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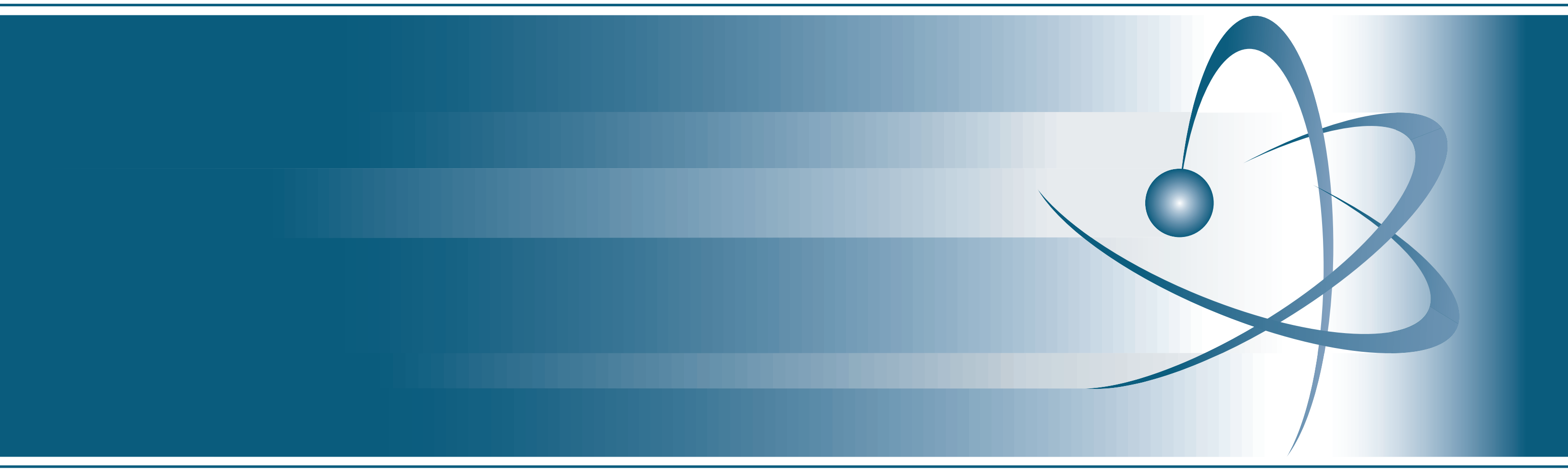
Canadian National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management



Second Report

October 2005

Canada

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In conformance with Article 32(1) of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

EXECUTIVE SUMMARY

1.0 Introduction

This is Canada's Second National Report and it demonstrates how Canada continues to meet its obligations under the terms of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The main aspect addressed in this report is the progress on initiatives for the long-term management of spent fuel and radioactive waste in Canada. This report also includes information on Canada's systematic monitoring programs and their implementation and addresses specific topics raised at the First Review Meeting.

Canada's Second National Report is the joint effort of government, industry and the Canadian regulator.

2.0 Key features of the Second National Report

Canada's Second National Report includes two significant changes from the First Report: comparison of Canada's programs with international standards, and; the status of decommissioning activities in Canada. In addition, it contains revisions and updates to Canada's First National Report (which can be viewed on www.nuclearsafety.gc.ca) and includes comments and issues raised at the First Review Meeting.

International Standards

In this, the Second National Report, Canada demonstrates that its policies, programs, standards and legislative and regulatory structures meet and in some instances exceed the requirements of applicable IAEA standards. In accordance with the Summary report of the First Review Meeting of the Contracting Parties, a Contracting Party may refer to the IAEA Standards to demonstrate implementation of the obligations set forth in the Joint Convention and this is what Canada has done.

Decommissioning Activities

Canada has several facilities under active decommissioning and preliminary decommissioning plans (PDP) are on file with the Canadian Nuclear Safety Commission (CNSC) for all other major and high risk facilities. In conjunction with the PDP, each licensee has in place a financial guarantee, based on the PDP, ensuring that sufficient funds will be available to carry out any required decommissioning.

3.0 Progress since First Review Meeting

Regulatory Document Improvement Program

Since the First Review Meeting in 2003, the CNSC has continued its document improvement initiative which has produced additional regulatory policies, standards and guides. Regulatory Policy P-290 *Managing Radioactive Waste* was issued in July 2004.

Regulatory Policy P-299 *Regulatory Fundamentals,* which promotes consistency and clarity in the way the CNSC achieves its regulatory objectives, was issued in April 2005. And, Draft Regulatory Guide G-320 *Assessing the Long-Term Safety of Radioactive Waste Management*, which was issued for public comment in April 2005, is expected to be issued by the time of the Joint Convention review meeting in May 2006.

Long-term Management of Spent Fuel

Canada is committed to ensuring a responsible approach for the long-term management of nuclear fuel waste. In 2002, the Canadian Parliament enacted the *Nuclear Fuel Waste Act*. Under this legislation, the nuclear industry was required to form a not-for-profit organization, the Nuclear Waste Management Organization (NWMO), which would develop options for a general approach for the long-term management of nuclear fuel waste and submit a recommendation to the federal Minister of Natural Resources by November15, 2005. In the spring of 2005, the NWMO released the draft study entitled "Choosing a Way Forward" for public comment, in which it describes four options and presents its preferred option for a general approach for the long-term management of nuclear fuel waste. After receipt of the study, a ministerial recommendation will be developed and presented to the Governor in Council. Under government oversight, the NWMO will implement the approved general approach, including starting the site selection process.

Long-term Management of Low-and Intermediate-Level Radioactive Waste

Low-and intermediate-level waste is presently well handled and stored in regulated facilities, well suited to short to mid-term time frames. Integrated approaches to storage or disposal are being discussed by licensees and industry. The following are some key initiatives:

In 2004, Ontario Power Generation (OPG), by far the largest producer of Low-and Intermediate-Level Radioactive Waste (LIRW), announced its intention to develop a long-term approach for its LIRW waste to ensure its isolation from the environment in the long-term, without burdening future generations with its caretaking. Work is proceeding on this undertaking which, if successful, would result in a deep geological repository being built to accommodate the waste. At the time of this report, OPG has signed an agreement with the host municipality and has commenced preliminary engineering work.

Atomic Energy of Canada Limited (AECL) initiated in 2004 the Liquid Waste Transfer Storage Project. This project will provide long-term storage for approximately 280 m^3 of intermediate- and high-level liquid waste currently in storage at the Chalk River Laboratories site. AECL's long-term strategy is to convert the liquid into a solid form suitable for long-term management in a storage or disposal facility.

Port Hope Area Initiative

The Port Hope Area Initiative (PHAI) is a project, initiated by the Government of Canada and local municipalities to address the long-term management of roughly 1.5 million cubic metres of radioactive waste contamination in the Port Hope area. As reported in the First National Report, the Initiative began on March 29, 2001. The PHAI consists of two waste management projects; the Port Hope Project and the Port Granby Project. At this time, the environmental assessment and regulatory review phase of the Initiative is well advanced. At the time of writing this report, an Environmental Assessment Study Report (EASR) has been submitted to federal decision-makers on the Port Hope Project. The EASR on Port Granby is expected prior to the end of 2005. With the submission of the EASR the federal environmental review of the projects has begun and should be completed, for both projects, by the end of 2006. Licensing decisions are expected in 2007.

Conclusion

Spent fuel and radioactive waste in Canada are currently managed in storage facilities that are safe, secure and environmentally sound. Canada recognizes that enhanced long-term management approaches for its spent fuel and radioactive waste will be required. Canada's Second National Report identifies several key initiatives demonstrating Canada's commitment to identifying long-term management approaches. Canada's long-term management approaches will ensure that spent fuel and radioactive waste are stored or disposed in a manner that does not pose undue burden on future generations.

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LIST OF ACRONYMS

AECA	*Atomic Energy Control Act*
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AGTMF	Above-Ground Tailings Management Facility
ALARA	As Low As Reasonably Achievable
CANDU	Canadian Deuterium Uranium
CCP	CNSC Compliance Program
CEAA	*Canadian Environmental Assessment Act*
CLEAN	Contaminated Lands Evaluation and Assessment Network
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DRL	Derived Release Limits
DSMs	Dry Storage Modules
EA	Environmental Assessment
FA	*Fisheries Act*
FNEP	Federal Nuclear Emergency Plan
IRUS	Intrusion Resistant Underground Storage
LLRWMO	Low-Level Radioactive Waste Management Office
MAGS	Modular Above-Ground Storage
MOE	Ministry of the Environment
NEA	*Nuclear Energy Act*
NFWA	*Nuclear Fuel Waste Act*
NLA	*Nuclear Liability Act*
NPD	Nuclear Power Development
NRU	National Research Universal
NSCA	*Nuclear Safety and Control Act*
NTR	Northern Transport Route
OPG	Ontario Power Generation
PHAI	Port Hope Area Initiative
PGWMF	Port Granby Waste Management Facility
PHWMF	Port Hope Long-Term Low-Level Radioactive Waste Management Facility
RCSA	Retube Components Storage Area
TMA	Tailings Management Area
TMF	Tailings Management Facility
WL	Whiteshell Laboratories
WLILWSF	Western Low and Intermediate Level Waste Storage Facility
WMAs	Waste Management Areas
WTC	Waste Treatment Center

SECTION A

A. INTRODUCTION

A.1 Scope of the Section

This section provides the general introduction, and a survey of the main themes of this report.

A.2 Introduction

Nuclear energy falls within federal jurisdiction and Natural Resources Canada is the federal department with responsibility for nuclear energy policy. The Government of Canada has funded nuclear research and has supported the development and the use of nuclear energy and related applications for several decades. Federal government funds for research and development activities primarily related to Canadian Deuterium Uranium (CANDU) technology are approximately $100 million annually.

As a result of this investment:

- on average, nuclear energy supplies about 15% of Canada's electricity;
- nuclear technology has allowed the medical world to improve cancer therapy and diagnostic techniques;
- the entire Canadian nuclear industry including power generation contributes several billions of dollars a year to the gross domestic product and creates more than 30,000 highly skilled jobs; and
- uranium continues to rank among the top 10 metal commodities in Canada for value of production and Canada is the world's largest supplier.

Radioactive waste has been produced in Canada since the early 1930s when the first radium/uranium mine began operating at Port Radium in the Northwest Territories. Pitchblende ore was transported from the Port Radium mine to Port Hope, Ontario where it was refined to produce radium for medical purposes. The uranium that was produced was later used for military purposes and the production of nuclear fuel. Research and development on the application of nuclear energy to produce electricity began in the 1940s on the site of the Atomic Energy of Canada Limited (AECL) Chalk River Laboratories (CRL). At present, radioactive waste is generated in Canada from the various stages and uses associated with the nuclear fuel cycle:

- uranium mining/milling;
- refining and conversion;
- nuclear fuel fabrication;

- nuclear reactor operations;
- nuclear research; and
- radioisotope manufacture and use.

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 established a comprehensive and robust regulatory regime. Canada's nuclear regulator is the Canadian Nuclear Safety Commission (CNSC), an independent federal agency. It is responsible for the regulation of the Canadian nuclear industry. The major federal government departments involved in the Canadian nuclear industry includes the following:

- Natural Resources Canada, which develops Canadian federal energy policy, administers the *Nuclear Fuel Waste Act*, and has overall responsibility for the management of historic wastes;

- 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. It is responsible for the administration of the *Canadian Environmental Protection Act.*

Other federal and provincial departments are involved to a lesser extent. Annex 1 provides detailed descriptions of these departments.

The *Nuclear Energy Act* (NEA), the *Nuclear Safety and Control Act* (NSCA), the *Nuclear Fuel Waste Act* (NFWA) and the *Nuclear Liability Act* (NLA) are the centerpieces of Canada's legislative and regulatory framework for nuclear matters. The NSCA is the key piece of legislation for ensuring the safety of the nuclear industry and radioactive waste management in Canada. Complementing these acts is other legislation which provides environmental protection. A detailed description of this legislative and regulatory framework is provided in Annex 2.

A.3 Nuclear Substances

Under the NSCA, the CNSC is authorized to regulate nuclear substances in order to protect human health and the environment. A nuclear substance is defined in the NSCA as any radioactive substance, plus deuterium, or any of their compounds, as well as any substance defined by regulations as being required for the production or use of nuclear energy. In general, the nuclear industry in Canada is regulated by prohibiting the following activities with respect to a nuclear substance without a licence issued by the regulatory body: possessing, transferring, importing, exporting, using, mining, producing, refining, converting, enriching, processing, reprocessing, packaging, transporting, managing, storing, decommissioning, abandoning or disposing.

Radioactive waste and spent fuel both contain nuclear substances and are therefore regulated in the same manner as any other nuclear substance. Refer to subsection B.5 for a description of Regulatory Policy P-290, *Managing Radioactive Waste*.

A.4 Canadian Philosophy and Approach to Safety

Canada actively promotes and regulates safety within the nuclear industry. Canada's approach to safety is based upon several factors including the review of international standards (i.e., IAEA standards and guides), improvements to regulatory policies and standards (i.e., Regulatory Policy P-299 and Regulatory Standard P-290) and the adoption of international recommendations, such as those regarding radiological dose limits to the public and workers contained in the International Commission on Radiological Protection Publication 60 (*1990) Recommendations of the International Commission on Radiological Protection* (ICRP-60), as well as the protection of the environment.

In Canada, the prime responsibility for safety rests with the person in possession of the associated nuclear substance or the operator of the associated facility. For example, it is the licensee's responsibility to demonstrate to the satisfaction of the regulatory body that a spent fuel facility or radioactive waste management facility can and will be operated safely throughout the lifetime of the facility. The licensee is free to decide on how to show that the design meets all applicable performance standards and will continue to do so throughout its design life.

A.5 Fundamental Principles

The Canadian regulatory approach towards the safety of spent fuel and radioactive waste management is based on three principles:

- Cradle-to-grave responsibility and licensing
- Defence-in-depth
- Multiple barriers

A.6 Main Safety Issues

The main safety issues addressed in this report include the following:

- Interim storage is currently being conducted in a safe manner. The Canadian nuclear industry and the Canadian government are developing long-term waste management solutions that will protect health, safety, security and the environment now and in the future. Key initiatives underway are described in Section K. A key challenge will be to continue to make progress on these initiatives and bring them to fruition and to develop and implement appropriate long-term solutions that have the confidence of the public.

Historical and contaminated lands have presented the Canadian and provincial governments with a challenge to develop and implement appropriate remedial strategies and long-term waste management solutions.

A.7 Survey of the Main Themes

The main themes in this report are summarized as follows:

- Canadian government departments and agencies and the nuclear industry have been assigned roles and responsibilities as confirmed by the 1996 *Radioactive Waste Policy Framework* to ensure the safe management of spent fuel and radioactive waste.

- The first responsibility for safety rests with the licensees. All licensees take their responsibility for safety seriously and are able to raise adequate revenue to support safe operations.

- The Canadian safety philosophy and requirements, applied through the regulatory process, ensure that the risk to the workers, the public and the environment associated with the operation of spent fuel management and radioactive waste management are kept as low as reasonably achievable, social and economic factors taken into consideration.

- The Canadian nuclear regulatory body has sufficient independence, legislated authority, and resources to make sure there is compliance and enforcement of regulatory safety requirements pertaining to the management of spent fuel and radioactive waste.

- Waste management issues in Canada include the long-term management of radioactive waste from power reactors, and the clean-up of legacy wastes from past uranium mining and processing. Industry and various levels of government in Canada are moving forward with a number of initiatives to address nuclear waste management issues.

SECTION B

B. POLICIES AND PRACTICES

B.1 Scope of the Section

This section addresses **Article 32 (Reporting) (1)** of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and provides information on Canada's policies and practices concerning spent fuel and radioactive waste management.

B.2 Introduction

Under the current legislative and regulatory framework, spent fuel is considered to be another form of radioactive waste. The legislative and regulatory policies that govern radioactive waste in Canada implicitly include spent fuel. As a result, legislation and policies on managing radioactive waste apply equally to spent fuel as they do to other forms of radioactive waste.

B.3 Legislative Instruments

The legislation enacted by the Government of Canada to regulate and oversee the nuclear industry, including the management of radioactive waste and spent fuel, consists of the NSCA, the NFWA, the NLA, and the NEA. These are described in Annex 2.

Other legislation to which the nuclear industry is subject includes the *Canadian Environmental Assessment Act* (CEAA), the *Canadian Environmental Protection Act* (CEPA) and the *Fisheries Act* (FA). A number of federal government departments are involved in administering this legislation. Where multiple regulators are involved, the CNSC takes the lead in establishing joint regulatory groups to coordinate and optimize the regulatory effort. Descriptions of federal legislation most important to the regulation of radioactive waste and spent fuel are provided in Annex 2.

In addition, the nuclear industry is subject to the provincial acts and regulations in force within the individual provinces and territories where nuclear-related activities are carried out. Where there is an overlap of jurisdictions and responsibilities, the CNSC takes the lead to harmonize the regulatory activities including involving provincial regulators in joint regulatory groups.

