which came into force in 2002, provides the process for decision-making and implementation of such an approach, and required that an organization, the Nuclear Waste Management Organization, be established to carry out the work.

In keeping with the *Policy Framework*, different approaches have been taken for the management of nuclear fuel waste, low and intermediate-level radioactive waste and uranium mine and mill tailings. These different approaches reflect not only the different scientific and technical characteristics of the wastes, but also economics and the geographic dimensions of Canada and the locations of the waste within the country. Canada's national strategy on radioactive waste management includes a national approach for the long-term management of nuclear fuel waste, regional solutions for low and intermediate-level

radioactive waste, and the long-term management of uranium mining and milling waste close to the mine and mill sites.

1.1.2 Overview of relevant institutions

Below is a diagram that depicts the federal government institutions involved in the management and regulation of radioactive waste and decommissioning.



NRCan is the lead federal government department responsible for the development and implementation of Canadian government policy on uranium, nuclear energy and radioactive waste management. It also administers the *Nuclear Fuel Waste Act* (NFWA), and has overall responsibility for the management of historic waste – waste that was managed in the past in a manner no longer considered acceptable, for which the current owner cannot be reasonably held responsible, and for which the federal government has assumed responsibility.

A number of other federal departments have been assigned roles and responsibilities related to the safe management of spent fuel and radioactive wastes. They include:

- Health Canada, which recommends radiological protection standards and monitors occupational radiological exposures;
- Transport Canada, which develops and administers policies, regulations and services for the Canadian transportation system including the transportation of dangerous goods; and,

- Environment Canada, which contributes to sustainable development through pollution prevention to protect the environment and human life and health from the risks associated with toxic substances. They are responsible for the administration of the *Canadian Environmental Protection Act.*

The Government of Canada gives high priority to the safety and protection of persons and the environment from the various operations of the nuclear industry, and has put in place modern legislation that provides the basis for Canada's comprehensive and robust regulatory regime. Canada's nuclear regulator is the Canadian Nuclear Safety Commission (CNSC), an independent federal agency. Its mission is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC's regulatory decision process is fully independent from the Government of Canada.

In the diagram above the CNSC and Atomic Energy Canada Limited (AECL) are shown with dashed line connections to the Government to illustrate their arms-length relationships. Both organizations report directly to Parliament through the federal Minister of Natural Resources.

AECL is a Crown Corporation which is wholly owned by the Government of Canada and is managed by a Board of Directors. AECL's mandate includes the management of the waste it generates from on-going research, legacy radioactive waste and decommissioning liabilities on its properties, and wastes it accepts for long-term management from non-utility radioactive waste producers across Canada on a fee-for-service basis. AECL also manages the Low-Level Radioactive Waste Management Office (LLRWMO), which is the national agent for the clean-up and management of Canada's historic waste.

1.2 National regulatory organisation

The task of the CNSC is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC consists of a President, the federally appointed members of the Commission, and approximately 600 staff members as of the end of March 2007. The organization's general structure is defined by the Nuclear Safety and Control Act (*NSCA*). The CNSC consists of two components:

(i) The "Commission" refers to the agency's tribunal component
(ii) The "CNSC" refers to the organization and its staff in general

(i) The Commission

The Commission is an independent, quasi-judicial administrative tribunal and court of record. The Commission can consist of up to seven members. Commission members are appointed by the Governor in Council (Cabinet) of Canada for terms not exceeding five years and may be reappointed. The members are to be independent of all influences, be they political, governmental, special interest groups or the private sector. The President of the CNSC is a full-time Commission member and other members generally serve on a part-time basis.

The Commission's key roles are to:

- establish regulatory policy on matters relating to health, safety, security and the environment;
- make legally-binding regulations; and
- make independent decisions on the licensing of nuclear-related activities in Canada.

The Commission takes into account the views, concerns and opinions of interested parties and intervenors when establishing regulatory policy, making licensing decisions and implementing programs.

CNSC public hearings are the public's primary opportunity to participate in the regulatory process. CNSC staff attends these hearings to advise the Commission. Subsection 17(1) of the *NSCA* stipulates that the Commission can also hire external staff members to advise it, independently of CNSC staff, although this is not currently being done.

The Commission Secretariat supports the tribunal by planning Commission business and offering technical and administrative support to the President and other Commission members. It is also the official registrar in relation to Commission documentation.

The Commission administers the *NSCA* and its associated regulations. Among these regulations are the *CNSC Rules of Procedure*, which outline the public hearing process, and the *CNSC By-laws*, which outline the Commission's meeting process.

(ii) CNSC

CNSC staff is primarily located at headquarters in Ottawa. The Uranium Mines and Mills Division is located in Saskatoon close to Canada's major uranium mining operations. CNSC satellite offices are also located at each of the five nuclear power plants in Canada and at the Chalk River Laboratories (AECL) to assess performance against regulations and specific conditions of operating licences. Regional offices, located in Quebec, Ontario and Alberta, conduct compliance activities for nuclear substances, transportation, radiation devices and equipment containing nuclear substances. They also respond to unusual events involving nuclear substances.

CNSC staff supports the Commission by:

- developing proposals for regulatory development and recommending regulatory policies,
- carrying out licensing, certification, compliance inspections and enforcement actions,
- coordinating the CNSC's international undertakings,
- developing CNSC-wide programs in support of regulatory effectiveness,
- maintaining relations with stakeholders and
- providing administrative support to the organization.

In addition, CNSC staff prepares recommendations on licensing decisions, presents them to the Commission for consideration during public hearings and subsequently administers the Commission's decision. Where so designated, CNSC staff also renders licensing decisions.

CNSC staff work within the following organizational structure:

The **President's Office** provides administrative support services directly to the President. Other groups in the CNSC organizational structure that support the President include the **Quality Council**; the **Legal Services Unit**; the **Office of Audit, Evaluation and Ethics**.

There are four major branches of CNSC staff: Regulatory Operations, Technical Support, Regulatory Affairs and Corporate Services.

1) Regulatory Operations Branch - is responsible for regulation of the development, production and use of nuclear energy, the production, possession, transport and use of nuclear substances and radiation devices in accordance with the requirements of the NSCA and its regulations. The Regulatory Operations Branch is

comprised of: Directorate of Power Reactor Regulation; Directorate of Nuclear Cycle and Facilities Regulation; Directorate of Nuclear Substance Regulation. These three directorates are responsible for the primary interface with the licensees including licensing, compliance and enforcement.

2) Technical Support Branch - provides the specialist engineering, scientific and technical functions in support of regulatory operations. The Technical Support Branch is comprised of: Directorate of Assessment and Analysis; Directorate of Safety Management and Standards; Directorate of Security and Safeguards; Directorate of Environmental Assessment and Protection. These four directorates with their wide range of specialist functions support the regulatory decision making of the Regulatory Operations Branch.

3) Regulatory Affairs Branch- is responsible for providing strategic direction and implementation of the CNSC's regulatory policy, communications and stakeholder engagement, strategic planning, international relations and Executive Committee services.

4) Corporate Services- is responsible for policies and programs related to the management of the CNSC's finances and administration, human resources, information technology, and information management.

CNSC Research and Support Program

CNSC's Research and Support program is managed within the Technical Service Branch. The program provides staff with access to independent advice; expertise, experience, information and other resources, via contracts or contribution agreements placed with private sector as well as other agencies and organizations in Canada and internationally. The work undertaken through the Research and Support Program is intended to support staff in meeting the CNSC's regulatory mission. Each year, the program is reviewed and evaluated, the need for research and support in the following year is identified, and a commensurate budget is allotted. The CNSC Research and Support Program is independent of R&D programs conducted by industry.

1.3 National implementing organisations

Canada's *1996 Policy Framework for Radioactive Waste* states that the waste owners are responsible for financing and managing their own waste. Described below are major national implementing agencies responsible for the long-term management of nuclear fuel waste and historic low-level radioactive waste, respectively.