B.4 National Framework for Radioactive Waste Management

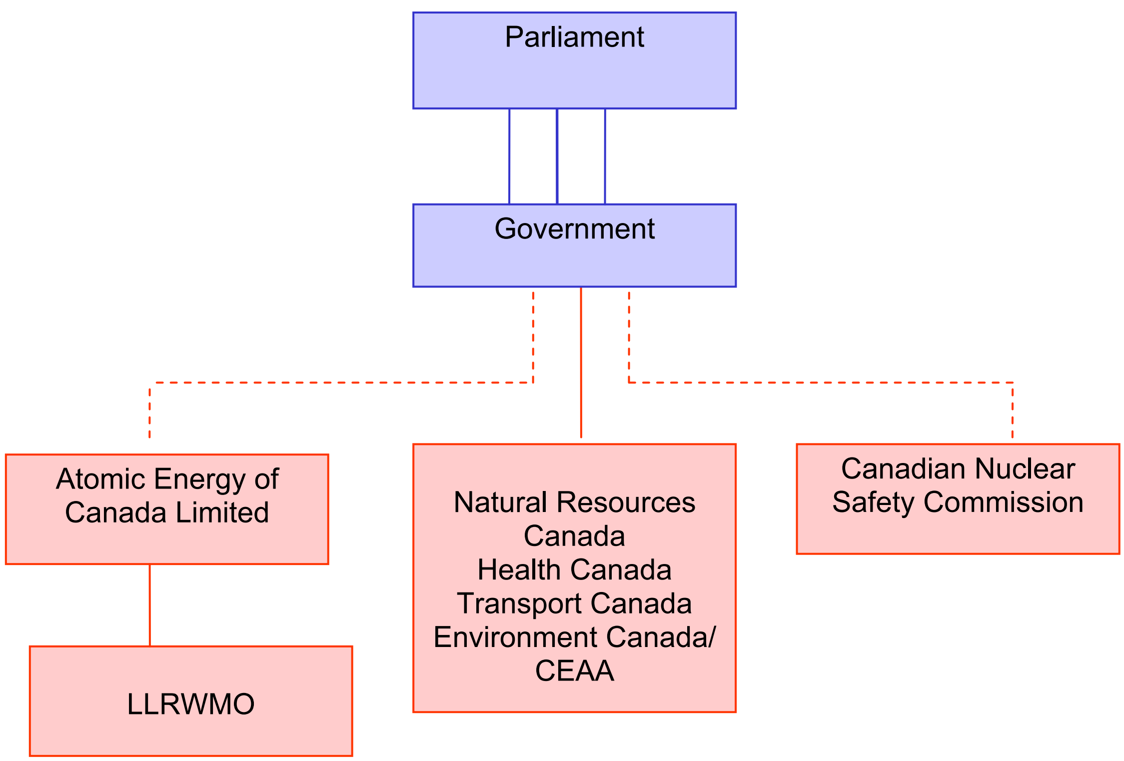
The 1996 Government of Canada *Radioactive Waste Policy Framework* provides a national context for waste management. This Policy Framework sets the stage for institutional and financial arrangements to manage radioactive waste in a safe, comprehensive, environmentally sound, integrated, and cost-effective manner. The *Radioactive Waste Policy Framework* specifies that:

- the federal government has the responsibility to develop policy, to regulate, and to oversee radioactive waste producers and owners so that they meet their operational and funding responsibilities in accordance with approved disposal plans; and

- waste producers and owners are responsible, in accordance with the "polluter pays principle," for the funding, organization, management and operation of disposal facilities and other facilities required for their waste.

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

Figure B.1 -The Canadian Institutional Framework



NRCan is the lead government department responsible for the development and implementation of Canadian government policy on uranium, nuclear energy and radioactive waste management.

It also administers the 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, including Health Canada (HC), Environment Canada (EC) and the Canadian Environmental Assessment Agency (CEAA). Additional information on these departments and all organizations shown in Figure B.1 is provided in Annex 1.

AECL and the CNSC are shown with dashed line connections to the Government to illustrate their arms-length relationships. They both report to Parliament but through a Minister within the Government. AECL is a Crown Corporation wholly owned by the Government of Canada that is run 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 staffs and 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. The LLRWMO is operated via a Memorandum of Understanding between NRCan and AECL whereby NRCan provides the funding and policy direction for the LLRWMO.

The CNSC is Canada's independent nuclear regulatory body. 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.

B.5 Regulatory Policy on Managing Spent Fuel and 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. It is fully consistent with the *Radioactive Waste Policy Framework.*

The policy statement in Regulatory Policy P-290 defines radioactive waste as any form of waste material that contains a nuclear substance as defined in the NSCA. This definition is sufficiently comprehensive to include spent fuel as a type of radioactive waste, without special consideration. The policy indicates that the CNSC, when making regulatory decisions concerning the management of radioactive waste, will seek to achieve its objectives by considering certain key principles, in the context of the facts and circumstances of each case. These principles are:

a) The generation of radioactive waste is minimized to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices.

b) The management of radioactive waste is commensurate with its radiological, chemical and biological hazards to the health and safety of persons and the environment and to national security.

c) The assessment of future impacts of radioactive waste on the health and safety of persons and environment encompasses the period of time when the maximum impact is predicted to occur.

d) The predicted impacts on the health and safety of persons and the environment from the management of radioactive waste are no greater than the impacts that are permissible in Canada at the time of the regulatory decision.

e) The measures needed to prevent unreasonable risk to present and to future generations from the hazards of radioactive waste are developed, funded and implemented as soon as reasonably practicable.

f) The trans-border effects on the health and safety of persons and the environment that could result from the management of radioactive waste in Canada are not greater than the effects experienced in Canada.

The differences between spent fuel and other forms of radioactive waste are addressed by application of principle (b), above, that wastes are expected to be managed according to their hazard.

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."

B.6 Draft 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 hazardous waste arising from licensed activities. Draft Regulatory Guide G-320 was developed to assist licensees and applicants assess the long-term storage and disposal of radioactive waste.

Draft Regulatory Guide G-320 describes typical ways to assess the long-term impacts that radioactive waste storage and disposal methods have on the environment and on the health and safety of people. The topics addressed in the guide are directed toward assessments of long-term safety. In addition to assessment methodologies, Draft Regulatory Guide G-320 also includes assessment structure and approach. However, it does not address social acceptability or economic feasibility of long-term management methods, or the assessment of facility operations.

Draft Regulatory Guide G-320 is, at the time of writing this report, in the public consultation phase. A copy of the guide is available at www.nuclearsafety.gc.ca. We expect the document to be completed in the spring of 2006.

B.7 Classification of Radioactive Waste in Canada

Radioactive waste in Canada is informally classified according to its radiological hazard and origin. Canada's informal system for classifying radioactive waste has proven adequate for the management and regulation of radioactive waste in Canada.

Radioactive waste generally falls within three categories:

1. **Spent Fuel Waste**: Spent fuel waste refers to the nuclear fuel waste discharged from CANDU power reactors, prototype and demonstration power reactors, and research and isotope production reactors. In Canada, nuclear fuel waste is synonymous with spent fuel, but is considered to be a more accurate term, meaning that discharged fuel is considered a waste material but may not be fully spent. In spite of the difference in name, the term spent fuel is used to be consistent with the terminology in the Joint Convention.

   Canada has small quantities of other high-level radioactive waste stored at the Chalk River Laboratories, including 280 m^3 of liquid high-level waste. This waste is included under the category 'spent fuel waste'; however, it is not included in the category name because the volume of high-level radioactive waste is small in comparison to the volume of nuclear fuel waste.

2. **Low-Level Radioactive Waste**: In Canada, low-level radioactive wastes comprise all forms of radioactive wastes except for spent fuel waste and for those wastes derived from uranium or thorium mining and milling. Canada does not have an intermediate-level radioactive waste category. Such wastes, as defined in other countries, are classified as low-level radioactive waste in Canada. Low-level radioactive waste is categorized further according to its source, either as part of the fuel cycle or from radioisotope production and use. The five major source sectors are the following:

   a) fuel manufacturing;
   b) electricity generation;
   c) radioisotope production and use;

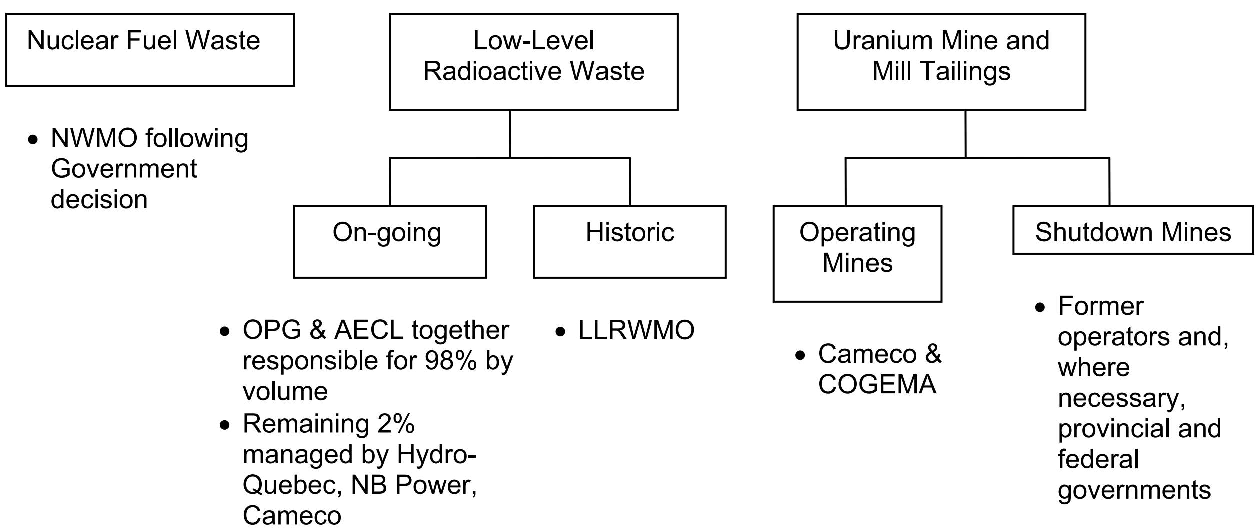
d) nuclear research and development; and
e) historic low-level waste.

3. **Uranium Mine and Mill Tailings:** Uranium mine and mill tailings are a specific type of radioactive waste generated during the mining and milling of uranium 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.

B.8 Operational Responsibilities for Long-Term Management

While numerous government departments, agencies, institutions such as hospitals and universities, and industry are involved in the management of radioactive waste, only a limited number of organizations are involved in long-term management. Figure B.3 shows the organizations responsible for the long-term management of spent fuel and radioactive waste in Canada.

Figure B.3 - Operational Responsibility Chart for Long-Term Management of Spent Fuel and Radioactive Waste



Regarding spent fuel, the Nuclear Waste Management Organization (NWMO) has responsibility for developing and implementing long-term solutions in Canada. The NWMO is owned by Canada's nuclear utilities, and is required under the NFWA to submit a report by November 15, 2005 to the government outlining possible long-term approaches for spent fuel management, including its recommendation on which approach should be adopted. The NWMO's draft recommendation, which was made public in May

2005, is described in Section K. Following the decision by the Government of Canada, the NWMO will be required to implement the government-selected approach.

Responsibilities for the long-term management of low-level radioactive waste are shown in Figure B.3 for on-going waste, and historic wastes. Together AECL and OPG own and manage 98% of the on-going low-level radioactive waste in Canada. OPG, with the agreement of the local municipality, plans to construct a deep geologic repository to dispose of its low-level radioactive waste in Kincardine, Ontario. As discussed in Section K, OPG's target is to have the facility operational by 2017. AECL submitted in March 2005 a long-term, 70-year strategy for the decommissioning and site restoration of its CRL site that includes the construction of the infrastructure required to characterize, treat, store and dispose of all of AECL's low-level radioactive waste. If the Commission (the tribunal body of the Canadian Nuclear Safety Commission) finds the strategy acceptable, the Government of Canada will consider how best to implement it.

Given that long-lived radioactive wastes from non-utility waste producers are generally shipped to CRL for long-term management, Hydro-Québec, New Brunswick Power and Cameco are the only other significant owners of long-lived, low-level radioactive waste in Canada. Hydro-Québec and New Brunswick Power's strategies are currently focused on storage. Cameco has arranged to have 150,000 m^3 of its low-level radioactive waste emplaced in the long-term waste management facilities to be constructed in the Port Hope, Ontario area as part of the clean-up of historic contamination in the area.

Historic wastes are wastes that were managed in the past in a manner that is no longer considered acceptable, for which the current owner cannot reasonably be held responsible, and for which the federal government has assumed responsibility. The LLRWMO is responsible for the management of Canada's historic waste. It is staffed and managed by AECL, but receives its funding and policy direction from NRCan. More than 90% of Canada's historic wastes are located in the Port Hope, Ontario area, and the LLRWMO has an 11-year initiative underway to clean-up the historic contamination, restore affected lands and construct new long-term waste management facilities. The LLRWMO plans to complete the work by 2013. The remainder is located across Canada with the bulk along the Northern Transport Route. Further information is provided in Annex 8.

Regarding uranium mines and mills, Cameco Corporation (Cameco) and COGEMA Resources Inc. (COGEMA) manage the only operational facilities in Canada. Both have designed, and are using, state-of-the-art in-pit tailings management facilities to optimize the long-term containment and isolation of the tailings. Regarding shutdown facilities, industry has successfully decommissioned and restored the mining and tailings facilities around Elliot Lake, Ontario, which has the greatest concentration of shutdown uranium mining and milling facilities in Canada. The owners continue to carry out monitoring and maintenance activities. There are former uranium mining and milling sites elsewhere in Canada, principally in Saskatchewan and the Northwest Territories, which have yet to be fully decommissioned and restored. This work will be performed by the former operators, or, where necessary, by provincial and federal governments.

B.9 Management Practices for Spent Fuel

All spent fuel in Canada is currently held in either wet or dry interim storage. Spent fuel discharged from CANDU reactors is placed into wet storage in spent fuel storage bays. It is kept in interim wet storage for several years, depending on site-specific needs, and is eventually transferred to an interim dry storage facility. Three designs of dry storage containers are used in Canada:

- AECL Silos
- AECL MACSTOR
- OPG Dry Storage Containers

For a complete description of these dry storage containers, refer to Annex 4.

Canada does not have a disposal program for nuclear fuel waste. All spent fuel is currently held in interim storage pending a Government of Canada decision on which long-term management method to implement. The NWMO, established under the NFWA, has a mandate to perform an options study and to make a recommendation to the Government of Canada by November 15, 2005, on the method for long-term management of nuclear fuel waste, and to implement the option selected by the government.

B.10 Management Practices for Low-Level Radioactive Waste

As there are currently no disposal facilities in Canada, all radioactive waste is currently in storage. Of the five sectors producing low-level radioactive waste, electricity production is the largest source. As the major nuclear utility in Canada, OPG is responsible for about 70% of the annual production of low-level radioactive waste. The low-level waste from all five OPG-owned nuclear generating stations is shipped to a central management facility known as the Western Low- and Intermediate-Level Waste Management Facility located at the Bruce Nuclear Power Development site. Low-level radioactive wastes generated at Hydro-Québec's Gentilly-2 Nuclear Generating Station (NGS) and at New Brunswick Power's Point Lepreau NGS are managed on site at their respective waste management facilities.

Radioactive waste from activities other than nuclear power generation is shipped to special storage sites, such as that operated by AECL at its CRL site. Typical storage facilities for this type of waste involve interim storage in modular above-ground storage buildings, concrete bunkers and tile holes.

Although the volumes of radioactive waste are small and are being safely stored on an interim basis, the Canadian nuclear industry has recognized that long-term solutions need to be implemented. As noted above, OPG plans to construct a deep geologic repository to dispose of its radioactive waste in Kincardine, Ontario. Further, AECL's long-term, 70-year strategy for the decommissioning and site restoration of its CRL site includes the construction of the infrastructure required to characterize, treat, store and dispose of all of AECL's low-level radioactive waste. The design and operation of these facilities would be regulated by the CNSC.

Some radioactive waste, such as that from hospital nuclear medicine departments, contains only small amounts of radioactive materials that have short half-lives. This means that radioactivity decays away in hours or days. After holding such waste until the radioactivity has decayed, it can be treated through conventional means.

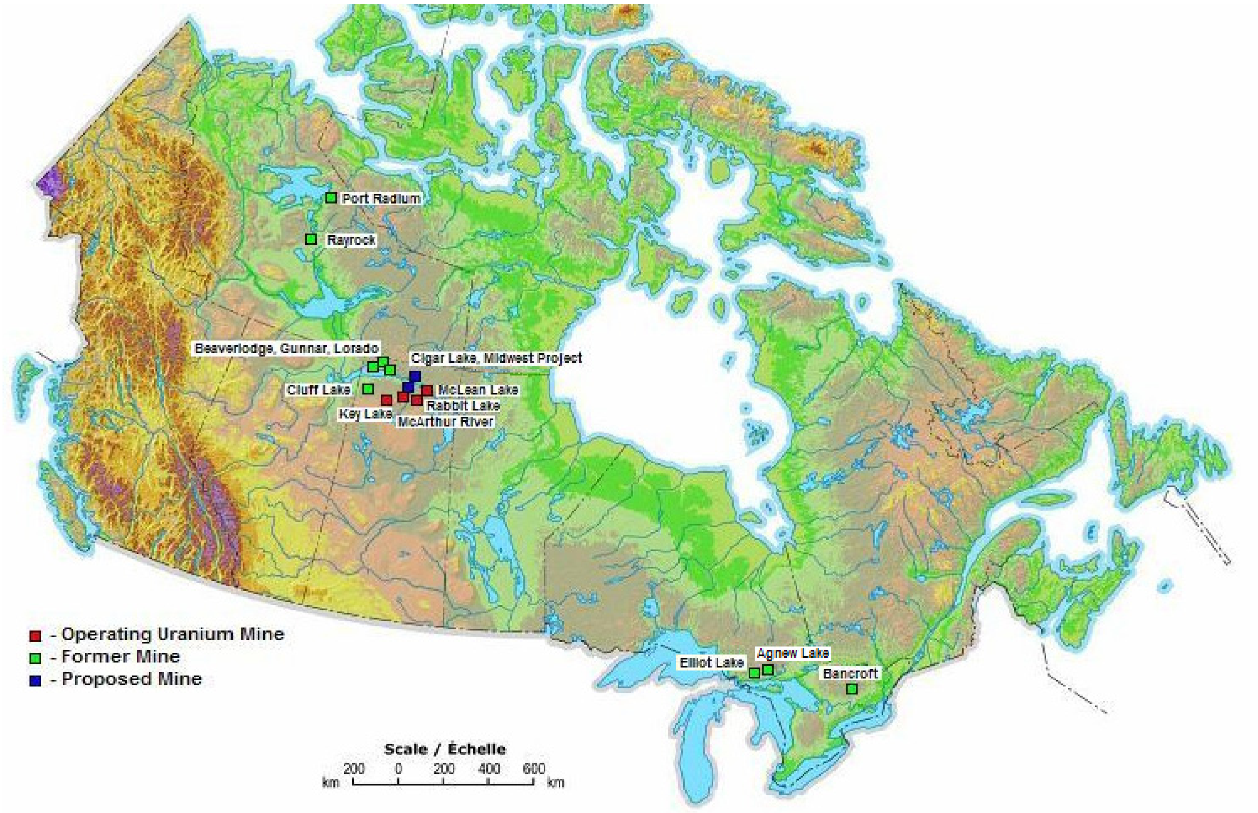
In Canada, historic radioactive waste resulted from the early practices of the nuclear industry, when regulatory oversight was limited. Uranium and radium mining in the early part of the twentieth century in northern Canada has left a number of abandoned mine sites and some small, mildly contaminated lands and contaminated equipment at several points along transport routes. At that time, the refining and use of radioactive material in Ontario also left some contaminated lands and buildings, principally in the municipality of Port Hope.

At some sites, decontamination has proven to be technically and economically feasible, with the radioactive waste being consolidated at licensed sites. The management methods used include packaging the low-level radioactive waste in drums or consolidating the material into engineered above-ground containment cells on access-controlled sites. Regular inspection and monitoring are used to verify the continued safety of these sites.

B.11 Management Practices for Uranium Mine and Mill Tailings

In Canada, more than 200 million tonnes of uranium mine and mill tailings have been generated since the mid-1950s. There are a total of 24 tailings sites in the provinces of Ontario and Saskatchewan and in the Northwest Territories. Twenty-one of these sites no longer receive waste material; only three tailings management facilities in Saskatchewan are now active. Both the active and historic tailings sites fall under the regulatory responsibility of the CNSC.

Figure B.4 - Operating, former and proposed uranium mines and mills in Canada



Historically, tailings were used as backfill in underground mines or placed in low areas on the ground surface and confined by dams (which could be either permeable or water-retaining). Surface tailings could be left bare, covered with soil or flooded. Bare or covered tailings may have been vegetated. In response to evolving regulatory requirements, the containment structures for surface tailings have become more rigorously engineered for long-term stability. Recent tailings management methods have included chemically treating the tailings to control their mineralogy prior to placing them in engineered mined-out open pits.

In addition to the tailings produced from milling uranium ore, millions of cubic meters of waste rock are excavated in gaining access to mine the ore. Special waste rock can contain low-grade ore or contain high concentrations of accessory minerals. If left exposed on the surface indefinitely, some of this “special waste rock” could generate acid or release metals at rates that could impact the local environment. The current method of managing special waste rock is to isolate it from atmospheric conditions (e.g. locating it at the bottom of a flooded pit) to keep it in an environment similar to that from which it was mined.

The inventory of nuclear substances in some non-operational uranium tailings management areas can result in these areas being licensed as Class I Nuclear Facilities under the Class I Nuclear Facilities Regulations, pursuant to the NSCA (see section E, subsection 4.3). This has implications for the licensing requirements and long-term management of such facilities. Those responsible for non-operational tailings management areas with smaller inventories can be licensed for possession of nuclear substances, a normally less stringent undertaking. Although it is acknowledged that such sites are tailings disposal areas and facilities, they are kept under license control with no consideration at this time for release from licensing.

On February 14, 2003, the CNSC, Saskatchewan Environment and Saskatchewan Labour signed an agreement for federal/provincial cooperation called the *Canadian Nuclear Safety Commission – Saskatchewan Administrative Agreement for the Regulation of Health, Safety and the Environment at Saskatchewan Uranium Mines and Mills.*

The implementation of the Agreement has resulted in the training of provincial inspectors, the development of a harmonized compliance program, as well as a review of a proposed harmonized reporting and a harmonized assessment and licensing regime.

Presentations and consultations with stakeholders concerning the Agreement occurred in the early stages of its development and implementation. Stakeholders included the CNSC, Saskatchewan Environment, Saskatchewan Labour, Saskatchewan uranium mines and mill licensees, and interest groups such as the Environmental Quality Committee that represent northern Saskatchewan communities on uranium mining issues.

SECTION C

C. SCOPE OF APPLICATION

C.1 Scope of the Section

This section addresses **Article 3 (Scope of Application)** of the Joint Convention. It provides Canada's position with respect to the reprocessing of spent fuel, naturally occurring radioactive materials, and military or defence programs.

C.2 Introduction

There is no definition for radioactive waste in the NSCA and associated regulations. Regulatory Policy P-290, *Managing Radioactive Waste,* defines radioactive waste as "any liquid, gaseous or solid material that contains a nuclear substance, as defined in Section 2 of the *Nuclear Safety and Control Act* and for which the owner of the material foresees no further use. By definition, a radioactive waste may contain non-radioactive constituents." As a result, in Canada, radioactive waste is regulated in the same manner as any other material containing a nuclear substance. All radioactive waste, whether it comes from a large nuclear facility or from a small-scale user, is considered by Canada to be subject to this Joint Convention, with the following exceptions:

- reprocessing of spent fuel;
- naturally occurring radioactive materials; and
- military or defence programs.

C.3 Reprocessing of Spent Fuel

Canada's nuclear industry uses natural uranium. As a result of Canada's large natural resource of uranium, reprocessing of spent fuel has not been deemed necessary at this time.

Therefore, pursuant to **Article 3(1)** of this Joint Convention, Canada declares that reprocessing activities are not part of Canada's spent fuel management program. Consequently, they are not included as part of this report. It should be noted that reprocessing at CRL occurred during the 1940s, 50s and 60s to extract plutonium. These reprocessing wastes are included as part of this report.

In accordance with **Article 3(1)** medical isotope production fuel is also excluded from the report because this fuel is processed to extract the isotopes, and is therefore outside the scope of the Joint Convention. Additionally pursuant to **Article 36**, this information is protected from disclosure under Canadian law.

C.4 Naturally Occurring Radioactive Materials

Naturally occurring radioactive materials, other than those that are, or have been, associated with the development, production or use of nuclear energy, are exempt from the application of all provisions of the NSCA and associated regulations except for the following:

- Provisions that govern the transport of radioactive materials; and
- In the case of radioactive material listed in the schedule to the *Nuclear Nonproliferation Import and Export Control Regulations*, the provisions that govern the import and export of radioactive materials.

Consequently, in accordance with **Article 3(2)** of the Joint Convention, naturally occurring radioactive materials that are exempt from the NSCA and associated regulations are not part of this report. The only naturally occurring radioactive material discussed in this report are radium bearing wastes that arose from the former radium industry and tailings and waste rock from uranium mines and mills.

C.5 Department of National Defence Programs

Section 5 of the NSCA excludes the Department of National Defence from the application of the Act or any associated regulations. However, the Royal Military College (RMC) SLOWPOKE reactor is regulated by the NSCA and associated regulations, as it is operated as a research reactor (see section H). Therefore in accordance with **Article 3(3)**, this report will not apply to the safety of spent fuel management or radioactive waste management within military or defence programs, except with regard to the RMC SLOWPOKE reactor.

SECTION D

D. INVENTORIES AND LISTS

D.1 Scope of the Section

This section addresses **Article 32 (Reporting) (2)** of the Joint Convention. It provides a list of the various spent fuel and radioactive waste management facilities in Canada, and indicates the total inventory of each of the waste categories in Canada. Each licensee is required to develop and implement an accountability system including the appropriate records. This system and associated records are subject to regulatory oversight. The requirements of Safety Series 115, Part IV.17, are addressed in this section.

D.2 Inventory of Spent Fuel in Canada

D.2.1 Spent Fuel Wet Storage Inventory at Nuclear Power Plants and Research Reactor Sites

Facilities to store nuclear fuel waste in irradiated fuel bays (wet storage) pending transfer to a spent fuel dry storage facility are located at the Nuclear Generating Stations and research reactor sites. Table D.1 provides an inventory of spent fuel bundles in wet storage in Canada.

Table D.1 - Spent fuel in wet storage as of December 31, 2004

Site	Number of Fuel Bundles in Wet Storage	Kilograms of Uranium
Bruce A	361,271	6,818,360
Bruce B	369,320	7,061,437
Darlington	256,068	4,885,943
Gentilly-2	33,814	651,999
Pickering	382,332	7,581,148
Point Lepreau	39,482	755,253
MNR (wet storage)	27 fuel assemblies**	7.3
NRU (wet storage)	525 items*	2348.6
TOTAL	**1,442,287**	**27,756,495.9**

D.2.2 Spent Fuel Dry Storage Inventory at Nuclear Power Plants and Research Reactor Sites

Table D.2 provides an inventory of spent fuel in dry storage.

Table D.2 - Spent fuel in dry storage as of December 31, 2004

Site	Number of Fuel Bundles In Dry Storage	Kilograms of Uranium
CRL WMA G (NPD Fuel)	4853	65,385
CRL WMA B (RR Fuel)###	4400 items	27,000
Douglas Point	22,256	299,827
Gentilly-1	3,213	67,596
Gentilly-2	60,000	1,149,550
Pickering	135,927	2,701,360
Point Lepreau	63,180	1,213,210
Western (located at the Bruce site)	29,184	553,555
WRL	2,268	24,503
TOTAL	**350,881**	**6,101,986**

*Items include elements, rods and bundles
** The McMaster Nuclear Reactor stores spent research fuel in wet storage until it is ready to be shipped back to the original supplier in the USA
###The fuel inventory in CRL WMA B includes a wide variety of fuel types

D.3 Radioactive Waste Inventory

D.3.1 Radioactive Waste Management Facilities

Table D.3 includes a list of radioactive waste management facilities used for the processing and storage of low-level radioactive waste. The table provides information about the waste management method and an inventory of the radioactive waste in storage at each site.

Table D.3 - Radioactive waste in storage at Canadian facilities as of December 31, 2004

Site	Type of Waste	Status	Storage Structures	Volume (M^3) in Storage	Activit (TBq)
Chalk River Laboratories	Various reactor and isotope production wastes	Operating / Storage with Surveillance	Concrete Bunkers, Above-ground storage buildings and Tile Holes	112,163.6	n/a
Douglas Point Waste Management Facility#	Decommissioned Reactor Waste	Storage with Surveillance	Reactor Building	123.4	118.15
Gentilly-1 Waste Management Facility#	Decommissioned Reactor Waste	Storage with Surveillance	Reactor Building	951.8	279.54

Gentilly-2 Waste Management Facility	Low-level reactor waste	Operating	Concrete bunkers	723	56.6
Nuclear Power Demonstration Waste Management Facility#	Decommissioned Reactor Waste	Storage with Surveillance	Reactor Building	30	2000* (1987
Pickering Waste Management Facility	Low-level reactor waste from refurbishment	Operating	34 Dry Storage Modules (no new waste accepted)	945	179,00
Point Lepreau Waste Management Facility	Low-level reactor waste	Operating	Concrete bunkers	1633	291.6
Port Hope Conversion Facility	Non-Combustible Process Waste	Operating Conversion Facility	205 L Drums stored in Warehouse	1738	n/a
RWOS1	Low-level reactor waste	Storage with Surveillance	Concrete trenches	638	25.34*
Western Waste Management Facility	Low-level reactor waste	Operating	In-ground containers Concrete trenches Quadricells Storage buildings Tile-holes	64,775	24,446*
Whiteshell Laboratories	Various type of reactor, liquid and decommission waste		Concrete bunkers, Above-ground storage buildings and Tile Holes	19,918.5	332
Total Volume Accumulation				**203,639.3**	**206,549.23**

Volume does not include reactor components (shielding, heat transport systems etc.) in the reactor buildings. However, the activity is inclusive of the whole facility, except spent fuel.
* Activity calculated when placed in storage
+ Estimated 2006 activity
a Estimated 2005 activity

D.3.2 Historic Sites

Table D.4 provides an inventory of radioactive waste at historic waste storage areas and contaminated sites in Canada. Note that radium-luminescent devices are included in this inventory. These sites are currently in a Storage with Surveillance mode.

Table D.4 - Historic waste accumulation as of December 31, 2004

Site	Type of Waste	Method of Storage	Volume (M^3)
Port Hope	Contaminated soils	Above-ground mounds	500,000
Welcome and Port Granby	Contaminated soils	Burial	1,150,000
Other locations across Canada	Contaminated soils	Above-ground mounds	52,900
Total Historic Waste			**1,702,900**

D.4 Uranium Mining and Milling Wastes

The two main waste streams associated with uranium mining and milling are tailings and waste rock. Historically, waste rock has been stockpiled on the surface or used as backfill in underground mines. Currently, mineralized “special waste rock” is managed with due consideration given to the hazards associated with the mineralization and contaminants of concern. Tailings are managed in engineered Tailings Management Facilities (TMFs).

D.4.1 Tailings Inventory at Operational Tailing Management Facilities

TMFs currently receiving tailings are listed below:

- Deilmann TMF at Key Lake
- Rabbit Lake In-Pit TMF at Rabbit Lake
- Jeb TMF at McClean Lake

Uranium mine and mill tailings are presented as dry mass in tonnes, since this is how the mining industry commonly tracks and reports materials. Table D.5 provides an inventory of the uranium tailings in storage at operational milling sites in Canada.

Table D.5 - Uranium tailings accumulation at operational milling sites as of December 31, 2004

Site	Method of Storage	Accumulation (tonnes)
Key Lake	Open Pit	2,274,778
Rabbit Lake	Open Pit	5,793,788
McClean Lake	Open Pit	691,431
Total Tailings		**8,759,997**

D.4.2 Uranium Tailings at Idle Tailings Management Facilities and Inactive/Decommissioned Mine Sites

Table D.6 provides an inventory of uranium tailings in idle TMFs and idle/decommissioned mine sites in Canada. Uranium mine and mill tailings are presented as mass in tonnes since this is how the mining industry commonly tracks and reports materials.

Table D.6 - Uranium tailings accumulation at inactive/decommissioned mines as of December 31, 2004

Site	Method of Storage	Accumulation (tonnes)
Key Lake	Above-ground tailings	3,586,000
Rabbit Lake	Above-ground tailings	6,500,000
Cluff Lake	Surface	3,230,000
Beaverlodge	Above-ground tailings and underground/mine backfill	10,100,000
Gunnar	Above-ground tailings	4,400,000
Lorado	Above-ground tailings	360,000
Port Radium	Above-ground tailings – four areas	907,000
Rayrock	Above-ground tailings – North and South tailings piles	71,000
Quirke 1 and 2	Flooded above-ground tailings	46,000,000
Panel	Flooded above-ground tailings	16,000,000
Denison	Flooded above-ground tailings – two areas	63,800,000
Spanish American	Flooded above-ground tailings	450,000
Stanrock/CANMET	Above-ground tailings	5,750,000
Stanleigh	Flooded above-ground tailings	19,953,000
Lancor	Above-ground tailings	2,700,000
Nordic	Above-ground tailings	12,000,000
Pronto	Above-ground tailings	2,100,000
Agnew	Lake Vegetated above-ground tailings	510,000
Dyno	Above-ground tailings	600,000
Bicroft	Above-ground tailings – two areas	2,000,000
Faraday/Madawaska	Above-ground tailings – two areas	4,000,000
Total Accumulation		**206,017,000**

D.4.3 Waste Rock Inventory

Table D.7 provides an inventory of mineralized and non-mineralized waste rock in Canada.

Table D.7 - Mineralized and non-mineralized Waste Rock Inventory as of December 31, 2004

Site	Mineralized (tonnes)	Non-Mineralized (tonnes)
McClean Lake	0	22,137,383
Key Lake	1,666,413	64,980,000
Rabbit Lake	1,380,191	13,993,756
Cluff Lake	0	8,700,000
McArthur River	14,920	1,567,157
Cigar Lake	126,000	84,600
Total	**3,187,524**	**111,462,896**

SECTION E

E. LEGISLATIVE AND REGULATORY SYSTEMS

E.1 Scope of the Section

This section addresses **Articles 18 (Implementing Measures)**, **19 (Legislative and Regulatory Framework)**, and **20 (Regulatory Body)** of the Joint Convention, describing Canada's legislative and regulatory framework, regulatory body, and approach to licensing radioactive material.

The requirements of IAEA Safety Standard GS-R-1 *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety*, with respect to Articles 19 and 20 are addressed in this section. The NSCA provides the Canadian Nuclear Safety Commission with a mandate to establish and enforce national standards in the areas of health, safety and environmental protection. It also establishes a basis for implementing Canadian policy and fulfilling Canada's obligations with respect to the non-proliferation of nuclear weapons.

The Act sets out a formal system for review and appeal of decisions and orders made by the Commission, designated officers and inspectors. It should be noted that the Commission is considered to be a court of record with powers to hear witnesses, take evidence and control its proceedings. The enforcement powers of compliance inspectors and the penalties for infractions are in line with current legislative practices. Additionally, the Act empowers the Commission to require financial guarantees, to order remedial action in hazardous situations, and to require responsible parties to bear the costs of decontamination and other remedial measures. Further information on the Commission, the CNSC and CNSC staff is provided in Annex 3.