1.3.1 Nuclear Waste Management Organization (NWMO)

Pursuant to the *Nuclear Fuel Waste Act (NFWA)*, the NWMO, which was established by the nuclear energy corporations, is required to implement the long-term approach selected by the Government of Canada for managing Canada's nuclear fuel waste, namely, the Adaptive Phased Management (APM) approach. This is discussed in greater detail in Section 3.2.1. The Government's role is to provide oversight of the NWMO's implementation of the APM approach to ensure compliance with the NFWA.

The NWMO was established in 2002 to develop and implement an approach for the long-term management of Canada's nuclear fuel waste. The NWMO's Mission is to develop collaboratively with Canadians a management approach for the long-term care of Canada's nuclear fuel waste that is socially acceptable, technically sound, environmentally responsible and economically feasible.

From 2002 to 2005 the NWMO studied approaches for long-term management of Canada's nuclear fuel waste. In 2005, the NWMO recommended the Adaptive Phased Management (APM) approach to the Minister of Natural Resources. The Government of Canada's decision to accept this recommendation on June 14, 2007 gave the NWMO the mandate to implement the APM approach.

In preparation for assuming its implementation mandate, the NWMO has grown and full time staffing levels are now approaching 30 persons. The 2008 Business Plan provides for additional growth.

As of March 2008, the NWMO's Board of Directors is comprised of eight members. In 2007, three new directors were added from outside the nuclear industry.

The NWMO has an independent Advisory Council which was established by the Board of Directors in 2002 as required by the *NFWA*. The Council regularly meets to review and discuss the NWMO's work plans and activities and receives regular briefings from the NWMO on all aspects of its work. The Advisory Council has an important statutory responsibility for providing independent comment on the NWMO's work to the Minister of Natural Resources Canada and to the public. In 2005, the Council fulfilled its statutory obligations of reviewing and commenting on the NWMO final study report and its comments were made public when the study was submitted to the Minster of Natural Resources.

The Council's next formal reporting requirement is to provide written comments for inclusion in the NWMO's 2011 triennial report. The NWMO's Advisory Council terms of reference and composition have recently been reviewed and updated in preparation for the implementation phase. The breadth of the Council's expertise has been expanded in the areas of geoscience, Aboriginal traditional knowledge and strategic communications.

The NWMO has other advisory bodies including an Aboriginal Elders' Forum, Niigani (the Aboriginal Working Group), and in 2008 the NWMO will establish a Technical Review Group to provide independent review and comment on the NWMO's technical research program.

1.3.2 Low-Level Radioactive Waste Management Office (LLRWMO)

The LLRWMO was established by the Government of Canada in 1982 to carry out the federal government's responsibilities for low-level radioactive waste management in Canada. The LLRWMO operates under a Memorandum of Understanding between NRCan and AECL. While the LLRWMO receives its funding and policy direction from NRCan, organizationally, it is a division of AECL. While the mandate of the LLRWMO is fairly broad, in practice, its function is to resolve historic low-level radioactive waste problems that are a federal responsibility; and to address public information needs concerning low-level radioactive waste. The LLRWMO is the proponent for the Port Hope Area Initiative (PHAI), which is discussed in Section 3.2.2.

2. LEGAL FRAMEWORK

2.1 Primary Legislation and General Regulations

Nuclear Safety and Control Act

In accordance with the Canadian system of Parliamentary government, the decision to introduce government legislation, such as the NSCA, into Parliament is made by the federal Cabinet on the advice and recommendation of the appropriate Minister. The *Nuclear Safety and Control Act* (NSCA) was passed by Parliament on 20 March 1997. This was the first major overhaul of Canada's nuclear regime since the *Atomic Energy Control Act* (AECA) and the creation of the Atomic Energy Control Board (AECB) in 1946. The NSCA provided the legislative authority for a number of nuclear regulatory developments, including health and safety standards for atomic energy workers, environmental protection measures, security regarding nuclear facilities, and public input into the licensing process. The NSCA can be viewed at www.nuclearsafety.gc.ca.

The NSCA established the CNSC as a departmental corporation, named in Schedule II of the Government of Canada *Financial Administration Act*. The NSCA establishes the CNSC, which is comprised of the Commission (the tribunal which makes licensing decisions), and the CNSC staff, who prepares recommendations to the Commission, exercises delegated licensing and authorization powers, and assesses licensee compliance with the NSCA, associated regulations, and licence conditions. The NSCA authorizes the CNSC to make regulations (see Section 2.2 below).

The CNSC regulatory framework consists of regulations and associated regulatory policies, standards and guides that apply to all nuclear industries including, but not limited to:

- nuclear power reactors
- non-power nuclear reactors, including research reactors
- nuclear substances and radiation devices used in industry, medicine and research
- the nuclear fuel cycle, from uranium mining through to waste management
- the import and export of controlled nuclear and dual-use substances, equipment and technology identified as a proliferation risk.

The CNSC's mandate includes protection of the environment and of the health and safety of workers as well as the public. It discharges these responsibilities through co-operative arrangements with regulators in other fields, such as environmental protection and occupational health and safety, at federal and provincial government levels.

The NSCA incorporates stringent regulations to ensure that public health and safety are protected. For example, the NSCA incorporates:

- radiation dose limits consistent with the recommendations of the International Commission on Radiological Protection (ICRP);
- regulations governing the transport and packaging of nuclear materials in order to reduce unnecessary risks to health and safety or the environment; and
- enhanced security at nuclear facilities including spent fuel dry storage facilities and radioactive waste management facilities.

The CNSC also has certain functions under the *Nuclear Liability Act*, conducts environmental assessments under the *Canadian Environmental Assessment Act*, and implements Canada's bilateral agreement with the International Atomic Energy Agency on nuclear safeguards verification. Towards

regulatory efficiency, the CNSC oversees the entire nuclear cycle and all aspects of nuclear safety in Canada.

2.2 General Regulations

The NSCA authorizes the CNSC to make regulations. There are nine safety related regulations issued under the NSCA:

- General Nuclear Safety and Control Regulations;
- Radiation Protection Regulations;
- Class I Nuclear Facilities Regulations;
- Class II Nuclear Facilities and Prescribed Equipment Regulations;
- Uranium Mines and Mills Regulations;
- Nuclear Substances and Radiation Devices Regulations;
- Packaging and Transport of Nuclear Substances Regulations;
- Nuclear Security Regulations; and
- Nuclear Non-proliferation Import and Export Control Regulations.

All the Acts, By-Laws and regulations listed above can be viewed at www.nuclearsafety.gc.ca.

In addition to the safety regulations, the CNSC *Rules of Procedure* must be followed. The *Rules of Procedure* apply to the public, licensees and CNSC staff and Commission members with respect to the conduct of Commission proceedings. The CNSC also has Cost Recovery Fees Regulations.

The regulations under the NSCA allow the licensee, under a risk-informed umbrella, flexibility in how they comply with the regulatory requirements. With some exceptions (such as the dose limits, transport packaging and licence exemption criteria for certain devices), the regulations do not specify in detail the criteria that will be used in assessing a licence application or judging compliance. These are provided in lower tier regulatory documents (see section 2.4). The regulations provide licence applicants with general performance objectives and a list of information that they must supply.

The regulations require licence applicants to submit information on the effects of their operations on the environment – for both radioactive and non-radioactive hazardous substances. This information is used by the CNSC, in consultation with other federal and provincial regulatory bodies, to establish the operating parameters for a nuclear facility. Brief descriptions of the regulations are provided in the subsections that follow.

General Nuclear Safety and Control Regulations (GNSCR) – contain the general requirements that apply to all licensees, including licensees for used fuel and radioactive waste management and decommissioning. Such requirements include explicit information required in licence applications, obligations of licensees and their workers, definition of prescribed nuclear facilities, prescribed equipment and prescribed information, and requirements for records and reports. These GNSCRs also exempt naturally occurring radioactive materials that are not associated with the development, production or use of nuclear energy from the nuclear regulatory regime. As authorized by the NSCA, a requirement to provide information on any proposed financial guarantees is also included under these regulations.

Radiation Protection Regulations **(RPR) –** contain radiation protection requirements; they apply to all licensees and others who fall within the mandate of the CNSC. The RPRs also require the development of action levels, which are proposed by the licensee and subject to acceptance by the regulatory body. The action levels are not intended to become secondary legal limits. Instead, they will serve as checks for the proper operation of a licensee's radiation protection program.