E.2 A Comprehensive Description of the Canadian Regulatory Systems

In Canada, matters related to nuclear energy and nuclear substances are under the jurisdiction of the federal government. NRCan has been charged with setting Canada's nuclear policy, including its policies concerning radioactive wastes. The *Radioactive Wastes Policy Framework* establishes the roles and responsibilities of the federal government and the waste producers. In particular, the federal government will provide guidance, oversight, and regulation over radioactive waste producers.

Canada established regulatory authority over the use of nuclear materials in the NSCA, which outlines the authority and responsibilities of the regulatory body under Section 9. The authority and responsibilities of the CNSC include the issuance of licenses, defining regulations, and compliance enforcement.

Lists of the various federal organizations and the pertinent Acts directly related to the nuclear industry in Canada are provided in Annexes 1 and 2. A detailed description of the regulatory body, its structure, operations, and regulatory activities is provided in Annex 3.

E.3 National Safety Requirements

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.

E.4 Regulations Issued under the *Nuclear Safety and Control Act*

The regulations under the NSCA allow licensees, 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. The regulations provide licence applicants with general performance objectives and lists of information that they must supply.

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 regulations listed above can be viewed at www.nuclearsafety.gc.ca.

In addition to the regulations, the *CNSC Rules of Procedure* must be followed. The CNSC *Rules of Procedure* do not impose requirements for health, safety and protection of the environment, per se, but set out the rules of procedure for public hearings to be held by the Commission and for certain proceedings conducted by Designated Officers of the CNSC. The *Rules of Procedure* apply to the public, licensees and CNSC staff and Commission members with respect to the conduct of licensing and other decisions.

The regulations also recognize the need for transparency. However, the security provisions concerning commercial, confidential and personnel information, along with the information on the transport of certain nuclear material must reflect a balance between the public's right to know and the need to maintain the security of sensitive information. The NSCA and associated regulations afford the CNSC discretion to ensure that those who "need to know" do know, while allowing Canada to abide by its international commitments regarding the security of prescribed information.

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.

E.4.1 General Nuclear Safety and Control Regulations

The *General Nuclear Safety and Control Regulations* contain the general requirements that apply to all licensees. 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 *Regulations* 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.

E.4.2 Radiation Protection Regulations

The *Radiation Protection Regulations* contain radiation protection requirements; they apply to all licensees and others who fall within the mandate of the CNSC. Medical doses, doses to caregivers who volunteer, and doses to volunteers in biomedical research are specifically excluded from the regulations. The *Radiation Protection Regulations* 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.

The dose limits are based on the 1990 recommendations of the ICRP:

- for nuclear energy workers – 100 millisievert (mSv) in any five year period with a maximum of 50 mSv in a given year;

- for pregnant nuclear energy workers – 4 mSv/year; and
- for members of the public – 1 mSv/year.

E.4.2.1 Rationale for the Pregnant Worker Dose Limit

When the predecessor of the CNSC, the Atomic Energy Control Board (AECB), issued draft regulations which reflected the ICRP 60 (1990) recommendations, the proposed 2 mSv dose limit[1] was criticized by some stakeholders as being unnecessarily low. The critics noted that doses at this level, especially those from the internal component, would be difficult to measure and compliance would be difficult to demonstrate. Workers who submitted comments feared that some employers might conclude that the only effective method of compliance with the dose limit of 2 mSv would be to remove a pregnant worker from work with radiation. If no other work was available, this could result in a lay-off, and could lead to discrimination against the hiring of women for some types of radiation work.

In response to these comments, the AECB initiated its own reviews of the literature. This review indicated that the risk to the foetus presented by a dose of 4 mSv to the mother is very small and not much greater than the dose limit recommended by the ICRP. Based upon this and the consultations with the stakeholders, the AECB set the dose limit for pregnant workers at 4 mSv.

Further details on this decision can be found in *Dose Limits for Pregnant Workers – Rationale for the Limits in the Radiation Protection Regulations* (INFO-0700 document published by the AECB. The document can be viewed at www.nuclearsafety.gc.ca.

E.4.3 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 include 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.

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[1]It is not clear in ICRP 60 whether the external dose limit was to be in addition to the internal limit. The AECB interpreted the recommended dose limit of 2 mSv as a combination of a 1 mSv limit for external radiation and a 1 mSv limit for the effect of intakes of radioactive material by the mother during her pregnancy.

E.4.4 Nuclear Substances and Radiation Devices Regulations

The *Nuclear Substances and Radiation Devices* (NSRD) *Regulations* apply to all nuclear substances, sealed sources, and radiation devices. As such, they apply to the vast majority of CNSC licences. These regulations also contain the criteria for consumer products such as smoke detectors and safety signs which use tritium.

In general, the NSRD regulations reflect international practice with minor variations based on Canadian policy and circumstances (e.g. exemption quantities and audible alarming dosimeters).

Amendments have been proposed to the NSRD regulations to introduce the latest international values for exemption quantities, surface contamination and clearance levels for regulating those who possess nuclear substances. Pre-consultation and publication is scheduled for 2005.

E.4.5 Packaging and Transport of Nuclear Substances Regulations

The Canadian requirements in the *Packaging and Transport of Nuclear Substances Regulations* are based on the 1996 IAEA recommendations. The CNSC has been a major participant in the development of the IAEA recommendations on the packaging and transport of nuclear materials. In developing a position on transportation issues, the CNSC has communicated regularly with the federal transportation department (Transport Canada) and major Canadian shippers. Transport Canada is normally represented at the IAEA meetings, and experts from the industry have accompanied CNSC staff to IAEA meetings when specific topics have been discussed.

E.4.6 Nuclear Security Regulations

The *Nuclear Security Regulations* are intended to align Canadian nuclear facilities with the internationally accepted recommendations of the IAEA. In the development of the *Nuclear Security Regulations*, 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.

Proposed amendments to the regulatory requirements for nuclear security have been developed, following extensive stakeholder input, that will make the regulations more consistent with international recommendations and best practices, take into account current security threats, and address stakeholder input. The proposed changes were published in the Canada Gazette in 2005 for comment.

E.4.7 Uranium Mines and Mills Regulations

The *Uranium Mines and Mills Regulations* 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.

E.4.8 Class II Nuclear Facilities and Prescribed Equipment Regulations

The *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.

E.4.9 Nuclear Non-proliferation Import and Export Control Regulations

These regulations apply to the import and export of controlled nuclear substances, controlled nuclear equipment and controlled nuclear information.

E.5 Comprehensive Licensing System

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.

The CNSC uses a comprehensive licensing system to establish regulatory control. It issues licences to permit activities that are otherwise prohibited by the NSCA. These licences may contain specific conditions that must be met by the licensee. Each licence is issued for a fixed period of time and is subjected to reassessment by the CNSC at each renewal. Typical licence periods can be from two to five years. 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.

Regulatory control is also achieved by setting standards that licensees must meet. Some standards are set by the Commission, such as requirements for special safety systems at nuclear power stations. 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.

For a new licence, the regulations require the applicants to submit comprehensive information on their policies and programs, details of the design of the facility and components, the manner in which the facility is expected to operate, facility operating manuals and procedures, and any potential effects on the site and on the surrounding environment. The design must be such that emissions from the facility can meet strict limits in normal operation and under commonly occurring upset conditions. Applicants are also required to identify the manner in which a facility may fail to operate correctly, to predict what the potential consequences of such a failure may be, and to establish specific engineering measures to mitigate the consequences to tolerable levels. In essence, those engineering measures may include multiple barriers to prevent the escape of noxious material. Many of the analyses of potential accidents are complex, covering a very wide range of possible occurrences.

CNSC staff reviews these submissions in detail to ensure they meet regulatory requirements, using existing legislation, and the best available codes of practice and experience in Canada and elsewhere. The expertise of CNSC staff covers a broad range of engineering and scientific disciplines. Considerable effort is expended in reviewing the analyses to ensure that the predictions are based on well-established scientific evidence and that the defences meet defined standards of performance and reliability.

In addition to reviewing the information described above, Section 24(4) of the NSCA places the onus on the CNSC to ensure that the applicant is qualified to carry out the licensed activity. The CNSC must also ensure that the programs proposed by the applicant to conform to the CNSC mandate (see Annex 3) will actually be implemented, stating “No licence may be issued, renewed, amended or replaced unless, in the opinion of the Commission, the applicant:

(a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and

(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.”

The comprehensive assessment that takes place during the licensing process may result in defining additional programs and criteria as a condition(s) of the licence. Once CNSC staff is satisfied that all of the requirements of the NSCA and its regulations are met, and the applicant’s documentation is acceptable, a licence is prepared and recommendations on the application are made to the Commission for a licensing decision. The licence includes any necessary conditions that were identified in the assessment, including a condition that references the documentation submitted in support of the application. By referring to the applicant’s documentation, the licence legally binds the applicant to comply with its own procedures and programs and makes them subject to the CNSC compliance verification program.

When a licensee applies to renew a licence, the documentation and assessments for the original licence are re-visited in light of the performance of the licensee and its compliance history. The approach is to place priority on certain areas based on performance history, risk and expert judgement. Licence conditions may be added, modified or removed as a result of this review. This sort of review also occurs when a licence amendment is requested.

The CNSC’s licensing system is administered with the co-operation of federal and provincial government departments in such areas as health, environment, transport and labour. It should however be noted that the CNSC retains overall responsibilities for licensing of nuclear substances in Canada. The responsibilities of these departments are considered during the licensing process for spent fuel and radioactive waste management facilities. Once a licence is issued, the CNSC carries out compliance verification activities to ensure that its requirements continue to be met.

E.5.1 Rating System

CNSC staff assesses licensee programs and their implementation according to the following five ratings:

A – Exceeds requirements

A rating of 'A' is merited when assessment topics or programs meet and consistently exceed applicable CNSC requirements and performance expectations. Performance is stable or improving. Any problems or issues that arise are promptly addressed such that they do not pose an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed.

B – Meets requirements

A rating of 'B' is merited when assessment topics or programs meet the intent or objectives of CNSC requirements and performance expectations. There is only minor deviation from requirements or the expectations for the design and/or execution of the programs, but these deviations do not represent an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. That is, there is some slippage with respect to the requirements and expectations for program design and execution. However, those issues are considered to pose a low risk to the achievement of regulatory performance requirements and expectations of the CNSC.

C – Below requirements

A rating of 'C' is merited when either performance deteriorates and falls below expectations, or assessment topics or programs deviate from the intent or objectives of CNSC requirements, to the extent that there is a moderate risk that the programs will ultimately fail to achieve expectations for the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Although the risk of failing to meet regulatory requirements in the short term remains low, improvements in performance or programs are required to address identified weaknesses. The licensee or applicant has taken, or is taking appropriate steps.

D – Significantly below requirements

A rating of 'D' is merited when assessment topics or programs are significantly below requirements, or there is evidence of continued poor performance, to the extent that whole programs are undermined. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Issues are not being addressed effectively by the licensee or applicant. The licensee or applicant has neither taken appropriate compensating measures nor provided an alternative plan of action.

E – Unacceptable

A rating of ‘E’ is merited when there is evidence of either an absence, total inadequacy, breakdown, or loss of control of an assessment topic or a program. There is a very high probability of an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. An appropriate regulatory response, such as an order or restrictive licensing action has been or is being implemented to rectify the situation.

These categories are assigned to summarize all assessment and inspection results, and are also used to summarize licensees’ programs and performance in several safety areas that are evaluated for licensing purposes. A standard list of programs or topics has been developed for each type of facility. The topics covered may include:

- Organization and Management
- Non-Radiological Health and Safety
- Public Information Programs
- Training and Qualification
- Radiation Protection
- Environmental Protection
- Emergency Preparedness
- Fire Protection
- Operation and Maintenance
- Incidents and Abnormal Events
- Quality Management
- Decommissioning and Financial Guarantees
- Security
- International Obligations (safeguards, etc.)

E.6 Compliance Verification Program

The CNSC rigorously enforces its regulatory requirement through a variety of measures. Licensee compliance is verified through inspections, reviews, audits and assessments. The CNSC also requires any licensee found to be non-compliant with either its licence conditions or the regulatory requirements to resolve the issue and demonstrate improvement by a specified deadline or face enforcement action.

In order to verify that licensees and other affected persons comply with these requirements, CNSC staff:

- applies the regulatory requirements in a manner that is fair, predictable, and consistent;

- uses rules, sanctions, and processes that are securely founded in law and graduated according to the seriousness of the violation, the compliance history of the licensee and the actions of the licensee once the violation is discovered;

- establishes and maintain a compliance verification program based upon the level of risk that the radioactive material or activity presents to human health, its authorized use, and the environment;

- ensures that its compliance activities are conducted by trained and qualified staff; and

- develops and implements a compliance promotion strategy and a compliance enforcement strategy.

The CNSC's Risk-Based Regulatory Program (RBRP) is designed to administer, promote and assess compliance. The CNSC uses risk-based formulas to determine inspection frequency and resource requirements. The CNSC is implementing the new RBRP Type I and Type II inspection planning program, along with associated compliance tools, and working cooperatively with licensees to improve transparency, communication, performance and safety.

Type I inspections are on-site audits and evaluations of a licensee's programs, processes and practices. Type II inspections are routine (item-by-item) checks and rounds that typically focus on the outputs, or performance of licensee programs, processes and practices. Findings from Type II inspections play a key role in identifying where a Type I inspection may be required to determine systemic problems in licensee programs, processes or practices.

E.6.1 Compliance Promotion

The objectives of the Compliance Verification Program are to inform the regulated community of the rationale behind the regulatory regime, to disseminate information to regulated areas about regulatory requirements and standards, and to design realistic and achievable requirements and standards. Promotional activities include communication and consultation.

The most common communication and consultation activity used to promote compliance is regularly scheduled meetings with the licensee. These are used to discuss ongoing activities and developments, licensing and compliance issues, safety performance, follow-up on outstanding commitments and emerging issues that arise from time to time. In addition, compliance verification activities generally result in follow-up meetings. The frequency of planned meetings varies by licensee, facility, and risk level.

E.6.2 Compliance Verification

To verify compliance with the regulatory requirements and with the conditions specified in the licence, the CNSC:

- evaluates the licensee's operations and activities;

- reviews, verifies and evaluates information supplied by licensees;
- ensures that administrative controls are in place; and
- evaluates the licensee's remedial action and the action taken to avoid incidents in the future.

The programs that are evaluated are those cited by reference in the licence and evaluated in the licence application review process. In verifying that licensees abide by their programs, the CNSC checks that the licensee's activities meet acceptance criteria derived from:

- legal requirements;
- CNSC policies, standards, or guides that clarify how the Commission intends to apply the legal requirements;
- information, supplied by licensees to the Commission, that defines how the licensees intend to meet the legal requirements in performing the licensed activity; or
- expert judgment of CNSC staff.

Type II, or routine inspections, are performed to gain an overall perspective of the status of the facility in the area examined, noting any obvious deficiencies or abnormalities. These may be planned or unscheduled inspections, but are usually conducted according to written check sheets which allow for the recording of the inspector's observations and recommendations for follow-up action. Such sheets are dated, signed and retained on file.

Type I, or evaluations, are usually done according to pre-planned inspection guides prepared for the specific occasion. Results are recorded in a CNSC report which is sent to the licensee for follow-up action as necessary and retained on file. When planned, the inspections are coordinated with the licensee and meetings are scheduled. When unscheduled inspections arise, follow-up meetings may not always be possible due to the schedules of the licensee contacts.

Type I, or audits, are always pre-planned to a high degree of detail, with acceptance criteria spelled out in advance. The licensee is notified in advance of the audit and its subject area. Entrance meetings, daily briefings of audit results and exit meetings are included in audit plans. The staff members who conduct the audit are chosen for their expertise in the area being assessed. They could include specialists from head office, project officers from site or head office, or a combination of the two. The audit results are recorded in a CNSC report to the licensee and follow-up actions are recorded and assigned target dates for completion.

CNSC staff also assesses the contents of submitted operations reports. Licensees are required to submit operating reports to the CNSC on a regular basis. This is a normally scheduled process defined in a licence condition. The frequency varies by licensee, facility, and risk level, but report submission frequencies generally range from quarterly to annually. Analysis of safety-significant events is another component in evaluating the safety performance of a facility. The objective of these analyses is not for CNSC staff to duplicate reviews done by licensees, but to ensure that licensees have adequate processes in place to take corrective actions when needed and to integrate lessons learned from past events into day-to-day operation. CNSC staff carries out a detailed review of only the most safety-significant events.

E.6.3 Compliance Enforcement

The CNSC uses a graduated approach to enforcement, commensurate with the risk or regulatory significance of the violation. The enforcement actions available to the CNSC are:

- discussion;
- verbal or written notice;
- warning;
- increased regulatory scrutiny;
- issuance of an order;
- licensing action (i.e. amendment or suspension of part of a licence);
- revocation of personal certification;
- prosecution; and
- revocation or suspension of a licence.

Depending on the effectiveness of the initial action, subsequent enforcement measures of increasing severity may be invoked.

E.7 Considerations Taken into Account in Deciding Whether to Regulate Nuclear Substances as Radioactive Waste

Subsection 1.2 indicates that the CNSC is authorized, under the NSCA, to regulate nuclear substances in order to protect human health and the environment. CNSC Regulatory Policy P-290, *Managing Radioactive Waste,* defines radioactive waste as any waste containing a nuclear substance. Therefore, there is no decision to be made on whether to regulate radioactive materials as radioactive waste. CNSC Regulatory Policy P-290 *Managing Radioactive Waste,* however, promotes the following key principles with respect to radioactive waste:

- The generation of radioactive waste should be minimized to the extent practicable;
- Radioactive waste should be managed in a manner that is commensurate with its radiological, chemical and biological hazards.