Class I Nuclear Facilities Regulations – under the NSCA, the definition of a nuclear facility includes "a facility for the disposal of a nuclear substance generated at another nuclear facility." A nuclear facility also includes, where applicable, the land on which the facility is located, a building that forms part of the facility, or equipment used in conjunction with the facility, and any system for the management, storage, or disposal of a nuclear substance. Radioactive waste management facilities or used fuel dry storage facilities whose inventory is greater than 10^{15} Bq are considered Class I Nuclear Facilities. The *Class I Nuclear Facilities Regulations* explicitly includes the information needed to apply for different types of licences for a Class I nuclear facility. These types of licences match the life cycle of a facility, including site preparation, construction, operation, decommissioning and abandonment. The regulations also address the certification of reactor operators and records to be kept and retained.

Nuclear Substances and Radiation Devices Regulations **(NSRDR)** – apply to all nuclear substances, sealed sources, and radiation devices used in Canada. In order to harmonize Canada's regulatory approach for the exemption and clearance of radioactive material with international practices the CNSC is amending the NSRDRs to consider the IAEA (International Atomic Energy Agency) Basic Safety Standards as well as the most recent guidance from the IAEA on the concepts of exemption, exclusion and clearance. CNSC staff expects to have these amendments approval by the Governor-in-Council and publication in the Canada Gazette Part II by 2008.

Packaging and Transport of Nuclear Substances Regulations **(PTNSR)** – the Canadian requirements in the PTNSRs are based on the IAEA *Safety Standards Series No. TS-R-1, Regulations for the Safe Transport of Radioactive Material, 1996 Edition*. The CNSC has been a major participant in the development of the IAEA regulations on the packaging and transport of nuclear materials. In developing a position on transportation issues, the CNSC has communicated regularly with Transport Canada and major Canadian shippers.

Nuclear Security Regulations **(NSR)** – are intended to align Canadian nuclear facilities with the internationally accepted recommendations of the IAEA. In the development of the NSRs, the CNSC has given consideration to the Canadian security context. These regulations include improved alarm assessment for protected areas, mandatory alarm assessment for high-security inner areas, and searches of persons and their belongings by non-intrusive technical means when entering or leaving a protected area. Amendments to the regulatory requirements for nuclear security were proposed and the revised NSRs were promulgated on December 2006 following extensive stakeholder input, which makes the regulations more consistent with international recommendations and best practices, taking into account current security threats.

Uranium Mines and Mills Regulations **(UMMR) -** apply to all uranium mines and mills, including mill tailings. They do not apply to uranium prospecting or surface exploration activities. These regulations explicitly include the information needed to apply for different types of licences for uranium mines and mills. These types of licences match the life cycle of a facility, including site preparation and construction, operation, decommissioning and abandonment. These regulations also include requirements for a code of practice, the obligations of licensees, and records to be kept and made available.

Class II Nuclear Facilities and Prescribed Equipment Regulations **-** specify the requirements for prescribed equipment which includes low-energy accelerators, irradiators, radiation therapy installations and equipment containing only sealed sources.

Nuclear Non-proliferation Import and Export Control Regulations **-** apply to the import and export of controlled nuclear substances, controlled nuclear equipment and controlled nuclear information.

2.3 Specific Regulations

The Canadian regulatory regime uses general regulations supported by regulatory documents, as described in the section 2.4. All facilities licensed to manage waste are subject to either, *Class I Nuclear Facilities Regulations*, the *Uranium Mines and Mills Regulations* or *Nuclear Substances and Radiation Devices Regulations*. *Class I Nuclear Facilities Regulations* and the *Uranium Mines and Mills Regulations* contain information on decommissioning licensing requirements. There are no separate regulations for waste management.

As stated in section 2.2, the *General Nuclear Safety and Control Regulations* contain the general requirements that apply to all licensees, including licensees for used fuel and radioactive waste management and decommissioning. *Radiation Protection Regulations* apply to all licensees and others who fall within the mandate of the CNSC.

2.4 Regulatory Documents

Regulatory documents support the CNSC's regulatory framework by expanding on expectations set out in the NSCA, its regulations and legal instruments, such as licences and orders. These documents provide instruction, assistance and information to the licensees. The CNSC issues four types of regulatory documents: policies, standards, guides and notices. These classifications are currently under review.

As outlined in CNSC regulatory policy *Regulatory Fundamental* (P-299) the CNSC sets requirements using appropriate industry, national, international or other standards. The CNSC regulatory framework draws upon Canadian and international standards and best practices, including the nuclear safety standards of the International Atomic Energy Agency (IAEA). Canada has been an active participant in the development of these IAEA safety standards, as well as the supporting technical documents which provide more specific technical requirements and best practices for radioactive waste management and decommissioning.

This section describes regulatory documents specific to used fuel, radioactive waste and decommissioning. There are other generic regulatory documents that may also apply to waste management facilities, such as action levels, environmental protection, etc. Early communication with the CNSC can help the applicant develop a good understanding of the regulatory requirements, for used fuel and radioactive waste management facilities, the licensing process and the information to be submitted in support of a licence. A complete list of regulatory policies, guides, standards and notices are available at www.nuclearsafety.gc.ca.

2.4.1 Radioactive Waste Management

Regulatory Policy P-290, *Managing Radioactive Waste*

Regulatory Policy P-290, "Managing Radioactive Waste", was issued by the CNSC in July 2004 following extensive consultation with the public, the nuclear industry, and other affected stakeholders. The policy expresses the philosophy and principles used by the CNSC in regulating radioactive waste. The policy considers the extent to which owners of radioactive waste must address waste minimization; the radiological, chemical and biological management of radioactive waste; the predicted impacts on the health and safety of persons and the environment; the measures needed to prevent unreasonable risk to both present and future generations; and the trans-border effects on the health and safety of persons and the environment. It is fully consistent with the Government of Canada's *Radioactive Waste Policy Framework*.

The principles contained in Regulatory Policy P-290 are consistent with those recommended by the International Atomic Energy Agency (IAEA) in Safety Series 111-F, "The Principles of Radioactive Waste Management". The policy statement also recognizes the regulatory body's commitment to optimizing regulatory effort with the following statement: "It is also the policy of the Commission to consult and cooperate with provincial, national and international agencies to:

- promote harmonized regulation and consistent national and international standards for the management of radioactive waste, and
- achieve conformity with the measures of control and international obligations to which Canada has agreed concerning radioactive waste."

Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management*

CNSC Regulatory Policy P-290 identifies the need for long-term management of radioactive waste and non-radioactive hazardous waste arising from licensed activities. In December 2006, Regulatory Guide G-320 "Assessing the Long Term Safety of Radioactive Waste Management" was published to assist licensees and applicants to address the long-term storage and disposal of radioactive waste. The guide addresses long term care and maintenance considerations, setting post-decommissioning objectives, establishing assessment criteria, assessing strategies and level of detail, selecting time frames and defining assessment scenarios (including institutional controls), identifying receptors and critical groups, and interpretation of assessment results. The guide was developed using provincial, federal and international documents, following a pre-consultation with the nuclear industry in Canada.

CSA Standards on Radioactive Waste Management

CNSC staff participated in the development of Canadian Standards Association (CSA) document N292.2 on the interim dry storage of nuclear fuel waste, which was published in 2007. CNSC staff is also participating in the development of CSA document N292.3 on the management of low and intermediate-level radioactive waste, which is expected to be finalized in 2008.

2.4.2 Decommissioning

Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*

Provides guidance on the preparation of plans for the decommissioning of activities licensed by the CNSC. Proponents and operators of all nuclear facilities including spent fuel and radioactive waste management facilities are required to propose decommissioning plans and funding measures. Decommissioning plans must be sufficiently detailed in order to:

- demonstrate that they will remediate all significant impacts and hazards to persons and the environment in a technically feasible fashion;
- ensure that compliance with all applicable requirements and criteria established in acts, regulations, and other regulatory standards is met; and
- enable credible estimates of financial guarantee amounts.