For a full description of Regulatory Policy P-290, refer to subsection B.5.

SECTION F

F. OTHER GENERAL SAFETY PROVISIONS

F.1 Scope of the Section

This section addresses **Articles 21 (Responsibility of the Licence Holder)** to **26 (Decommissioning)** of the Joint Convention. It provides information on the steps Canada takes to meet obligations regarding general safety provisions at either the national level or, more appropriately, at the facility level. The requirements of several IAEA Standards are addressed in this section. These include:

Article 21 – Responsibility of the Licence Holder – IAEA Safety Standard GS-R-1
Article 22 – Human and Financial Resources – IAEA Safety Standard GS-R-1
Article 23 – Quality Assurance – IAEA Safety Standards GS-R-1, WS-R-1 and Safety Series 50-C/SG-Q
Article 24 – Operational Radiation Protection – IAEA Safety Standard 115
Article 25 – Emergency Preparedness – IAEA Safety Standard GS-R-2
Article 26 – Decommissioning – IAEA Safety Standard WS-R-2 and Safety Guide WS-G-2.4

F.2 Human Resources

Each licensee in Canada has the prime responsibility for the safety of its spent fuel and radioactive waste management facilities. This responsibility includes providing adequate human resources to support the safety of each spent fuel and radioactive waste management facility throughout its lifespan. Adequate human resources are defined as the employment of enough qualified staff to carry out all normal activities without undue stress or delay, including the supervision of work done by external contractors. Section 44(1)(*k*) of the NSCA provides the legislative basis for the qualification, training and examination of personnel. Sections 12(1)(*a*) and 12(1)(*b*) of the *General Nuclear Safety and Control Regulations* specify that the licensee must ensure the presence of a sufficient number of trained qualified workers.

As in the case of many countries with mature nuclear programs, the nuclear industry and the CNSC have both faced challenges in recruiting experienced personnel in recent years, due in part to the aging demographics of the Canadian population. The sections below outline initiatives that have been taken to develop the human resources required to ensure the long-term sustainability of the workforce.

F.2.1 University Network of Excellence in Nuclear Engineering

The University Network of Excellence in Nuclear Engineering (UNENE) is an alliance of Canadian universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, research and development capability in Canadian universities. UNENE was established in July 2002. Its purpose is to assure a sustainable supply of qualified nuclear engineers and scientists to meet the current and future needs of the nuclear industry in Canada through university education, university-based training and by encouraging young people to choose a career in the nuclear industry. More information is available at http://epic.mcmaster.ca/~unene/ .

The alliance currently consists of nine universities and several industrial partners (CANDU Owners Group, OPG, Bruce Power, AECL, CNSC and Nuclear Safety Solutions).

F.2.2 OPG Funding

OPG has committed funding towards the support of engineering programs at five Ontario universities in support of education and research in nuclear engineering:

- Queen's University;
- University of Toronto;
- McMaster University;
- University of Waterloo; and
- University of Western Ontario.

The funds will create five Research Chairs and sponsor up to 30 students in master's level programs. In addition, OPG has committed funding to a Natural Sciences and Engineering Research Council (NSERC) research chair in nuclear fuel waste research, and for nuclear engineering scholarships.

F.2.3 CANTEACH

The CANTEACH program was established by AECL, OPG, the CANDU Owners Group, Bruce Power, McMaster University, École Polytechnique, and the Canadian Nuclear Society to meet succession planning requirements. The aim of the CANTEACH proposal is to develop a comprehensive set of education and training documents at several Canadian universities. The CNSC is contributing information to the program. More information is available at http://canteach.candu.org/catalog.html#CNSC **.**

F.2.4 Canadian Nuclear Safety Commission

The CNSC has developed a workforce sustainability strategy that promotes workforce sustainability through improvements in recruitment, retention, and succession planning. In addition, it has also developed and initiated an internship program, designed to combine practical work assignments with comprehensive classroom and on-site training in nuclear and non-technical areas.

F.3 Financial Resources

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 *Radioactive Waste Policy* (refer to Annex B). 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.

With respect to so-called abandoned mine sites where no owner can be held responsible, the Government of Canada's policy is that financial responsibility should be shared between different levels of government. For example, a Memorandum of Agreement was signed in 1996 by the Government of Canada and the Province of Ontario. However, financial commitments pursuant to this Memorandum of Agreement have never been required, since there have been no "abandoned" uranium mine sites identified in the province.

Licensees of spent fuel and radioactive waste management facilities must provide guarantees that adequate financial and human resources are available for:

- decommissioning of spent fuel and radioactive waste management facilities; and
- management of the resulting radioactive wastes, including spent fuel.

Section 24(5) of the NSCA provides the legislative basis for this requirement. 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." Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities,* covers the provision of financial guarantees for decommissioning activities. 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. These guides can be viewed at www.nuclearsafety.gc.ca

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 guarantees 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 or disposal 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 to be part of 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 fulfill its obligations for decommissioning. Measures to fund decommissioning may involve various types of financial guarantees. Acceptable guarantees 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.

F.4 Quality Assurance

The NSCA and associated regulations require licensees to prepare and implement Quality Assurance (QA) programs for nuclear facilities. The licensees of spent fuel and radioactive waste management facilities submit their overall QA programs when applying for a spent fuel or radioactive waste management licence. The organization responsible for the facility must establish and implement a QA program for the items and services that they supply. The overall QA program may cover all sites licensed for that licensee.

For example, if a spent fuel and radioactive waste management facility is licensed by a nuclear power plant licensee; the overall QA program established by the licensee power plant may be applied to the spent fuel or radioactive waste management facility. This requirement is referenced as part of a licence condition.

F.4.1 Uranium Mining

QA principles and programs for uranium mines must comply with the QA expectations of the NSCA and *Uranium Mines and Mill Regulations*. After the licence is granted, the licensee and the other organizations involved must demonstrate the effective fulfillment of the QA requirements to the satisfaction of the CNSC. Reviews conducted by CNSC staff concentrate on the licensee's application of these standards and on its ability to demonstrate:

- consistent definition of roles and responsibilities for the facility;
- structured implementation of the QA program;
- control changes and program interactions; and
- internal self-assessment and corrective action

F.4.2 QA Program Assessment

To assess licensee QA programs, CNSC staff examines the results from internal reviews and audits carried out by the licensees, and also perform a detailed review of the documentation that communicates the requirements of the QA program to licensee personnel. After the QA program is found to be acceptable, the CNSC then plans and carries out real-time performance-based audits to ensure that the licensee complies with its provisions. When deficiencies are detected, the CNSC produces detailed reports of the audit findings and forwards them to the licensee for corrective action and response. The CNSC may decide an enforcement action is appropriate. Subsection E.6.3 provides further information on the CNSC Enforcement Policy.

F.5 Operational Radiation Protection

F.5.1 The ALARA Principle

Operations at Canada's spent fuel and radioactive waste management facilities are carried out such that doses to workers and the public are as low as reasonably achievable, all economic and social factors being taken into consideration. This is known as the As Low As Reasonably Achievable principle (ALARA). The nuclear industry implements ALARA through radiation protection programs that focus on the use of time, distance, and shielding for reducing radiation exposure. Regulatory Guide G-219, *Guidelines on How to Meet the Requirements to Keep All Exposures As Low As Reasonably Achievable,*) was issued by the CNSC in October 2004 in relation to the ALARA Principle.

The ALARA principle is legislatively supported through the NSCA and the *Radiation Protection Regulations*. The regulations require that each licensee implement a program to minimize the exposure to workers, the public, and the environment, economic and social factors being taken into account, through practices such as:

- management control over work practices;
- personnel qualification and training;
- control of occupational and public exposure to radiation;

- planning for unusual circumstances; and
- ascertaining the quantity and concentration of any nuclear substance released as a result of a licensed activity.

F.5.2 Derived Release Limits

Some nuclear facilities release small quantities of radioactive material into both the atmosphere as gaseous effluents (e.g. incineration of radioactive waste) and adjoining water bodies as liquid effluents (e.g. treated aqueous waste water) in a controlled manner. Radioactive material released into the environment through gaseous and liquid effluents from nuclear facilities can result in radiation doses to members of the public through:

- direct irradiation;
- inhalation of contaminated air; or
- ingestion of contaminated food or water.

The doses received by the members of the public through routine releases from nuclear facilities are very low, almost always too low to measure directly. Therefore, to ensure that the public dose limit is not exceeded, the *Radiation Protection Regulations* limit the amount of radioactive material that may be released in effluents from nuclear facilities. These effluent limits are derived from the public dose limit and are referred to as “derived release limits” or DRLs. The nuclear industry sets operating targets or administrative limits that are typically a small percentage of the derived release limits. These targets are based on the ALARA principle, and are unique to each facility depending on the factors that exist at each one.

When approving DRLs for nuclear facilities, the CNSC considers the environmental pathways through which radioactive material could reach the most exposed members of the public (also known as the “critical group”) after being released from the facility. Members of the critical group are those individuals who are expected to receive the highest dose of radiation because of such considerations as their age, diet, lifestyle and location.

F.5.3 Dose Limits and Action Levels

The CNSC has prescribed limits, based on the recommendations from the ICRP, on the amount of dose that may be received by a worker or a member of the public (effective dose). The CNSC requires that every licensee ascertain and record the magnitude of exposure to workers by direct measurement or monitoring, or in cases where this is not possible, by estimation. To monitor internal uptakes of radiation, bioassay samples are collected and analyzed. Other methods such as hand and foot monitoring and whole body counting are implemented when the probability for contamination is high.

Licensees are also required to establish “action levels.” An action level is a specific level, that if reached, may indicate a loss of control of part of the radiation protection program and triggers a specific action to be taken. If an action level is reached, the following actions must be taken:

- investigate to establish the cause;

- take action to restore the effectiveness of the radiation protection program; and
- notify the CNSC.

Regulatory Guide G-228, *Developing and Using Action Levels,* has been published by the CNSC to help licensees develop action levels in accordance with Section 6 of the *Radiation Protection Regulations*.

F.5.4 Preventing Unplanned Releases

The nuclear industry uses several means to reduce the risk of unplanned effluent releases of radioactive material into the environment. This approach uses multiple barriers, reliable components and systems, competent staff, and the detection and correction of failures to accommodate mistakes and failures without increasing the risk or consequences of an accident.

Owing to the robust design of storage facilities housing high-risk materials such as spent fuel, the potential for a significant release is present mainly during material handling operations. These operations are closely monitored by licensee staff that would be available in the unlikely event of an accidental release. The process of transferring waste from the point of origin to a storage site is under stringent controls and is only done so in the safest manner possible. Some of these controls involve prohibiting the transfer of spent fuel during periods of rain or snow and transporting the spent fuel at extremely low speeds.

In the event that an uncontrolled release into the environment occurs, competent licensee staff is available for an initial mop-up exercise to prevent further spread of radioactive contaminants. If necessary, the stored waste may be retrieved and held more securely. Depending on the magnitude and seriousness of the release, emergency procedures and emergency preparedness (EP) plans may be activated.

F.5.5 Protection of the Environment

Regulatory Policy P-223, *Protection of the Environment,* describes the principles and factors that guide the Commission in regulating the development, production and use of nuclear energy. It also covers the production, possession and use of nuclear substances, prescribed equipment and prescribed information to prevent unreasonable risk to the environment in a manner consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations. This policy applies to all regulatory decisions made by the Commission or staff.

Each facility in Canada that stores radioactive waste or spent fuel has a monitoring program in place to ensure that radioactive discharges released to the environment are kept at an acceptable level. Samples are obtained at regular intervals at various locations around the site, and the results are analyzed for trends. The monitoring programs ensure the detection of any chronic radiation releases at very low levels and steps can then be taken to control the releases. As a condition of the licence, licensees submit the results of their monitoring programs to the CNSC at specific intervals described in the licence.

F.5.6 Canadian Nuclear Safety Commission Activities

To verify compliance with the requirements in the licences and the regulations, CNSC staff:

- reviews documentation and operational reports submitted by licensees;
- conducts radiation protection evaluations; and
- conducts evaluations of licensee environmental protection programs and other programs as required.

A detailed description of the Compliance Verification Program is provided in subsection E.6.

F.6 Nuclear Emergency Management

Nuclear emergency preparedness and response in Canada is a multi-jurisdictional responsibility shared by all levels of government and licensees. In case of emergency, licensees are responsible for implementing measures to prevent or mitigate the effects of accidental releases of nuclear or hazardous substances to protect health, safety, security and the environment and respect Canada's international commitments on the peaceful use of nuclear energy. The provinces have the primary responsibility for implementing measures of civil protection and off-site nuclear emergency preparedness and response; they designate municipalities within their jurisdictions to carry out nuclear emergency planning. The Government of Canada has the responsibility through the Federal Nuclear Emergency Plan (FNEP) to coordinate federal actions in support of the provinces during a nuclear emergency and has procedures to respond to emergencies with international or inter-provincial implications. The FNEP outlines the federal role, organization and capability in responding to a nuclear emergency. Health Canada, as the lead department, is responsible for coordinating the nuclear emergency response of more than fourteen federal departments and six federal agencies, including the CNSC. These organizations each have distinct roles and responsibilities; therefore a structured framework is required to facilitate coordination. The FNEP provides this structure. The FNEP can be viewed at www.hc-sc.gc.ca/hecs-sesc/neprd/fnep/introduction.htm .

The CNSC is employing a collaborative approach in developing a new Nuclear Emergency Management (NEM) policy and upgraded programs. It is being developed in partnership with external stakeholders, and has included extensive consultations with licensees, provincial, municipal and federal government organizations involved in emergency preparedness management.

The CNSC NEM policy provides the foundation for all CNSC emergency management activities. Specifically, it outlines responses consistent with the risks at hand, clarifies roles and responsibilities, and helps maintain current capacity while taking future requirements into account. The policy will be adopted following public consultation. In addition to developing the policy, key elements of an improved nuclear emergency management program have been identified, and updated emergency plans and procedures are under development.

In addition, the CNSC Emergency Operations Centre (EOC) has been redesigned and reorganized to increase reliability and functionality, and enhance back-up resources. Extensive training on roles, responsibilities, procedures, and emergency response to chemical, biological, radiological and nuclear-related events has been conducted for staff and other Government of Canada departments. A wide variety of activities have been undertaken, ranging from creating a federal-provincial-territorial committee on radiological/nuclear emergencies to the installation of an emergency power generator at CNSC headquarters to maintain the CNSC's capacity in the event of an outage.

The CNSC requires licence applicants to assess the impacts of their proposed activities on health, safety, security and the environment and propose measures to prevent or mitigate the effects of accidental releases of nuclear or hazardous substances. Once these measures have been reviewed and accepted by the CNSC, they become binding upon the licensee as part of the licence requirements. Due to the variance in risk associated with radioactive waste facilities in Canada, some facilities require detailed emergency preparedness and response plans while others require internal emergency procedures only.

The CNSC maintains its regulatory role and responsibilities in overseeing the licensees' response actions and providing technical and advisory support to the provincial and federal authorities through the FNEP. Potentially, this collective responsibility encompasses a wide range of contingency and response measures to prevent, correct or eliminate accidents, spills, abnormal situations and emergencies.

The Province of Ontario, where 20 of Canada's 22 reactors and the largest nuclear waste management facility are located, named its first Commissioner of Emergency Management in 2004. The Commissioner's role is to: oversee Ontario's emergency planning and preparedness; monitor emergency situations in other jurisdictions to ensure the province is prepared for similar situations; work in partnership with the Government of Canada on the co-location of an emergency management centre; lead the development of necessary regulations to implement emergency management across key government ministries; and assist in a review of the current provincial *Emergency Management Act* and related legislation and regulations.

The province of Québec has one reactor located at Gentilly, near Trois-Rivières off the St. Lawrence River. "L'Organisation de la sécurité civile du Québec" (OSCQ) has the lead responsibility for emergency management to all hazards which includes off-site nuclear emergencies. L'OSCQ has a plan in place entitled "Plan des measures d'urgence nucléaire externe à la centrale nucléaire Gentilly-2. This Plan is in accordance with the Québec provincial bill "Civil Protection Act" and defines the government agencies' responsibilities with specific objectives of minimizing the consequences, protecting the public and providing support to the municipality.

The province of New Brunswick has one reactor located near Point Lepreau off the Bay of Fundy. The New Brunswick Emergency Measures Organization (NB EMO) coordinates preparedness for emergencies by provincial government departments and municipal governments. At the federal, provincial and municipal levels, planning is the key to emergency preparedness. Although, many extraneous factors are at play, a well established and tested emergency plan will help to ensure a prompt and co-ordinated response by responsible agencies in a time of crisis. NB EMO works at both provincial and municipal levels to ensure that New Brunswick communities are protected by emergency plans. NB EMO district coordinators, as well as headquarters staff, are there to help municipalities and local service districts with contingency planning for major emergencies. Recently, New Brunswick has invested significantly in provincial communications infrastructure to improve connectivity and harmonization with federal and provincial intervening organizations during a nuclear emergency.

The province of Saskatchewan has several uranium mines located in the northern part of the province. Saskatchewan Emergency Management Organization (SaskEMO) is the provincial government's lead agency for emergency management. SaskEMO coordinates overall provincial emergency planning, training and response operations for the safety of residents and the protection of property and the environment, before, during and after an emergency or disaster. Corrections and Public Safety is responsible for “The Emergency Planning Act”. The Act contains provisions for emergency planning, emergency powers and disaster relief. Corrections and Public Safety, through SaskEMO, is the provincial government’s lead agency for emergency management. SaskEMO supports community preparedness by encouraging the formation of local government emergency measures organizations, assisting in the development of local emergency plans and providing on-site consultation to municipal officials during government states of emergency. SaskEMO also supports provincial preparedness by maintaining the provincial government emergency plan and related contingencies, coordinating provincial government resources during a state of emergency, assisting government departments, Crown corporations and agencies with emergency planning, and coordinating federal government emergency preparedness programs within Saskatchewan.