CNSC staff is participating in the development of a Canadian Standards Association (CSA) document on decommissioning nuclear facilities, CSA N294. This document is expected to be finalized in 2009. Additionally, CNSC staff is also participating in the development of an IAEA Safety Report that is comprised of four volumes: safety assessment methodology, safety assessment for decommissioning of

three test cases, graded approach to safety assessment for decommissioning and regulatory review to safety assessment for decommissioning. The safety report is scheduled for publication in 2008.

2.5 Licensing Procedure

The general philosophy adopted in Canada about the regulation of the nuclear industry is that the licensee has the prime responsibility for safety and that CNSC staff performs a regulatory function. Licensees must make routine safety-related decisions in their day-to-day operations. They are expected to have in place a standard set of programs and processes to provide adequate protection of the environment and the health and safety of workers and the public.

General Process

The licensing process under the NSCA is initiated by an application that the proponent sends to the CNSC. Regulations under the NSCA provide licence applicants with general performance criteria and details about information and programs they must prepare and submit to the CNSC as part of the licence application process. In addition, CNSC staff publish regulatory documents (policies, guides, standards, notices), which help licensees to meet regulatory requirements. The information and specified programs submitted by the proponent, when referenced in the licence, become legal requirements for licensees. The Commission holds public hearings to consider licence applications for major facilities (see Section 2.6.1).

An application for a licence (including renewals or amendments) may trigger other legislation and regulations. Prior to any licence being granted pursuant to the NSCA and its regulations, the CNSC must meet its obligations under the *Canadian Environmental Assessment Act* (CEAA). For example, an Environmental Assessment (EA) under the CEAA may be a prerequisite to proceeding with a licence application. The CEAA may require an EA of a project to analyze potential environmental impacts. The range of stakeholder consultations is partially determined by the possible environmental impacts and the size and complexity of the project.

The CNSC utilizes a harmonized or joint review approach with provincial or territorial departments in such areas as health, environment, transport and labour participation in the CNSC's assessment, licensing and compliance programs for waste management facilities and decommissioning. It should however be noted that the CNSC retains overall responsibilities for licensing of nuclear substances in Canada. Any applicant must be aware that other provincial or territorial legislation may also apply in regards to their project, and it is the responsibility of the applicant to address this issue.

Licences may also contain other terms and conditions, such as references to standards, with which licensees must comply. For example, occupational and public radiological exposure limits are derived (or adopted) from internationally-accepted standards such as those of the ICRP. Limits for controlled release of gaseous or liquid effluents or solid materials are adopted from complementary regulatory regimes (such as the Provincial Water Quality Objectives or Metal Mining Limits for Liquid Effluent Releases) or are derived from specific licence conditions (such as the Derived Release limits). Other standards established by organizations like the Canadian Standards Association (CSA) or the American Society of Mechanical Engineers (ASME) may be adopted by the CNSC.

Early communication with the CNSC can help the applicant develop a good understanding of the regulatory requirements for radioactive waste management facilities and decommissioning, the licensing process and the information to be submitted in support of a licence. Early communications also enable the CNSC to plan for the regulatory review, including making sure that qualified staff are available to carry out the assessment.

Licence Type and Length

There are several types of licences issued. A nuclear facility, for example a Class I Nuclear Facility, a Class II Nuclear Facility or a Uranium Mine or Mill, is licensed during its life cycle. Typical licence periods can be from two to ten years. Each licence is issued for a fixed period of time and is subjected to reassessment by the CNSC at each renewal. Often, the Commission requires that status reports be submitted at specified points in time during the licence period. Licenses are required for site preparation, construction, operations, decommissioning, and abandonment. Taken together, the different types of licences cover the entire life cycle of the facility or of the activity being permitted, providing "cradle-to-grave" regulatory oversight. Once a licence is issued, the CNSC carries out compliance verification activities to ensure that its requirements continue to be met**.**

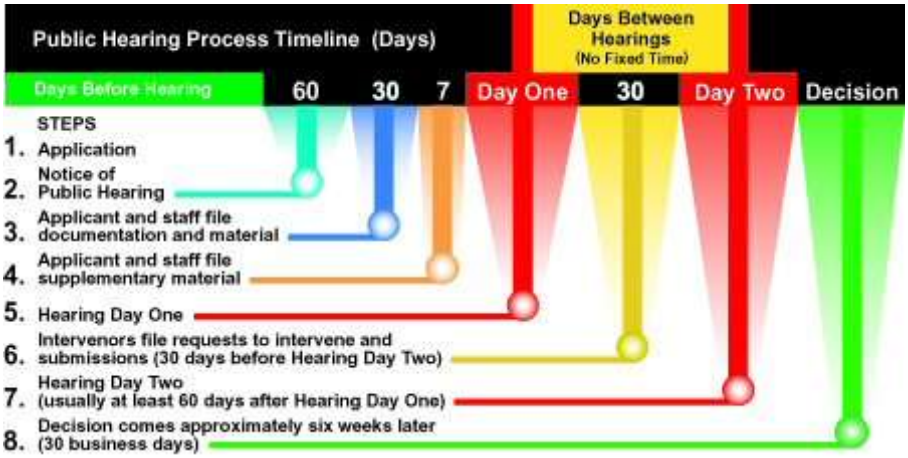
In addition to the formal licensing process, depending on the type of application, the CNSC encourages licence applicants to undertake pre-application communications activities, such as public consultations, regarding their plans for radioactive waste facilities and decommissioning. The CNSC has issued a regulatory guide which provides general information to licensees on the regulatory requirements for public information programs. This document is titled *Licensee Public Information Programs*, and is available at the CNSC website (see document G-217 www.nuclearsafety.gc.ca/eng/regulatory_information/documents/current_docs.cfm).

2.6 Information and Participation of the Public

2.6.1 Public Hearings

As discussed in the CNSC Licensing Procedure (see section 2.5), the NSCA requires the Commission to hold a public hearing before making a licensing decision pursuant to subsection 24(2) of the NSCA or where it would be in the public interest to do so. A public hearing is a proceeding structured so as to give interested members of the public a reasonable opportunity to make submissions in relation to the matter to be decided by the Commission. The NSCA also requires that licensees and anyone named in or subject to an order have the opportunity to be heard. Accordingly, the *CNSC Rules of Procedure* apply to these proceedings and set out the requirements for, among others, the notification of public hearings and publication of decisions from public hearings.

In accordance with the *CNSC Rules of Procedure*, a public hearing before the Commission may take place on one day or on two non-consecutive days. Most major decisions are made following a two-day public hearing. Day 1 and Day 2 may be held several months apart but are typically 60 days apart to permit stakeholders time to review the application and recommendations. The following figure shows the timelines for a two-day public hearing process:



Hearing Day One - A *Notice of Public Hearing* is published 60 days prior to the hearing date. Applicants and CNSC staff file the documentation they intend to present at the hearing at least 30 days prior to the hearing. All documents filed by both the applicant and staff become public record and are distributed as required (e.g. submissions by staff are provided to the applicant and to any other person who requests them).

Supplementary information the applicant or staff wishes to provide to the tribunal are filed seven days in advance of the hearing. During the hearing, applicants present the information on their application and CNSC staff presents its comments and recommendations to the Commission. Commission members question both staff and applicant regarding the information on the record. No decision is made during the first day of the hearing.

Prior to Hearing Day Two - Anyone wishing to take part in the process can file a request to intervene at least 30 days prior to Hearing Day Two. Documents received from interveners become public record and are sent to the applicant and staff for review. Supplementary information must be filed seven days prior to the hearing.

Hearing Day Two - As appropriate, the applicant and CNSC staff presents additional information to the tribunal. Members of the public that have been granted the status of intervener may attend in person to make their presentations or have their written submissions considered in a public forum. Commission members can pose questions to the applicant, CNSC staff and any interveners present regarding the submissions made. Participants at the hearing may question each other through the presiding members.

Commission Decisions - After the Hearing Day Two, the tribunal deliberates *in camera* the application and all information submitted during the public hearing to reach a decision. Typically, six weeks following the hearing, a notice of decision and a *Record of Proceedings, including Reasons for Decision* are sent to all participants and published on the CNSC Web site (www.nuclearsafety.gc.ca). Transcripts of the hearing are also posted on the CNSC Web site in the weeks following the Hearing Day One and Hearing Day Two.