Finally, in the province of Nova Scotia many shipments containing radioactive substances will navigate and possibly dock at the Port of Halifax. The “Emergency Measures Act” is Nova Scotia's emergency management and emergency powers legislation. It establishes the rules for managing emergencies in Nova Scotia and requires municipal governments to have emergency plans. Nova Scotia Emergency Measures Organization’s (NS EMO) ensures the safety and security of residents in Nova Scotia, their property and environment by providing for a prompt and coordinated response to an emergency. A lot of the work is intended to mitigate the effects of emergencies of any size or type. This is accomplished by providing assistance in planning before an emergency occurs, and by coordinating the provision of provincial resources when an emergency occurs. NS EMO is also responsible for ensuring all emergency planning in the province is done in a cooperative and consultative manner. During an emergency, the individual efforts of the parties must complement each other and contribute to the overall response effort. NS EMO facilitates and coordinates communication and emergency planning efforts among the various levels of government.

F.6.1 Types of Nuclear Emergencies

Nuclear emergency planning includes on-site and off-site emergencies as described below:

- On-site nuclear emergencies are those that occur within the physical boundaries of a nuclear facility licensed by the CNSC. The operators of nuclear facilities are responsible for on-site emergency planning, preparedness and response.

- Off-site nuclear emergencies are those that originate from a licensed facility, are associated with a licensed activity or originate from outside Canada and require intervention from provincial, territorial or municipal authorities outside of a licensed facility or activity. Off-site emergencies may require support from the licensee and of the federal government, under the FNEP.

F.6.2 Federal Government Responsibilities

In the event of a nuclear emergency, the federal government is responsible for:

- coordinating the federal response and providing support to provinces in their response to a nuclear emergency;
- liaising with the international community;
- liaising with diplomatic missions in Canada;
- assisting Canadians abroad;
- coordinating the national response to a nuclear emergency occurring in a foreign country affecting Canadians; and
- managing third-party nuclear liabilities.

To the extent possible, the Government of Canada emergency planning, preparedness, and response are based on the "all-hazards" approach. Because of the inherent technical nature and complexity associated with a nuclear emergency, hazard-specific planning, preparedness and response arrangements are required. These special arrangements, which are one component of the larger federal emergency management framework described in Part 1 of Annex D of the *National Support Planning Framework*, constituted the FNEP. The FNEP describes the federal government's preparedness and coordinates response to a nuclear emergency.

Under the common administrative framework of the FNEP, the development and implementation of emergency preparedness and response plans to off-site nuclear emergencies is primarily a provincial responsibility. However, there are direct inputs from the local government, the nuclear facility, and federal government departments and agencies (including the CNSC). This allows the various jurisdictions and organizations that have responsibilities for aspects of nuclear emergency management to discharge their responsibilities in a cooperative, complementary and coordinated manner.

The Government of Canada is responsible for the third-party nuclear liability regime that would address the liability and compensative scheme applicable for nuclear incidents occurring at certain nuclear facilities. This regime is established under the NLA. The CNSC designates certain nuclear facilities as coming within the scope of the NLA. These are typically facilities which pose a risk of criticality. An operator of such an installation is absolutely and exclusively liable for any third-party damages caused by an incident at that installation. The operator must carry mandatory insurance. In the event of a serious incident, the NLA provides for special compensation measures that may be imposed by the government to replace the normal court process.

F.6.3 International Arrangements

Canada has signed and ratified the following three international emergency response conventions:

Canada-US Joint Radiological Emergency Response Plan (1996) — this plan focuses on emergency response measures of a radiological nature rather than generic civil emergency measures. It is the basis for co-operative measures to deal with potential or actual peacetime radiological events involving Canada, the United States, or both countries. Cooperative measures contained in the FNEP are consistent with this plan.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1986) — this international assistance agreement, which was developed under the auspices of the IAEA, promotes cooperation between signatories and facilitates prompt assistance in the event of a nuclear accident or radiological emergency to minimize its consequences and to protect life, property, and the environment. The agreement sets out how assistance is requested, provided, directed, controlled and terminated.

Convention on Early Notification of a Nuclear Accident (1987) — this international convention, which was developed under the auspices of the IAEA, defines when and how the IAEA would notify the signatories of an international event which could have an impact in their respective countries.

F.7 Decommissioning

Section 24(5) of the NSCA provides the legislative basis for requiring licensees of nuclear facilities to provide guarantees that adequate financing and human resources will be available for the decommissioning of facilities and management of the resulting radioactive wastes including spent fuel. Section 3(1)(l) of the *General Nuclear Safety and Control Regulations* states “An application for a licence shall contain a description of any proposed financial guarantee relating to the activity to be licensed.” Financial guarantees applicable to the decommissioning process have been described in subsection F.3.

SECTION G

G. SAFETY OF SPENT FUEL MANAGEMENT

G.1 Scope of the Section

This section addresses **Article 4 (General Safety Requirements)** to **Article 10 (Disposal of Spent Fuel)**. It provides a comprehensive description of spent fuel management in Canada. At all stages of spent fuel management, there are effective defences against potential hazards which protect individuals, society and the environment from the harmful effects of ionizing radiation, now and into the future.

In addition to describing facilities and their normal operation, this section discusses what steps or what controls are in place to prevent accidents with radiological consequences and to mitigate their consequences should they occur.

The information contained in this section demonstrates that the requirements of the following applicable IAEA Safety Standards are addressed:

Article 4 – General Safety Requirements – IAEA Safety Requirements NS-R-1, WS-R-1 and WS-R-2
Article 6 – Siting of Proposed Facilities – IAEA Safety Requirement NS-R-3
Article 7 – Design and Construction of Facilities – IAEA Safety Requirements NS-R-1 and WS-R-1
Article 8 – Assessment of Safety of Facilities – IAEA Safety Requirements NS-R-1, WS-R-1 and Safety Series 115
Article 9 – Operation of Facilities – IAEA Safety Standards NS-R-1, WS-R-1WS-R-2 and Safety Series 115
Article 10 – Institutional Measures after Closure – IAEA Safety Standard WS-R-1

G.2 Power Reactors

Used fuel in Canada is stored in wet and dry states at the locations where they are produced. When the fuel first exits a power reactor it is placed in water-filled bays. Water cools the fuel and shields the radiation. After several years in the bays (nominally 6 to 10 years, depending on site-specific needs and organizational administrative controls) and when the associated heat generation has diminished, the used fuel can then be transferred to an on-site dry storage facility. These dry storage facilities are large reinforced concrete cylinders or dry storage containers. There is enough storage space at each nuclear generating station in Canada to store all the used fuel produced during the operating life of the station. A 600MW CANDU nuclear reactor produces approximately 20 m^3 of used fuel per year.

G.3 CANDU Fuel

All CANDU fuel bundles are fabricated from natural uranium oxide pellets that are contained in a zirconium-alloy (Zircaloy-4) tube (cladding). There are normally 30 uranium oxide pellets per element. The maximum nominal bundle diameter is 102 mm with an overall bundle length of 495 mm. The weight of a nominal bundle is 23.6 kg, of which 21.3 kg is due to the uranium oxide. Each year 4,500 to 5,400 fuel bundles per reactor are added to the wet storage bays, based on 80% to 95% full power reactor power operation.

G.4 Research Reactors

In support of the international regime, Canada contributed its expertise and perspective towards the development of two IAEA documents, the *Code of Conduct on the Safety of Research Reactors* and *Safety Requirements for Research Reactors.* These documents will help strengthen the regulatory framework governing the safe operation of research reactors in Canada.

As of March 31, 2000, there were nine operating research reactors in Canada. Seven of these research reactors were located at Canadian universities; two in Ontario (McMaster University and RMC), two in Quebec (both at École Polytechnique), and one each in Nova Scotia (Dalhousie University), Alberta (University of Alberta) and Saskatchewan (Saskatchewan Research Council). Of these research reactors, five are of the SLOWPOKE-2 type designed by AECL. The remaining two include a sub-critical assembly at École Polytechnique and a 5 MW pool-type reactor at McMaster University. The last two research reactors, namely National Research Universal (NRU) and Zero Energy Deuterium-2 (ZED-2), are located at the AECL CRL.

Research reactors use high-enriched fuel (HEU) or low-enriched fuel (LEU). Some HEU reactors have been converted to LEU operation, in line with the U.S. Department of Energy’s reduce enrichment for research test reactors (RERTR) program. This program aims to convert all HEU research reactors to LEU fuel. The HEU fuel used in Canadian reactors comes from the U.S.

G.4.1 Nuclear Fuel Waste from Research Reactors

Two of the five SLOWPOKE-2 reactors in Canada use LEU (below 20% U-235); all others use HEU. All SLOWPOKE-2 cores are pre-assembled and cannot be modified by the licensee. The cores, which contain approximately 20 kg U, last many years with reactivity decreases in fuel being compensated by the addition of reflector shims. Once the decreased reactivity of the used fuel can no longer be compensated by the addition of reflector shims (after about 20 years), the complete core is removed and the used fuel is either sent to the CRL for waste management storage or returned to the United States.

The waste and used fuel for CRL reactors is stored on site. The used fuel from NRU is stored in fuel storage pools until it can be transferred to Waste Management Area ‘B’ which is described in Annex 9. The ZED-2 reactor (200 W) is operated occasionally and is mainly used for prototype testing of fuel to determine fuel characteristics.

McMaster Nuclear Reactor (MNR) has both HEU and LEU. Some of the LEU comes from France. All MNR used fuel (HEU and LEU), irrespective of its origin, is sent to Savannah River, located in the United States.

G.5 Medical Isotope Production Fuel

This type of fuel is not included in the report because this spent fuel is reprocessed for extraction of medical isotopes and is therefore outside the scope of the Joint Convention, according to **Article 3(1)**.

G.6 Storage of Spent Fuel

In Canada, all spent fuel is stored at the site where it was produced, with the following exceptions:

- Small quantities that are transported to research facilities for experimental or examination purposes, and which are stored at those facilities; and
- The fuel from the Nuclear Power Demonstration reactor which is stored at the nearby CRL site.

All Canadian power reactors were constructed with on-site spent fuel storage bays or water pools. Secondary or auxiliary bays have also been constructed at Pickering A, Bruce A, and Bruce B for additional storage. Since 1990, dry storage technology has been chosen for additional on-site interim storage. In addition, the spent fuel from the earlier decommissioned prototype reactors is stored on-site in dry storage facilities.

G.7 Spent Fuel Management Methods

The fuel cycle in Canada is a once-through process (i.e. at present, there is no reprocessing or intent to reprocess spent fuel for recycling of the uranium and plutonium content). Development and selection of an approach for long-term management of spent fuel is discussed in subsection G.17.

G.7.1 Requirements for Spent Fuel Storage

Spent fuel handling and storage facilities are required to provide the following:

- containment;
- shielding;
- dissipation of decay heat;

- prevention of criticality;
- assurance of fuel integrity for the required time of storage;
- allowance for loading, handling and retrieval;
- mechanical protection during handling and storage;
- allowance for safeguards and security provisions; and
- physical stability and resistance to extreme site conditions.

The Canadian Standards Association has developed a standard consisting of best practices for the safe siting, design, construction, commissioning, operation, and decommissioning of facilities and associated equipment for the dry storage of irradiated fuel (CSA #N292.2-96 [R2001]). The Canadian nuclear industry uses this standard as a guide to facilitate the licensing process.

G.8 Safety of Spent Fuel and Radioactive Waste Management

In Canada, spent fuel management and radioactive waste management and associated facilities are regulated in a similar fashion. The approach to safety and licensing is regulated according to the same requirements under the NSCA and associated regulations.

G.8.1 General Safety Requirements

Canada ensures that individuals, society and the environment are adequately protected at all stages of spent fuel and radioactive waste management. This is accomplished through the Canadian regulatory regime. Canada's approach to the safety of spent fuel and radioactive waste management is in line with the guidelines provided by the IAEA *Safety Guides and Practices*.

G.8.2 Canadian Licensing Process

The Canadian licensing process covers siting, construction, operation, decommissioning and abandonment. No phase may proceed without corresponding applications, documentation, assessments and approvals. A full description of Canada's comprehensive licensing system is provided in subsection E.5.

G.8.3 Protection and Safety Fundamentals

The main objective in the regulation of spent fuel and radioactive waste management is to ensure that these facilities and activities do not pose unreasonable risks to health, safety, security and the environment. The regulation of spent fuel and radioactive waste can be divided into:

- generic performance requirements;
- generic design and operational principles; and
- performance criteria.

G.8.4 Generic Performance Requirements

There are three main generic performance requirements:

- the applicant must make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of security;

- the applicant must comply with all applicable laws, regulations and limits (i.e. dose limits, ALARA principle, etc.); and

- the applicant must assure or demonstrate compliance with tests, analyses, monitoring programs, records, data and relevant reports, and so on.

G.8.5 Generic Design and Operational Principles

There are two main principles for generic design and operations:

- the use of multiple, engineered barriers to ensure adequate containment and isolation of the spent fuel and radioactive waste from humans and the environment during normal and abnormal conditions; and

- the use of administrative controls and procedures to augment and monitor the performance of the engineered barriers.

G.8.6 Performance Criteria

The performance criteria that have been accepted by the CNSC are:

- structural integrity shall be maintained over the design life of the structure;
- radiation fields at one metre from the storage structure and at the facility perimeter must be such that the public and worker regulatory limits are not exceeded;
- no loss of effective shielding during the design life of the storage container;
- no significant release of radioactive or hazardous contaminants over the design life of the storage container;
- no significant tilt, or upset, of the storage containers under normal conditions;
- maintenance of safeguard and physical security systems of the contents and facility components.

G.8.7 Safety Requirements

Spent fuel and radioactive waste management facilities must be operated in a safe manner. Management of spent fuel and radioactive waste must include provisions for the protection of the environment and the health and safety of workers and the public. System components that may require periodic maintenance must be readily accessible and designed to permit safe and efficient maintenance.

Safety requirements at spent fuel and radioactive waste facilities are:

- nuclear criticality safety;
- radiation safety;
- physical security and safeguards; and
- industrial safety.

G.8.7.1 Nuclear Criticality Safety

Nuclear criticality safety requirements must address both normal and abnormal conditions. When spent fuel is stored or handled, a criticality analysis must be performed. The criticality analysis must clearly demonstrate that the storage and handling of the spent fuel or radioactive waste is safe (i.e. inadvertent criticality cannot occur under normal or credible abnormal conditions).

G.8.7.2 Radiation Safety

The storage of spent fuel and radioactive waste systems are designed to reduce occupational radiation doses and radioactive emissions to the environment in accordance with the ALARA principle. The current regulatory requirement is that dose rates at the storage area boundary or at any accessible point within the storage area must be maintained at a level that would not result in an exposure to workers or to a member of the public in excess of the regulatory limit.

The majority of, if not all, spent fuel and radioactive waste management facilities were designed, constructed and operated to meet the public regulatory limit of 5 mSv per year under the *Atomic Energy Control Regulations.* With the coming into force of the NSCA in 2000, the public regulatory dose limit was subsequently reduced to 1 mSv per year. As a result, operators of spent fuel and radioactive waste management facilities were required to reassess the radiation safety of the facilities. Operational experience demonstrated that all spent fuel and radioactive waste management facilities were currently operating at a small fraction of the new public regulatory limit. Consequently, no design or operating changes were required.

G.8.7.3 Physical Security and Safeguards

The CNSC monitors and assesses the effectiveness of security measures in place for nuclear facilities and nuclear materials, and provides advice and assistance to licensees in determining appropriate application of the *Nuclear Security Regulations.* The CNSC administers the agreement between Canada and the IAEA for the application of safeguards to nuclear activities in Canada. The exclusive purpose of this safeguards agreement is to verify that Canada's obligations under the non-proliferation treaty are being met. CNSC staff coordinates the access and activities of IAEA inspectors who are authorized to carry out safeguards inspections and activities at nuclear facilities in Canada. The operator of spent fuel management facilities is required, pursuant to Section 5(h) of the *Class I Nuclear Facilities Regulations*, to provide in a construction application the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement.

G.8.7.4 Industrial Safety

At all stages in the life cycle of a spent fuel and radioactive waste management facility, the licensee must take into consideration the occupational health and safety of workers. The handling of hazardous materials must meet all federal and provincial legislation.

G.9 Protection of Existing Facilities

The safety of spent fuel management facilities existing at the time the Joint Convention entered into force was ensured through the Canadian regulatory regime, as all facilities were under a CNSC licence. Consequently, the operation of spent fuel management facilities must be conducted in accordance with the requirements of the NSCA, the associated regulations, and the licence conditions.

Facilities for the storage of spent fuel and radioactive waste were designed to ensure that there are no effluent discharges to the environment. Effluent discharges from the processing of spent fuel or radioactive waste (e.g. incineration of combustible radioactive waste) are monitored to ensure they are below regulatory guidelines. All discharges from nuclear facilities must be in conformance with the NSCA, associated regulations, and if applicable, conditions specified in the licence.

G.10 Protection in the Siting of Proposed Facilities

Spent fuel storage facilities are considered to be Class I nuclear facilities in accordance with the definition provided in the *Class I Nuclear Facilities Regulations*. The *Class I Nuclear Facilities Regulations* stipulate several licensing steps for these types of facilities:

- a site preparation licence;
- a construction licence;
- an operating licence;
- a decommissioning licence; and
- an abandonment licence.

Requirements for a licence to site a Class I nuclear facility are listed in Section 4 of the *Class I Nuclear Facilities Regulations*. Additionally, the information indicated in Section 3 of the *General Nuclear Safety and Control Regulations* and Section 3 of the *Class I Nuclear Facilities Regulations* is also required.