Compliance - Administering licensing decisions of the tribunal entails planned and continuous oversight. Whether based on or offsite, CNSC staff work on a daily basis carrying out regular inspections, audits and reviews to provide a comprehensive overall and day-to-day picture of operations, ensuring that it is safe and in compliance with the licence.

2.6.2 CNSC Outreach Program

The CNSC recognizes open, transparent and timely communications as being central to the work and management of Canada's nuclear regulatory regime. As a function of good management, open and proactive communications ensure that stakeholders receive information, and that their views and concerns are taken into account in the formulation, implementation, and evaluation of CNSC policies, programs, services, and initiatives.

The CNSC strives to operate with a high level of transparency in all of its activities. This involves engaging stakeholders through a variety of appropriate consultation processes, effective information sharing and communications. In 2003, the CNSC Executive Committee approved the CNSC Outreach Program Framework. The Framework provides a detailed description of the need for an Outreach Program and the steps that are taken to successfully implement it.

The CNSC's Outreach Program:

- provides the context and framework for outreach activities;
- provides tools and materials for existing and new activities;
- sets targeted, measurable outcomes;
- tracks and continuously seeks to improve the CNSC's performance in doing outreach;
- identifies opportunities for new activities; and
- provides the structure and necessary resources to support additional CNSC personnel to carry out related activities.

The CNSC uses outreach to communicate scientific, technical and regulatory information to stakeholders concerning the activities of the CNSC and the effects of the uses of nuclear energy and materials on health, security, and the environment, to consult with stakeholders, and to be aware of issues and concerns stakeholders have that relate to the CNSC as Canada's nuclear regulator and to the regulatory regime.

3. WASTE MANAGEMENT STRATEGY AND CURRENT PRACTICE

3.1 Waste classification and quantities

Canada's current waste classification system is based on the following three categories.

Nuclear Fuel Waste: Nuclear fuel waste is defined in the *NFWA* as being "irradiated fuel bundles removed from a commercial or research nuclear fission reactor", and thus includes CANDU fuel bundles discharged from power and prototype reactors, as well as the shutdown WR-1 research reactor at Whiteshell Laboratories. For the purpose of this report and other inventories, it also includes other forms of research reactor fuel waste, such as the fuel rods discharged from AECL's research reactors at Chalk River Laboratories. In Canada, nuclear fuel waste is synonymous with spent fuel, as defined in the *Joint Convention*, but is considered to be a more accurate term, because discharged fuel is considered a waste material but may not be fully spent.

Nuclear Fuel Waste Accumulation Rate and Inventory, 2003

Nuclear Fuel Waste Accumulation Rate in 2003		Nuclear Fuel Waste Inventory to 2003 December 31			
		Dry Storage	Wet Storage	Total Storage	
No. of Fuel Bundles/yr	**Estimated Volume (m^3/yr)**	**No. of Fuel Bundles**	**No. of Fuel Bundles**	**No. of Fuel Bundles**	**Estimated Volume (m^3)**
POWER REACTORS					
61,645	246	230,386	1,427,552	1,657,938	6,632
PROTOTYPE/DEMONSTRATION/RESEARCH REACTORS					
863	3	52,873	0	52,873	212
Total					
62,508	**249**	**283,259**	**1,427,552**	**1,710,811**	**6,844**

Source: Inventory of Radioactive Waste in Canada – December 2004, LLRWMO

In addition, Canada has a small quantity of high-level liquid radioactive waste, approximately 280 m^3, which is stored at AECL's Chalk River Laboratories.

Low and Intermediate-Level Radioactive Waste: In Canada, low and intermediate-level radioactive waste comprises all forms of radioactive waste except for nuclear fuel waste and for those wastes derived from uranium or thorium mining and milling.

Low and Intermediate-Level Radioactive Waste (LIRW)
Accumulation Rate and Inventory, 2003

Waste Source	LIRW Accumulation Rate in 2003 (m^3/yr)	LIRW Inventory to 2003 December 31		
		Waste (m^3)	Contaminated Soil (m^3)	Total (m^3)
A. ONGOING AND NUCLEAR LEGACY LIABILITIES (NLL) WASTE				
Operations	7,220	194,980	382,800	577,780
Decommissioning	40	6,160	0	6,160
Total Ongoing & NLL Waste	**7,260**	**201,140**	**382,800**	**583,940**
B. HISTORIC WASTE				
Total Historic Waste	0	0	1,702,900	1,702,900
TOTAL	**7,260**	**201,140**	**2,085,700**	**2,286,840**

Source: Inventory of Radioactive Waste in Canada – December 2004, LLRWMO

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 ore and production of uranium concentrate. In addition to tailings, mining activities typically involve the production of large quantities of waste rock, as workings are excavated to access the ore body to extract the ore. Because of the large mass, management options for uranium tailings and for waste rock are limited.

Uranium Mill Tailings Accumulation Rate and Inventory, 2003

Status of Tailings Site	Accumulation Rate 2003 (tonnes/yr)	Accumulated Mass 2003 Dec. 31 (tonnes)
Operating Tailings Sites	628,746	8,158,290
Inactive/Decommissioned Tailings Sites	0	205,067,000
Development Sites	0	0
TOTAL	**628,746**	**213,225,290**

Source: Inventory of Radioactive Waste in Canada – December 2004, LLRWMO

The Canadian Standards Association (CSA), which is a not-for-profit member-based association serving industry, government and consumers, is in the process of developing radioactive waste management standards that include a more detailed classification system for radioactive waste. These standards are developed through a consensus process involving persons representing varied viewpoints and interests. They represent industry, government, regulatory agencies and other interested parties.

3.2 Waste Management Strategy

3.2.1 Nuclear Fuel Waste

Three provincial nuclear energy corporations, namely Ontario Power Generation (OPG), Hydro-Québec and New Brunswick Power, own 98 percent of the nuclear fuel waste in Canada, and most of the remainder is owned by AECL. Following a decade-long environmental assessment of a deep geological disposal concept for nuclear fuel waste that ended in 1998, it became clear that the Government of Canada needed to put in place a process to ensure that a long-term management approach for Canada's nuclear fuel waste would be developed and implemented. Given the relatively small volume of nuclear fuel waste in Canada, it was determined that a national solution would be in the best interest of Canadians. In keeping with the *Policy Framework*, owners of nuclear fuel waste would be responsible for developing, proposing, financing, and implementing long-term management strategies. Government would oversee the owners' efforts, evaluate the strategies, and select a general, sound approach for Canada. The CNSC would be responsible for regulatory matters pursuant to the *Nuclear Safety and Control Act (NSC Act)*.

On November 15, 2002, the Government brought into force the *Nuclear Fuel Waste Act* (*NFW Act*), which made owners of nuclear fuel waste clearly responsible for the development of long-term waste management approaches. It required that the three nuclear energy corporations establish a waste management organization as a separate legal entity to manage the full range of long-term nuclear fuel waste management activities. It also required that the major waste owners (nuclear energy corporations and AECL) establish trust funds with independent third-party trust companies to finance their long-term waste management responsibilities. The NWMO was required to prepare and submit a study of proposed approaches for the long-term management of the waste to the Government of Canada, along with a recommendation on which of the proposed approaches should be adopted. The *NFW Act* required that the analysis include feedback from comprehensive public consultation, including aboriginal peoples, and be evaluated in terms of social and ethical considerations.

The *NFW Act* also placed the federal government in the role contemplated by the *Policy Framework*. The Government of Canada was tasked with reviewing the study prepared by the waste management organization, selecting a long-term management option from those proposed, and providing oversight during implementation.

As required by the *NFW Act*, the nuclear energy corporations established the NWMO. The waste owners established trust funds to finance the implementation of long-term waste management activities. Following extensive studies and public consultation, the NWMO submitted its study of options to the Government of Canada on November 3, 2005. The NWMO presented four options, including those listed in the *NFW Act*, namely long-term storage at the reactor sites, central shallow or below ground storage, deep geological disposal, and a fourth option called the Adaptive Phased Management (APM) approach which essentially combines the three listed options within a flexible adaptive management decision-making process

In studying these options, the NWMO held 120 public consultations and numerous full-day dialogues on values, covering a cross-section of the population in every province and territory. All in all, 18,000 citizens contributed directly to the study, while more than 60,000 people expressed interest by visiting the NWMO website.