G.10.1 International Arrangements with Neighbouring Countries That Could Be Affected

The Canadian regulatory regime does not oblige proponents of domestic nuclear facilities that could affect the United States to consult with U.S. jurisdiction or the U.S. public regarding the proposed siting of such facilities.

Canada and the U.S., however, are signatories to the *International Convention on Environmental Impact Assessment in a Transboundary Context* (Espoo, Finland 25 February 1991). With ratification of this Convention, both parties will be bound by its provisions. Ratification obliges the "Party of Origin":

- to "take all appropriate and effective measures to prevent, reduce, and control significant adverse transboundary environmental impacts of proposed activities" (including the siting, construction, and operation of nuclear installations);
- to "ensure that affected Parties are notified" of the proposed installation;
- to "provide an opportunity to the public in the areas likely to be affected to participate in relevant environmental impact assessment procedures regarding proposed activities, and to ensure that the opportunity provided to the public of the affected Party is equivalent to that provided to the public of the Party of origin;" and
- to include in the notification "information on the proposed activity, including any available information on its possible transboundary impact."

The Government of Canada and the Government of the United States of America, in cooperation with state and provincial governments, are also obligated to have in place programs for the abatement, control and prevention of pollution from industrial sources which include measures to control the discharges of radioactive materials into the Great Lakes System. These obligations are by virtue of the *Great Lakes Water Quality Agreement of 1978*, as amended by the protocol signed November 18, 1987.

Since the 1950s, the CNSC and the U.S. Nuclear Regulatory Commission, as the national regulatory authorities of their respective countries, have had a long practice of cooperation and consultation. On August 15, 1996, they entered into a bilateral administrative arrangement for "cooperation and the exchange of information on nuclear regulatory matters." This commitment includes, to the extent permitted under laws and policies, the exchange of certain technical information that "relates to the regulation of health, safety, security, safeguards, waste management and environmental protection aspects of the siting, construction, commissioning, operation and decommissioning of any designated nuclear facility" in Canada and the United States.

G.11 Design/Construction and Assessment of Safety of Facilities

After the granting of a siting authorization, the second formal licensing step for nuclear facilities is the construction licence. Requirements for a licence to construct a Class I nuclear facility are listed in Section 5 of the *Class I Nuclear Facilities Regulations*. Additionally, the information indicated in Section 3 of the *General Nuclear Safety and Control Regulations* and Section 3 of the *Class I Nuclear Facilities Regulations* is also required. The required information includes such items as the proposed design (including systems and components), the proposed QA program, the possible effects on the environment, and the proposed measures to control releases to the environment.

G.12 Operation of Facilities

The third step in the licensing process is the operating licence. Requirements to operate a Class I nuclear facility are listed in Section 6 of the *Class I Nuclear Facilities Regulations*. Additionally the information indicated in Section 3 of the *General Nuclear Safety and Control Regulations* and Section 3 of the *Class I Nuclear Facilities Regulations* is also required. The required information includes such items as a safety analysis report, commissioning program, the measures to prevent or mitigate releases of nuclear substances and hazardous substances to the environment and a preliminary decommissioning plan.

Also as a requirement of a licence to operate, the licensee must keep a record of the results of:

- effluent and environmental monitoring programs;
- operating and maintenance procedures;
- commissioning program;
- inspection and maintenance programs;
- nature and amount of radiation, nuclear substances and hazardous substances within the nuclear facility; and
- status of each worker's qualifications, re-qualification, and training.

G.13 Monitoring of Spent Fuel Dry Storage Facilities

Dry storage facilities are required to have an Operational Monitoring Performance Assessment Program. The monitoring program is the means by which the performance of the individual barriers, as well as the entire containment system, is evaluated with respect to:

- established safety criteria; and
- standards related to potential impacts on human health and safety as well as to non-human biota and the physical environment.

A monitoring program for a dry storage facility must be able to detect, in a timely manner, any unsafe condition or the degradation of structures, systems and components that could result in an unsafe condition. A typical monitoring program for a spent fuel dry storage facility may include the following elements:

- gamma radiation monitoring;
- canister monitoring for leak tightness verification of the baskets and canister liners;
- effluent monitoring (including airborne emissions and liquid emissions); and
- An environmental monitoring program.

G.13.1 Gamma Radiation Monitoring Experience

Routine gamma radiation surveys are performed using a hand-held monitor at appropriate points inside the dry storage facility fence and on all sides of the dry storage containers or by TLD mounted devices to monitor cumulative fields. Operating experience has demonstrated that gamma radiation at dry storage facilities is significantly less than that predicted during the design phase and that is acceptable within the facility licence.

G.13.2 Leak Tightness Verification Experience

Leak tightness verification of the AECL-type fuel baskets and concrete canister consists of connecting a pump to the liner cavity and re-circulating the air through filters. Excessive humidity indicates either a liner leak or water holdup in the canister from operations carried out before sealing. The presence of radioactivity indicates a basket leak. Based on operational experience to date, the various dry storage structures and components currently used in Canada effectively provide containment of the fission products contained in the fuel bundles.

For the OPG-type dry storage containers, verification of leak tightness is conducted on an approved cycle in order to ensure that the welds have not deteriorated to the point where intervention is required.

G.13.3 Environmental Monitoring Experience

Each nuclear generating station and AECL's research facilities have an environmental monitoring program in place. Spent fuel dry storage facilities at these sites are addressed in the site environmental monitoring program. The environmental programs:

- provide an early indication of the appearance or accumulation of any radioactive material in the environment;
- verify the adequacy and proper functioning of effluent controls and monitoring programs;
- provide an estimate of actual radiation exposure to the surrounding population;
- provide assurance that the environmental impact is known and within anticipated limits; and
- provide standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material.

Based on operational experience to date, spent fuel dry storage facilities in Canada have operated, and continue to operate, safely and within prescribed regulatory limits.

G.13.4 Effluent Monitoring Experience

G.13.4.1 AECL

AECL fuel baskets are wet-loaded in the generating station's fuel bay area. The loaded fuel basket is raised into the shielded workstation. While being raised, an annular ring with spray nozzles washes the chain and loaded fuel basket with de-mineralized water to clean them as they emerge from the spent fuel storage bay. All liquids are returned to the spent fuel storage bay. Once in the shielded workstation, the loaded fuel basket is air dried and seal welded. The air drying system consists of:

- two heaters to heat the air;

- blowers, High Efficiency Particle Absolute (HEPA) filters;
- associated ductwork; and
- dampers.

The hot air is blown in via a swan neck duct and removed via a plenum formed by the basket cover and the rotating table. The return air is filtered before being exhausted into the Spent Fuel Bay Active Ventilation System. Monitoring results have shown no significant levels of particulates in the ventilation system resulting from the dry storage operations. As the fuel baskets are processed in the fuel bay area where active ventilation is provided and any liquids generated by the drying of the spent fuel are returned to the storage pool, no airborne or liquid emissions are encountered during the transfer of the loaded basket to the dry storage facility. At the dry storage facility, the cylinders are filled with loaded baskets and a cover plate is then welded in place. Monitoring results have shown no airborne or liquid effluents at significant levels generated from the loaded baskets in the sealed storage cylinders.

G.13.4.2 OPG

OPG dry storage containers are wet-loaded in the fuel bay, decontaminated, drained and dried, and the transfer clamp and seal are installed to secure and seal the lid during on-site transfer. The fuel bay area is equipped with an active ventilation system and all liquids resulting from the draining and vacuum drying is returned to the fuel bay. At the dry storage facility, a dedicated workshop houses the following dedicated systems for dry storage container processing:

- closure welding and welding-related systems;
- x-ray radiography system;
- vacuum drying system;
- helium backfilling system; and
- helium leak detection system.

Airborne contamination hazards may present a danger if any loose surface contamination on the dry storage container becomes airborne, or if there is leakage of the dry storage container internal gas (e.g. such gas could contain krypton-85 as well as radioactive particulates). The processes that could potentially give rise to this airborne hazard are:

- dry storage container draining and drying;
- transfer clamp and seal removal; and
- the dry storage container back-filling with helium.

Airborne particulate monitors and gamma radiation monitors are used to detect any abnormally high levels. The workshop is also provided with active ventilation consisting of exhaust fans, radioactive filter assemblies and a discharge stack. Airborne radioactive particulate contamination, if present in the ventilation exhaust, is effectively removed by HEPA filters in the active ventilation system. Monitoring results to date with the Pickering Used Fuel Dry Storage Facility and the Western Used Fuel Dry Storage Facility have shown no significant levels of particulates in the active ventilation exhaust.

As the dry storage containers are fully drained, vacuum dried and helium backfilled at the generating station fuel bay area, there are no liquid emissions from the dry storage container during on-site transfer to the dry storage workshop. The exterior surfaces of dry storage containers are decontaminated prior to their transfer from the fuel bay area to the dry storage workshop. Spot decontamination operations, which may be carried out in the workshop, do not generate liquids. No liquid is present inside the dry storage containers during storage in the storage area. Liquids are not normally used in the storage areas. Since no liquids are present in the dry storage containers and loose contamination is not permitted on dry storage containers or facility surfaces, no contaminated liquid effluents are expected from the dry storage operations. However, some liquid effluents may originate in the processing area as a result of maintenance. Such liquids are sampled and pumped into the generating station's active liquid waste management system. Monitoring results at the Pickering Used Fuel Dry Storage Facility have shown no significant levels of activity in active drainage effluent transferred to the generating station system.

G.14 Disposal of Spent Fuel

Currently, Canada does not have a disposal facility for spent fuel. Any proposal for the siting, construction, and operation of a disposal facility must satisfy the requirements of the CEAA, the NSCA and associated regulations.

G.15 New Facilities

The only new spent fuel management facility is located at the Darlington Nuclear Generating Station. The regulatory body issued a construction licence to OPG for the Darlington Used Fuel Dry Storage Facility. When construction is completed, OPG will be required to apply for an operating licence.

G.16 Proposed Facilities

Spent fuel from the National Research Experimental (NRX) and NRU research reactors at the AECL CRL is currently stored, below-grade, in vertical cylindrical concrete structures called "Tile Holes" in Waste Management Area B. The fuel that was initially loaded into these storage structures from 1963 to 1983 was research reactor prototype fuel and included uranium metal fuel that has less corrosion resistance than modern day alloy fuels. While these fuels are stored, monitoring and inspection of these older fuel types have shown that some of the fuel containers and fuels are corroding.

AECL intends to construct, operate and ultimately decommission a new dry storage array that will replace about 100 tile holes that contain research fuels which are vulnerable to degradation. These fuels consist of about 700 prototype and research reactor fuel rods with a total mass of approximately 22 tonnes. The new dry storage system will be located in a Fuel Packaging and Storage (FPS) building.

This building will contain a packaging and vacuum drying station, and a monitored storage structure. The fuel will be retrieved in its existing storage container, which will be placed in a new stainless steel container with a vented closure, and then will be dried before emplacement in the monitored storage structure. The storage structure will be engineered to last at least 50 years and will provide safe and interim storage for the packaged fuel until a disposal or long-term storage facility is available.

G.17 Long-term Management of Spent Fuel

Since the early days of the CANDU program, several concepts for long-term management of nuclear fuel waste have been under consideration. The options for long-term management in Canada were reviewed by a Royal Commission in 1977. Subsequently, Canada's nuclear fuel waste management program was formally initiated by the governments of Canada and the Province of Ontario. Responsibility for research and development of the concept for emplacement of used fuel in a deep underground repository within the plutonic rock of the Canadian Shield was assigned to AECL. Responsibility for studies and technology development for storage and transportation of used fuel, plus technical assistance to AECL in repository development, was assigned to Ontario Hydro (now Ontario Power Generation Inc). In 1981, the governments of Canada and Ontario announced that site selection for a repository would not be undertaken until after the disposal concept had been accepted.

In 1994, AECL submitted its Environmental Impact Statement (EIS) on the deep geologic repository concept for review by a federal Environmental Assessment Panel. This review included input from government agencies, non-government organizations and the general public. Public hearings associated with the review took place during 1996 and 1997. The Government of Canada announced a radioactive waste policy framework in 1996, which specifies the roles of government and waste producers in the long-term management of radioactive waste in Canada. The major elements of the framework included the following:

- The federal government will ensure that radioactive waste disposal is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.

- The federal government has the responsibility to develop policy, to regulate, and to oversee producers and owners to ensure that they comply with legal requirements and meet their funding and operational responsibilities in accordance with approved waste disposal plans.

- The waste producers and owners are responsible, in accordance with the principle of "polluter pays," for the funding, organization, management and operation of disposal and other facilities required for their wastes. This recognizes that arrangements may be different for nuclear fuel waste, low-level radioactive waste and uranium mine and mill tailings.

The report of the federal Environmental Assessment Panel was submitted to the federal government in 1998. It made recommendations to assist the federal government in reaching a decision on the acceptability of the disposal concept and on the steps to be taken to ensure the safe long-term management of nuclear fuel waste in Canada. The federal government responded to the Panel report later in 1998, and announced the steps it would require the producers and owners of nuclear fuel waste in Canada to take, including the formation of a Nuclear Waste Management Organization (NWMO) by the nuclear utilities.

In 2002, the Canadian Parliament passed the *Nuclear Fuel Waste Act* (NFWA). The NFWA indicates that the Governor-in-Council will select an approach for the long-term management of nuclear fuel waste from those approaches examined by the NWMO. The NFWA includes the following:

1. The nuclear energy corporations (i.e. the owners of the nuclear fuel waste) are to establish a waste management organization, the purpose of which is to study and propose approaches for the management of nuclear fuel waste, and to implement the approach selected by the Governor-in-Council.

2. The waste management organization will create an Advisory Council which will reflect a broad range of scientific and technical disciplines; expertise including public affairs, other social sciences as needed, and traditional aboriginal knowledge. It will also include representatives of local and regional governments and Aboriginal organizations which are affected by the selected approach by reason of their location.

3. The waste management organization will submit, within three years of the Act coming into force, a study setting out proposed approaches for the management of nuclear fuel waste, and its recommendation. The study must include approaches based on the following methods:

    - a modified AECL concept for deep geological disposal in the Canadian Shield;
    - storage at nuclear reactor sites; and
    - centralized storage, either above or below ground.

The study will include a technical description, and a comparison of the benefits, risks and costs, and ethical, social and economic considerations associated with each approach, together with specification of economic regions for implementation and plans for implementation of each approach in the study. The waste management organization will consult the general public and in particular Aboriginal peoples, on each approach.

The waste management organization will report annually to the Minister of Natural Resources. Every third year following the selection by the Governor-in-Council of an approach, this report will include a summary of activities and a strategic plan for the following five years.

In 2002, the NWMO was set up by the nuclear energy corporations. The incorporated name is the Nuclear Waste Management Organization and its Board of Directors includes representatives from OPG, Hydro-Québec, and New Brunswick Power Nuclear Corporation. In accordance with the NFWA, the NWMO must submit options for the long-term management of spent fuel within three years. The organization’s report would include a proposed implementation plan for each of the options proposed, including a time schedule. Once the Governor-in-Council selects an option, a site selection process will ensue. In time, the NWMO will need to submit detailed information for a specific project in order to obtain a licence from the CNSC.

SECTION H

H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

H.1 Scope of the Section

This section addresses **Article 11 (General Safety Requirements)** to **Article 17 (Institutional Measures After Closure)**. It provides a comprehensive description of radioactive waste management in Canada.

At all stages of radioactive waste management, there are effective defences which protect individuals, society, and the environment against potential hazards and the harmful effects of ionizing radiation, now and into the future. In addition to describing facilities and their normal operation, this section describes the steps or controls in place to prevent accidents with radiological consequences, and to mitigate their consequences should they occur.

The information contained in this section demonstrates that the requirements of the following applicable IAEA Safety Standards are addressed.

Article 11 – General Safety Requirements – IAEA Safety Requirements NS-R-1, WS-R-1 and WS-R-2
Article 13 – Siting of Proposed Facilities – IAEA Safety Requirement NS-R-3
Article 14 – Design and Construction of Facilities – IAEA Safety Requirements NS-R-1 and WS-R-1
Article 15 – Assessment of Safety of Facilities – IAEA Safety Requirements NS-R-1, WS-R-1 and Safety Series 115
Article 16 – Operation of Facilities – IAEA Safety Standards NS-R-1, WS-R-1WS-R-2 and Safety Series 115
Article 17 – Institutional Measures After Closure – IAEA Safety Standard WS-R-1

H.2 Radioactive Waste in Canada

Nuclear facilities and users of prescribed substances produce radioactive waste. The Government of Canada establishes the policy framework for the management of these wastes. The CNSC regulates the management of radioactive waste to ensure that it causes no undue radiological hazard to the health and safety of persons or to the environment. The radioactive content of the waste varies with the source. Management techniques, therefore, depend on the characteristics of the waste (see subsection H.3).

Certain types of radioactive waste, such as that from hospitals, universities, and industry contains only small amounts of radioactive materials with short half-lives. This means that radioactivity decays away in hours or days. After holding the waste until the radioactivity has decayed to acceptable levels authorized by the CNSC, it can be disposed by conventional means (local landfill or sewer system).

Radioactive waste from activities other than nuclear power plants, which is contaminated with long-lived radioisotopes, is shipped directly or via a waste broker to the waste management facility operated by AECL at its CRL. Typical storage facilities for this type of waste include both concrete bunkers and concrete tile holes.