The NWMO recommended the APM approach to the federal government as the most appropriate long-term solution for managing Canada's nuclear fuel waste in a way that safeguards the public and the environment and ensures that the present generation deals with its waste. The APM approach comprises both a technical method and a management system.

The technical method is based on an end-point of centralized containment and isolation of the used fuel in a deep geological repository in a suitable rock formation. It provides for continuous monitoring of the used fuel and the potential for retrievability for an extended time. Consistent with adaptive management, there is provision for contingencies, such as the optional step of shallow storage at the selected central site, in the event that circumstances favour early centralization of the used fuel before the repository is ready.

The management system is based on phased and adaptive decision-making. Flexibility in the pace and manner of implementation allows for phased decision-making, with each step supported by continuous learning, research and development, and public engagement. An informed, willing community will be sought to host the centralized facilities. Sustained engagement of people and communities is a key element of the plan, as the NWMO continues to work with citizens, communities, municipalities, all levels of government, Aboriginal organizations, NGOs, industry and others.

On June 14, 2007 the Government of Canada announced that it had selected the APM approach for the long-term management of nuclear fuel waste in Canada. The APM approach recognizes that people benefiting from nuclear energy produced today must take steps to ensure that the wastes are dealt with responsibly and without unduly burdening future generations. At the same time, it is sufficiently flexible to adjust to changing social and technological developments.

The NWMO is required to implement the Government's decision according to the *NFWA*, using funds provided by the waste owners. The NWMO will now begin by developing a five-year implementation plan on how the organization will position itself to move forward with implementing the government-selected approach. An important element of implementation will be identification of an informed, willing host community. Once the five-year plan is confirmed, the NWMO will begin dialogues mainly in the four nuclear provinces, namely Ontario, Quebec, New Brunswick and Saskatchewan, to begin to develop a process for identifying a suitable site in an informed, willing host community, with discussion around the

principles on which a process should be based. Through subsequent phases of engagement, the NWMO will bring forward a draft siting process proposal for review and discussion with Canadians. It is likely to take a number of years before a suitable site within an informed and willing host community is found. Siting will not begin until the siting process has been discussed and confirmed, and the readiness of the NWMO's public engagement program has been confirmed.

3.2.2 Low and Intermediate-Level Radioactive Waste

In Canada, low and intermediate-level radioactive waste (LIRW) comprises all forms of radioactive waste except for nuclear fuel waste and waste derived from uranium and thorium mining and milling. Low and intermediate-level radioactive waste is discussed below under three broad categories:

- Ongoing Waste: Low and intermediate-level radioactive waste that is generated by the ongoing activities of companies currently in operation, such as nuclear electricity generators. Owners are responsible for the safe management of the waste in keeping with the *Policy Framework*.

- Nuclear Legacy Liabilities: Legacy radioactive wastes at AECL sites that date back to the Cold War and the birth of nuclear technologies in Canada. These include shutdown contaminated buildings and contaminated lands, and are managed by AECL on behalf of the Government of Canada. The nuclear legacy liabilities include some high-level waste, in particular research reactor fuel and 280 m^3 of high-level liquid waste, that are being dealt with under the Nuclear Legacy Liabilities Program, as described below.

- Historic Waste: Low-level radioactive waste that was managed in the past in a manner that is no longer considered acceptable and for which the current owner cannot be reasonably held responsible. Canada's historic waste inventory consists largely of radium and uranium contaminated soils. The Government of Canada has accepted responsibility for this waste.

Ongoing Waste

OPG, which owns 20 of Canada's 22 CANDU reactors, is responsible for about 77 percent of the ongoing waste generated in Canada annually. AECL generates approximately 17 percent of the annual volume. It also accepts low and intermediate-level radioactive waste from a number of small producers and users of radioactive materials for long-term management, which amounts to a further 3 percent of Canada's annual volume. The remaining 3 percent is largely generated by New Brunswick Power and Hydro-Québec, which own and operate the other 2 CANDU reactors in Canada, and Cameco Corporation's uranium processing and conversion facilities in Ontario. The owners of ongoing low and intermediate-level radioactive waste are all managing and operating storage facilities for their wastes. In addition, the two major waste owners, OPG and AECL, are pursuing initiatives to develop and implement long-term management solutions.

OPG's LIRW is safely stored on an interim basis at the Western Waste Management Facility (WWMF) adjacent to the Bruce Nuclear Power Development (BNPD), 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 was based on the results of a Geotechnical Feasibility Study, a Preliminary Safety Assessment, a social and economic assessment, an environmental review, and a community attitude survey and interviews with local residents, businesses and tourists. Another component of the IAS was a public consultation program conducted in Kincardine and surrounding municipalities.

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 LIRW because it had the highest margin of safety and is consistent with best international practice. Other considerations were that:

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

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 700 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.

Following the Council resolution, Kincardine and OPG began to negotiate terms for a hosting agreement. The Kincardine Hosting Agreement, which sets out the terms under which the project would proceed, was signed on October 13, 2004. The DGR will be designed to hold OPG's current and future LIRW from its 20 CANDU reactors. The DGR project is now proceeding through an environmental assessment and regulatory review phase.

AECL's ongoing low and intermediate-level radioactive waste will be dealt with in waste management facilities that will be built under the Nuclear Legacy Liabilities Program, as described in the following section.

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. More than half of the liabilities are the result of Cold War activities during the 1940s, 50s and early 60s. The remaining liabilities stem from R&D for medical isotopes and nuclear reactor technology, as well as national science programs.

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, high-level, 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. The estimated cost to implement the strategy over 70 years is about $7 billion (current-day Canadian dollars).

The development of the strategy had to take into account two fundamental conditions:

- CRL will continue to operate for the foreseeable future; and,
- a full suite of waste management facilities will be required.

Implementation of the strategy at CRL will need to be coordinated with ongoing site operations, and deal with operational facilities and other infrastructure over time as they are shutdown and taken out of service. Waste characterization, processing, conditioning, treatment, packaging, storage and long-term waste management facilities will need to be designed and constructed prior to being able to effectively deal with much of the waste.

The Government of Canada has committed $520 million to fund the 5-year start-up phase of the Nuclear Legacy Liabilities Program. The 5-year plan, which was initiated in 2006, focuses on:

- addressing immediate health, safety, and environmental priorities;
- accelerating the decommissioning of shutdown buildings; and,
- laying the groundwork for subsequent phases of the strategy,

while continuing necessary care and maintenance activities to maintain the liabilities in a safe state until they can be fully addressed in future phases of the program. Further development and refinement of the strategy will be informed by public consultations.

The 5-year plan is being implemented through a Memorandum of Understanding 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 5-year plan. NRCan represents the interests of the Government, providing policy direction and oversight; ensuring value for money, transparency and accountability; and providing for public consultations to inform the further development of the long-term strategy. 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. Over the course of its existence, the LLRWMO has completed historic waste cleanups across Canada.

The bulk of Canada's historic low-level radioactive waste is located in the southern Ontario communities of Port Hope and Clarington. These wastes and contaminated soils amount to roughly 2 million cubic meters and relate to the historic operations of a radium and uranium refinery in the Municipality of Port Hope dating back to the 1930s. While there are no urgent health or environmental risks, the Government of Canada determined that intervention measures are required to deal with the impacts of past waste management practices in the Port Hope area.

In March 2001, the Government of Canada and the local municipalities entered into an agreement on community-developed proposals to address the cleanup and long-term management of these wastes, thereby launching the Port Hope Area Initiative (PHAI). The LLRWMO 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. The current phase of the PHAI involves environmental assessment and regulatory review, and is expected to be completed in 2010. Ongoing public consultation remains a priority as municipal support is required for successful completion of the planning phase. The environmental assessment for the Port Hope waste management facility was completed in March 2007, and the municipality has given its consent to continued project implementation. With this, the licensing process is now proceeding. The environmental assessment process for the facility in Clarington (the Port Granby facility) is ongoing. Once a federal decision on the environmental assessment is complete, licensing may proceed for the Port Granby facility. Cleanup, waste facility construction and waste emplacement will take place in the following years, after which the facilities will continue to be monitored and maintained for the long-term.

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. 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.

3.2.3 Uranium Mine and Mill Tailings

In keeping with the *Policy Framework*, Canadian uranium mining companies are responsible for the funding, organization, management, and operation of facilities required for their wastes. Canada's operating uranium mining companies, Cameco Corporation and Areva Resources Canada, are not only leaders in uranium production, but they also are leading in the development of environmentally sustainable uranium mining practices. They have developed new technologies to manage uranium mill tailings and reduce environmental impacts.

Owners of closed uranium mines are also required to ensure that their sites are properly decommissioned, and they have set the standard for decommissioning uranium mine sites. In particular, Rio Algom and Denison Mines have successfully decommissioned and remediated the extensive Elliot Lake uranium-mining facilities that were the centre of Canada's uranium mining industry from the 1950s through to the early 1980s.

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 entered into a Memorandum of Agreement in 1996 outlining their respective roles in the management of "abandoned" uranium mine and mill tailings. In keeping with the *Policy Framework*, 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 September 2006, the Governments of Canada and Saskatchewan entered into a Memorandum of Agreement that defines roles and responsibilities for the remediation of certain cold war era uranium mine sites, principally the Gunnar mine and mill site, in northern Saskatchewan. Private sector companies that no longer exist operated these sites from the 1950s until the early 1960s. When the sites were closed, there was no regulatory framework in place to ensure appropriate containment and treatment of the waste, which has led to environmental impacts to local soils and lakes. On April 2, 2007, the Government of Canada and the Government of Saskatchewan announced the first phase of the cleanup. The total cost, which the Governments of Canada and Saskatchewan will share, will be $24.6 million. NRCan has advanced $1.13 million as its share of Phase 1 of the project, and a comprehensive study environmental assessment of the project began on June 15, 2007. In October 2007, the Government of Saskatchewan and Encana Corporation entered into an agreement for the decommissioning and reclamation of the nearby Lorado uranium mill site. Encana is the current owner of the Lorado site and will fund the project.

3.3 Waste management issues at national level

With the June 14, 2007 Government decision to select the Adaptive Phased Management (APM) approach for the long-term management of nuclear fuel waste, the NWMO has been given a mandate for implementation.

Over the next five years, the NWMO will focus its efforts on a number of areas: continuing to build long-term relationships with interested Canadians and Aboriginal People to involve them in setting future directions; broadening its foundation of technical and social knowledge; financial surety; continuing to review and validate its plans against a changing external landscape; further developing its governance structure; building a sustaining organization with a full range of capabilities; and proceeding with the collaborative design of a siting process.

The NWMO is presently engaging Canadians and Aboriginal Peoples in collaborative planning. Through 2007 and early 2008 the NWMO will be inviting input for the development of its five-year Implementation Plan and then testing and confirming that plan.

Once the foundation is laid, the NWMO will engage Canadians in the collaborative development of a process to guide site selection, and later the development of a draft plan for site selection. The NWMO is continuing its social and technical research programs (see section 3.4 for further details). Research in technical and social domains will play an important role in confirming the technical and social conditions to proceed at each step, and to develop confidence in the process.

It will be important to consider how plans may need to be adapted over time. Processes for continually reviewing, updating and validating the NWMO's plans against changes in the external landscape will be required, to take into account implications of ongoing technological innovation, changing social priorities and industry decisions that may have implications for changes in volumes and types of

used fuel to be managed. Another priority for the NWMO will be sustaining the engagement of Canadians and Aboriginal Peoples on a broad scale in the four nuclear provinces. Once a siting process is confirmed, the NWMO will initiate a site selection process to identify a willing and informed host community.

3.4 Research and Development

3.4.1 Research infrastructure

Most research on the long-term management of nuclear waste is presently being carried out by either the NWMO or AECL. A small amount of research is supported directly through the federal government, such as through the CNSC or through the National Sciences and Engineering Research Council of Canada (NSERC) funding program. The research is carried out within industry and at universities and AECL research facilities.

Geological site characterization is presently being carried out at the Bruce site in support of the OPG proposed deep geological repository for low and intermediate-level waste.

3.4.2 Contents of R&D plans

The NWMO R&D plans will advance research to broaden the NWMO's foundation of technical and social knowledge to support implementation of the Government decision.

The objective of the NWMO's social research program is to assist the NWMO in exploring and understanding the social issues and concerns associated with the implementation of Adaptive Phased Management, and to support the organization in adopting appropriate processes and techniques to engage potentially affected citizens in decision-making. The research focus will include such topics as: evolving approaches to dialogue, collaboration and dispute resolution; approaches to capacity building of dialogue participants and the implementation process itself; interweaving the insight from Traditional Knowledge with that of natural and social scientific research in decision-making; identifying and exploring the evolving framework of values and ethics of Canadians which comes to bear; approaches to ensuring the well-being of potentially affected communities; approaches to long-term knowledge management and transfer between generations; and anticipating the requirements of evolving institutional/legal frameworks in Canada. The social research program includes work to engage potentially affected citizens in near term visioning of the implementation process going forward, long term visioning and the development of decision-making processes to be used into the future. The program also includes work to learn from the experience of others through examination of case studies and conversation with those involved in similar processes both in Canada and abroad.

On the technical program, in the initial phases the NWMO program will focus on building human capacity, developing means to evaluate sites from a technical perspective, strengthening its understanding of the safety case for a geologic repository and developing conceptual designs. Participation in international projects is an important component; for example the NWMO is currently involved with several experiments at the Äspö Underground Research Laboratory.

Examples of current and ongoing work in the technical program include:

- Used Fuel Storage and Repository Engineering – Fuel integrity, repository design, container design and integrity, sealing materials, microbial studies, monitoring and retrievability.

- Geoscience – Glaciation and climate change studies, regional groundwater flow systems, site characterization technology, geochemical data analysis, mass transport in fractured rocks, and examination of different potential host rocks.

- Safety Assessment – Used fuel dissolution, biosphere data, safety assessment system model and code development, safety case studies.

- Other Technologies – Monitor developments on alternative technologies, notably reprocessing, partitioning, transmutation, and very deep boreholes

3.5 Financing of Radioactive Waste Management

3.5.1 Framework and responsibilities

By applying the principle of "the polluter pays," the Government of Canada has clearly indicated that waste owners are financially responsible for the management of their radioactive waste, and has set in place mechanisms to ensure that this financial responsibility does not fall to the Canadian public. This position was clearly enunciated in the 1996 *Policy Framework for Radioactive Waste*. In 2002, under the NFWA, the owners of nuclear fuel waste were specifically required to establish segregated funds to fully finance long-term waste management activities.

The CNSC requires licensees of spent fuel and radioactive waste management facilities to provide guarantees that adequate financial and human resources will be available for the decommissioning of those facilities, and the management of the resulting radioactive wastes, including spent fuel. Where a producer or owner of waste cannot be identified or located, the owner is unable to pay, or it is unreasonable for the owner to pay, federal and/or provincial governments have taken on these responsibilities as managers of last resort.

The NFWA provides the legal and financial framework needed for the long-term management of nuclear fuel waste. One of the cornerstone elements of the NFWA requires nuclear energy corporations and AECL to establish trust funds with an independent third-party trust company to finance their long-term management responsibilities for nuclear fuel waste. Trust funds have been set up by the affected organizations, namely Ontario Power Generation Inc, Hydro-Québec, NB Power and AECL.

3.5.2 Status of financing schemes

The NFWA requires nuclear energy corporations and AECL to set aside funds, in trust, to pay for the long-term management of their nuclear fuel waste. As of December 2007, funds set aside totalled approximately $1.4 billion.

Following the Government's acceptance of the APM approach for the long-term management of nuclear fuel waste, the NWMO is required, pursuant to the NFWA, to submit a funding formula in its next annual report, which is due March 31, 2008, to the Government for approval. The funding formula will ensure that, over the long-term, there are sufficient funds available to implement the APM approach.

The funding formula is subject to the approval of the Government at two different points in time: first, when the formula is proposed in the first annual report following the Government's decision on the approach to be taken for managing Canada's nuclear fuel waste; and second, when the formula is proposed in the first annual report after the issuance, under section 24 of the *Nuclear Safety and Control Act*, of a licence for construction or operation of a nuclear fuel waste management facility.

In accordance with the NFWA, the NWMO may only withdraw funds to implement the APM approach, and only after a construction or site licence for a long-term waste management facility has been granted by the Canadian Nuclear Safety Commission.

4. DECOMMISSIONING STRATEGY AND CURRENT PRACTICE

4.1 Decommissioning strategy

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. 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 waste management sites, will be under permanent institutional control, i.e., it will never be possible to release these sites for unrestricted use, and they may be regarded as indefinite safe storage sites. The preliminary decommissioning plans for many other large nuclear sites are based on a planned end-state of reuse for conventional industrial purposes. Some smaller facilities, including research reactors at locations such as universities, have been or will be cleared for unrestricted use.

To reduce the volume of radioactive waste generated by decommissioning and dismantling operations requiring long-term management, waste clearance programs are implemented to separate "clean" waste from radioactive waste.

4.2 Status of decommissioning projects

4.2.1 Nuclear Power Reactor Sites

Eighteen of Canada's 22 commercial nuclear power reactors are operational, two are being refurbished, and the remaining two are being prepared for safe storage. Three prototype power reactors (NPD, Douglas Point and Gentilly-1), which are owned and managed by AECL, have been partially decommissioned and put into a safe storage-with-surveillance state pending final decommissioning. The Nuclear Legacy Liabilities Program (see Section 3.2.2 and below) provides funding for management and decommissioning planning for the prototype reactors. The Douglas Point and Gentilly-1 reactors are located at sites with operational, commercial nuclear power reactors.

4.2.2 Atomic Energy of Canada Limited (AECL) Research Sites

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 decommissioning a section of the former fuel bays associated with the NRX reactor, and is seeking approvals to decommission a heavy water upgrading plant, some facilities formerly associated with plutonium extraction, and a wastewater processing plant.

AECL submitted a site-wide comprehensive preliminary decommissioning plan for CRL to the CNSC in 2005, and additional information on the costing and the short-term, 5-year implementation plan in 2006. 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 (current day Canadian dollars), with a net present value of about $3 billion. In June 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 Nuclear Legacy Liabilities Program. The Nuclear Legacy Liabilities Program is discussed in greater detail under Section 3.2.2

4.2.3 Other sites

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.

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.

4.3 Decommissioning issues at national level

While Canada does not have a long-term management facility in place to accept low and intermediate-level waste, this has not been a significant impediment to decommissioning activities because of the extensive use of waste clearance in Canada to minimize the generation of radioactive waste from operational and decommissioning activities. For many shutdown facilities, the building care and maintenance costs avoided by decommissioning and dismantling the structure can make the alternative of storing the residual "radioactive" building components and elements (i.e., following clearance activities) financially attractive, particularly considering the reduced risks and liabilities once the facility is demolished. Further, the OPG and AECL initiatives underway to develop and implement long-term management facilities for low and intermediate-level radioactive waste include provisions for decommissioning waste.

4.4 Research and development

To date, decommissioning activities in Canada have been carried out using largely conventional techniques, and this is not expected to change. Thus, Canada does not have a formal decommissioning research and development (R&D) program. AECL does; however, conduct R&D on an as-required basis to identify and assess potential characterization, conditioning and processing technologies for dealing with its legacy wastes from Cold War activities and early R&D initiatives. This R&D is carried out at Chalk River Laboratories, and to a lesser degree at Whiteshell Laboratories.

4.5 Financing

4.5.1 Framework and responsibilities

Licensees of nuclear facilities must provide assurances that adequate resources are available for the decommissioning of facilities and for the management of radioactive wastes, including spent fuel. The CNSC requires all Class I and Uranium Mine and Mill licensees to have in place acceptable Preliminary Decommissioning Plans and associated financial guarantees. The legal basis by which a licensee is required to provide a financial guarantee and its decommissioning plan is through the addition of specified conditions in each facility licence which is issued.

Section 24(5) of the NSCA provides the legislative basis for this requirement while sections within the regulations made under the NSCA provide additional clarification. Section 3(1)(l) of the *General Nuclear Safety and Control Regulations* stipulates that "an application for a licence must contain a description of any proposed financial guarantee related to the activity for which a licence application is submitted."

The CNSC has prepared guidance to licensees on these topics. Regulatory Guide G-206 (*Financial Guarantees for the Decommissioning of Licensed Activities, June 2000*) gives guidance in relation to the development of a financial guarantee and the development of the guarantee cost estimate. Regulatory Guide G-219 (*Decommissioning Planning for Licensed Activities, June 2000*) provides guidance on the preparation of decommissioning plans which form the basis of the financial guarantee cost estimate. These guides can be viewed at www.nuclearsafety.gc.ca.

Operators of Class I and Uranium Mine and Mill facilities are required to provide acceptable decommissioning plans and financial guarantees. Decommissioning plans must be sufficiently detailed in order to:

- demonstrate that they will remediate all significant impacts and hazards to persons and the environment in a technically feasible fashion;
- ensure that compliance with all applicable requirements and criteria established in acts, regulations, and other regulatory standards are met; and
- enable credible estimates of financial guarantee amounts.

Financial guarantees must be sufficient to fund all approved decommissioning activities. These activities include not only dismantling, decontamination and closure, but also any post-decommissioning monitoring or institutional control measures that may be required as well as subsequent long-term management of all wastes including spent fuel. In order to ensure that licensees are required to cover the costs of spent fuel only once, the money in the trust funds set up under the NFWA is considered when evaluating the licensee's total financial guarantee to the CNSC.

The CNSC must be assured that it, or its agents, can access adequate funding measures upon demand if a licensee is not available to fulfil its obligations for decommissioning. Measures to fund decommissioning may involve various arrangements. Acceptable guarantees may include: cash, letters of credit, surety bonds, insurance, and legally binding commitments from a government (either federal or provincial). The acceptability of any of the above measures will be ultimately determined by the CNSC on the basis of the following general criteria:

- **Liquidity**: The proposed funding measures should be such that the financial vehicle can be drawn upon only with the approval of the CNSC, and that pay-out for decommissioning purposes is not prevented, unduly delayed, or compromised for any reason.

- **Certainty of Value:** Licensees should select funding, security instruments, and arrangements that provide full assurance of their value.

- **Adequacy of Value:** Funding measures should be sufficient, at all or predetermined points in time, to fund the decommissioning plans for which they are intended.

- **Continuity**: The required funding measures for decommissioning should be maintained on a continuing basis. This may require periodic renewals, revisions, and replacements of securities provided or issued for fixed terms. Where necessary, to ensure that there is continuity of coverage, funding measures should include provisions for advance notice of termination or intent to not renew.

4.5.2 Status of financial guarantees

Preliminary Decommissioning Plans (PDP) are on file with the CNSC for all major facilities. In conjunction with the PDP or Detailed Decommissioning Plan, each licensee has in place a financial guarantee, based on the plan, ensuring that sufficient arrangements are in place to carry out any required decommissioning should the licensee be financially unable to do so.

ACRONYMS AND ABBREVIATIONS

AECA	*Atomic Energy Control Act*
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
CCP	CNSC Compliance Program
CEAA	*Canadian Environmental Assessment Act*
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
EA	Environmental Assessment
LIRW	Low and Intermediate-Level Radioactive Waste
LLRWMO	Low-Level Radioactive Waste Management Office
NEA	*Nuclear Energy Act*
NFWA	*Nuclear Fuel Waste Act*
NLA	*Nuclear Liability Act*
NPD	Nuclear Power Development
NSCA	*Nuclear Safety and Control Act*
NWMO	Nuclear Waste Management Organization
OPG	Ontario Power Generation
PHAI	Port Hope Area Initiative