The methods practiced in Canada for the management of radioactive waste are similar to those practiced in other countries. Primary emphasis is placed on minimization, volume reduction, conditioning and long-term storage of the waste as disposal facilities are not yet available. Radioactive waste is stored on-site or off-site in above- or below-ground engineered structures. Some of the waste may be volume-reduced by compaction or incineration prior to storage. All radioactive waste currently generated is stored in such a way that it can be retrieved. Operators have instituted methods to recover storage space by cascading the waste after sufficient radioactive decay or reclaiming existing storage space through further compaction (super compaction), segregation, or both.

As for all nuclear activities, facilities for the handling of radioactive waste must be licensed by the CNSC and conform to all of the pertinent regulations and licence conditions. The waste management objective throughout the industry—from mines to reactors—is the same, which is to control and limit the release of potentially harmful substances into the environment.

H.3 Characteristics of Radioactive Waste in Canada

H.3.1 Fuel Manufacturing Waste

In the past, wastes from refineries and conversion facilities were managed by means of direct in-ground burial. This practice was discontinued in 1988, after the closure of Port Granby. The volume of low-level waste produced from these operations has been greatly reduced by recovery and reuse of feedstock materials, conversion of waste materials into by-products, and decontamination of wastes for disposal with non-radioactive wastes. The residual volume of low-level waste now being produced is drummed and stored in warehouses pending the establishment of an appropriate long-term waste management facility. The seepage and runoff from the waste management facilities where direct in-ground burial was practiced continues to be collected and treated prior to discharge.

Fuel manufacturing waste consists of a variety of potentially alpha-contaminated wastes including the following types:

- uncontaminated and contaminated zirconium dioxide;
- graphite crucibles used to cast billets;
- filters;
- scrap lumber;
- pallets;

- rags;
- paper;
- cardboard;
- rubber;
- plastic;
- oils; and
- solvents.

H.3.2 Electricity Generation Waste

Radioactive wastes resulting from reactor operations are stored in a variety of structures in waste management facilities located at reactor sites. Prior to storage, the volume of the wastes may be reduced by incineration, compaction, shredding or baling. In addition, there are facilities for the decontamination of parts and tools, laundering of protective clothing, and the refurbishment and rehabilitation of equipment. Electricity generation waste consists of varying types of low-, and intermediate-level activity waste such as:

- filters;
- light bulbs;
- cable;
- used equipment;
- metals;
- construction debris;
- absorbents (sand, vermiculite, sweeping compound);
- ion exchange resins;
- reactor core components;
- retube materials;
- paper;
- plastic;
- rubber;
- wood; and
- organic liquids.

H.3.3 Historic Waste

Historic waste is defined as low-level radioactive waste that was managed in the past in a manner no longer considered acceptable for which the original producer cannot reasonably be held responsible or no longer exists, and for which the federal government has accepted responsibility. Typically, these wastes are either consolidated and managed in above-ground mounds, or drummed and consolidated at a central storage facility, or managed and monitored in situ.

H.3.4 Radioisotope Production and Use Waste

Radioisotope production and use generate a variety of radionuclides for commercial use, such as cobalt-60 for sterilization and cancer therapy units and molybedenum-99 or other isotopes for use as tracers for medical research, diagnoses, and therapy. A number of waste management facilities process and manage the wastes that result from the use of radioisotopes for research and medicine. In general, these facilities collect and package waste for shipment to approved storage sites. In some cases, the waste is incinerated or allowed to decay to insignificant radioactivity levels, then discharged into the municipal sewer system or municipal garbage system.

H.3.5 Uranium Mining and Milling Waste

After ore is removed from the ground, either by underground mining or from an open pit, it is milled. The milling process, in which the ore is crushed and treated with chemicals, extracts the ore's uranium content, leaving a waste product known as mill tailings.

Waste rock ranges from benign material devoid of the metal or mineral being sought, to mineralized material that contains sub-economical concentrations of the metal or mineral being extracted.

Although having a common objective, the method used for the management of tailings from uranium mine operations varies from mine to mine. Much depends on where the mine is located. The quantity of tailings produced at any uranium mine is determined by the grade of the ore as well as the size of the deposit. Canada's operating mines (all in northern Saskatchewan) have high-grade ore deposits, and as such smaller volumes of tailings are being produced in comparison to historic mining operations in Canada.

Different mines use different chemicals, chemical concentrates or mixtures of chemicals in the milling process due to varying mineralogy. As a result, tailings vary in composition from mine to mine.

Tailings management facilities have evolved over the decades from simple deposition into natural landforms and lakes to the construction of surface storage facilities complete with seepage collection systems and finally to the current practice of placing the tailings in mined-out pits. Tailings in modern facilities are covered with water to avoid winter freezing problems and to reduce tailings segregation during deposition.

The volume of water that is generated from mining and milling processes is too large to be stored indefinitely. The water discharged from uranium mines and mills in Canada is monitored to ensure that it meets regulatory standards prescribed by the Canadian government. These limits ensure that the impact on the environment is minimal.

Waste rock characteristics are highly variable. Some waste rock contains sufficient concentrations of sulphur minerals to generate moderate levels of acidity, which can mobilize secondary contamination. In Saskatchewan, some waste rock contains secondary arsenic and nickel minerals, often to the point that it is the long-term care and control of these non-radioactive contaminants that drive the level of care needed to manage the waste rock, not its radioactivity.

H.3.6 Radioactive Waste at Research Reactors

Radioactive waste materials at all research reactors are segregated by licensees into short-lived and long-lived radioactive waste. Short-lived radioactive wastes are stored on site to allow for decay until they can be disposed of in a conventional manner. The long-lived radioactive wastes are kept on site temporarily until a certain amount or volume is accumulated; thereafter they are transported to CRL for storage. This is also the case for TRIUMF (TriUniversity Meson Facility) radioactive waste.

Liquid wastes from research reactors mostly consist of water that contains radioactive contamination. Typically, the water is cleaned up through a water purification system that would include filtration and ion exchange. Once ion exchange resins are used up they are stored with the long-lived radioactive waste that is eventually sent to CRL. At the TRIUMF (accelerator), there is also a small amount of contaminated oil produced annually from oil used in the vacuum pumps. All of this slightly contaminated oil (approximately 2 litres per year) is presently stored on site. Waste management at the CRL research site is described in detail in Annex 4.

H.4 Waste Minimization

The practice of waste minimization in Canada is currently not a regulatory requirement. It should however be noted that one of the key principles of CNSC Regulatory Policy P-290, *Managing Radioactive Waste,* is that the generation of radioactive waste should be minimized to the extent practicable by the implementation of design measures and operating and decommissioning practices. Regulatory Policy P-290 is presented in subsection B.5.

The only regulatory requirement is that the facility must be operated safely and provide adequate protection for the safety of humans and the environment. However, the Canadian nuclear industry actively promotes and practices waste minimization. For example, OPG policy is to minimize the production of radioactive waste at source by preventing materials from unnecessarily becoming radioactive. The Canadian nuclear industry practices waste minimization by:

- implementing material control procedures to prevent materials from unnecessarily entering into radioactive areas;
- implementing enhanced waste monitoring capabilities to reduce inclusion of non-radioactive wastes in radioactive wastes;
- implementing improvements to waste handling facilities; and
- enhancing employee training and awareness

H.5 General Safety Requirements

The main objective in the regulation of either a spent fuel dry storage facility or a radioactive waste management facility is to ensure that these facilities and their activities do not pose unreasonable risk to health, safety, security and the environment. Canada's comprehensive licensing system, described in detail in subsection 5.5, does not differentiate between a spent fuel management facility and a radioactive waste management facility. The design, construction, and operation of either facility must ensure the safety of human health and the environment.

H.5.1 Protection and Safety Fundamentals

The regulation of spent fuel and radioactive waste can be divided into generic performance requirements, generic design and operational principles, and performance criteria. These criteria are described in subsection 7.8.

It is worthwhile noting that the uranium mine and mills that are governed by the same principles as those for spent fuel or radioactive waste are also governed by the *Uranium Mines and Mills Regulations*.

H.5.2 Safety Requirements

Safety requirements for the management of spent fuel and radioactive waste must provide for the protection of the environment and the health and safety of workers and the public. During normal operations, spent fuel and radioactive waste management facilities must be operated in a safe manner. System components that may require periodic maintenance must be readily accessible and designed to permit safe and efficient maintenance. The safety requirements are described in detail in subsection 7.8.

H.6 Protection of Existing Facilities

The safety of radioactive waste management facilities which existed at the time the Joint Convention entered into force was ensured through the Canadian regulatory regime. The operation of radioactive waste management facilities must be conducted in accordance with the NSCA, associated regulations, and the licence conditions. The CNSC compliance program activities verify that operators comply with the requirements for safe operation of radioactive waste management facilities.

H.6.1 Past Practices

The results of past practices, such as in-ground burial, are continuously under review by the CNSC. The CNSC ensures that Environmental Risk Assessments are performed to determine the potential impact these facilities have on the environment. Progress in this area is proceeding. CNSC staff's 2005 mid-term report for the CRL site indicated that an Environmental Effects Review demonstrated that the risk to the environment at CRL is predominately low.

H.7 Protection in the Siting of Proposed Facilities

The *Class I Nuclear Facilities Regulations* stipulate a life-cycle licensing approach for radioactive waste management facilities. This includes:

- a site preparation licence;
- a construction licence;
- an operating licence;
- a decommissioning licence; and
- an abandonment licence.

The *General Nuclear Safety and Control Regulations*, *Nuclear Security Regulations*, *Radiation Protection Regulations*, and *Nuclear Substance and Radiation Devices Regulations* also have requirements that must be met.

Requirements for a licence to site a Class I radioactive waste management facility are listed in Section 3 and 4 of the *Class I Nuclear Facilities Regulations*. Note that additional information is also required by Section 3 of the *General Nuclear Safety and Control Regulations*.

At the time this report was written, there were no existing contracting parties that could be affected by the siting of a nuclear facility in Canada. However, the United States and Canada have a Nuclear Cooperation Agreement that was concluded in 1955. Article 2 of that agreement provides for the exchange of "classified and unclassified information, etc., with respect to the application of atomic energy for peaceful uses, including research and development relating thereto, and including problems of health and safety." Article 2 also covers the entire field of health and safety as related to this Joint Convention.

H.8 Design, Construction and Assessment of Facilities

The second formal licensing step for nuclear facilities, including radioactive waste management facilities, is the construction licence. Requirements for a licence to construct a Class I nuclear facility are listed in section 3 and 5 of the *Class I Nuclear Facilities Regulations*. Note that additional information is also required by Section 3 of the *General Nuclear Safety and Control Regulations*.

H.9 Operation of Facilities

The third step in the licensing process is the operating licence. Requirements to operate a Class I nuclear facility are listed in Section 3 and 6 of the *Class I Nuclear Facilities Regulations*. Additional information indicated in Section 3 of the *General Nuclear Safety and Control Regulations* and Section 3 of the *Class I Nuclear Facilities Regulations* is also required. The required information includes such items as safety analysis report, commissioning program, the

measures to prevent or mitigate releases of nuclear substances and hazardous substances to the environment, and a preliminary decommissioning plan.
As a requirement of a licence to operate, the licensee is also required to keep a record of:

- the results of effluent and environmental monitoring programs;
- the operating and maintenance procedures;
- the results of the commissioning program;
- the results of the inspection and maintenance programs;
- the nature and amount of radiation, nuclear substances, and hazardous substances within the nuclear facility; and
- the status of each worker's qualifications, re-qualification, and training.

H.9.1 Criticality Safety

Criticality safety requirements must address both normal and abnormal conditions. Criticality safety analyses must be performed when significant quantities of special fissionable materials are stored or handled. When nuclear waste containing significant quantities of special fissionable materials is stored or handled, a criticality analysis must be performed. The analysis must clearly demonstrate that the storage and handling of the nuclear waste is safe; that is, inadvertent criticality cannot occur under normal or credible abnormal conditions.

H.10 Institutional Measures after Closure

Canada does not currently have a disposal facility in operation. Closed tailings facilities at shutdown mine sites represent long-term waste management facilities. Tailings facilities at operating mines have been designed or will be upgraded to function as long-term waste management facilities. Long-term management, including monitoring and maintenance programs, is being carried out to ensure the protection of the environment and human health and safety.

There are two ways the word "disposal" is used in Canada with respect to radioactive waste. In terms of a disposal facility, disposal means that the radioactive waste is disposed of in a manner in which there is no intent to retrieve material and further human intervention (surveillance and monitoring) is not required.

The other way disposal is used in Canada is in the context where, due to past practices, radioactive waste was disposed of directly into the ground. Although there is currently no intent to retrieve this material, surveillance and monitoring is still required.

Any proposal for the siting, construction, and operation of a disposal facility must satisfy the requirements of the NSCA and associated regulations.

H.11 Monitoring Programs

Each radioactive waste management facility in Canada must have in place an approved monitoring program. The monitoring program for a waste management facility must be able to detect any unsafe condition or degradation of structures, systems, and components that could result in an unsafe condition. It is the means by which the performance of the individual storage structures, as well as the entire waste storage system, is evaluated with respect to established safety criteria and standards related to potential human health and safety as well as to non-human biota and the physical environment.

A typical monitoring program for a radioactive waste management facility, including a uranium mine tailings area, may include the following elements:

- gamma radiation monitoring;
- effluent monitoring including airborne and liquid emissions;
- environmental monitoring program which may include water quality, soil sampling, sediment sampling and fish sampling; and
- surface water and groundwater monitoring.

SECTION I

I. TRANSBOUNDARY MOVEMENT

I.1 Scope of the Section

This section addresses **Article 27 (Transboundary Movement)** of the Joint Convention, and provides information on Canada's experience and practices pertaining to the transboundary movement of radioactive material. The information in this section demonstrates that such movements are undertaken in a manner consistent with the provisions of the Joint Convention and relevant binding international instruments.

I.2 Introduction

Canadian laws and regulations that are used to control imports and exports in support of Canada's bilateral and multilateral agreements are as follows:

- *Nuclear Safety and Control Act* and the associated *Nuclear Non-Proliferation Import and Export Control Regulations*;
- *Canadian Environmental Protection Act* and the associated *Export and Import of Hazardous Wastes Regulations*; and
- *Export and Import Permits Act*.

The NSCA deals specifically with nuclear substances, while the other acts and regulations are more generic and deal with other proliferation and environmentally-significant substances.

I.3 Controlled Substances

Licences issued by the CNSC stipulate limitations that are placed on the licensee importing and exporting the nuclear substances which they are authorized to possess.

The *Export and Import Permits Act* and the NSCA list substances that require authorization to be legally exported from Canada and have no *de minimus* quantities. These lists and regulations are administered by International Trade Canada (ITC) under the *Export and Import Permits Act* and the CNSC under the NSCA.

The list consists of the following nuclear materials and radioisotopes, considered significant for nuclear weapons proliferation and, in accordance with the NSCA, are referred to as "controlled nuclear substances":

- Plutonium;
- Uranium depleted in U-235;

- Thorium;
- Tritium;
- Radium-226 (greater than 370 MBq);
- Uranium-233 and Uranium-235, or material containing either isotope;
- Alpha-emitting radioisotopes with a half-life of 10 days or greater, but less than 200 years, with a total alpha activity of 37 GBq/kg or greater (with the exception of material with less than 3.7 GBq of total alpha activity); and
- Fresh and spent nuclear reactor fuel, including uranium ore concentrate.

A sealed source of a radioisotope not contained in the list above that has been designated as surplus waste may not necessarily require a specific licence to export. However, under current Canadian regulations, the licence must authorize export or import activities; otherwise, a formal authorization granted by the regulatory body to export or import must be obtained.

I.4 Exporting State

The CNSC and ITC have adopted a one-door approach for submitting an application for the export authorizations required under the *Nuclear Non-Proliferation Import and Export Control Regulations* and the *Export and Import Permits Act* for substances listed in subsection I.3. The application for a permit is provided to ITC four to six weeks before the scheduled export in order to allow sufficient time to process, consult intra- and inter-departmentally, and issues both the CNSC licence and the ITC export permit. The ITC provides a copy of the permit application immediately to the CNSC which then performs an evaluation for a licensing decision. It is important to note that both the permit and licence application evaluations are performed independently and in parallel with each other.

A substance would be made subject to a Nuclear Cooperation Agreement (NCA) if it is intended for nuclear use which means for all practical purposes, for use in a nuclear reactor. Of the substances listed in section I.3, only uranium, plutonium and thorium would be made subject to an NCA. Deuterium and heavy water, along with nuclear grade graphite, which are also controlled nuclear substances under the NSCA but not listed in section I.3, could also be subject to an NCA if for use in a reactor.

It is policy that Canada holds NCAs with any country to which nuclear substances, equipment and technology may be exported for nuclear use, so that there may be appropriate binding undertakings that these materials will be used for peaceful, non-explosive purposes. Note that substances can be exported outside of Canada to countries with which Canada does not have an NCA, so long as the substances are for non-nuclear use. Canada also imports substances from countries with which we may have not have a NCAs.

Typically, the exporting country is required to produce a prior notification to the Importing State if, and only if, the Shipping State wishes to make the material subject to a NCA. Often, a notification of shipment is also expected by the Importing State, allowing it the opportunity to make necessary preparations. These notifications are typically transmitted directly between governmental authorities via established information channels dictated by administrative arrangements negotiated in support of the applicable NCA. In Canada, the CNSC is responsible for transmitting prior notifications.

I.5 State of Destination

Possession licences issued by the CNSC specify the nuclear substance(s) that the licensee is authorized to hold. These possession licences also authorize certain types and maximum quantities of nuclear substances to be imported without additional authorizations. For cases of import of substances described in subsection I.3, specific authorization must be obtained. This authorization entails the verification that the applicant holds the necessary possession licences in place to receive and properly handle the nuclear substance. If the applicant does not hold the necessary licence, the applicant would be notified of the requirements to hold the substance shown in the application.

The Canada Border Services Agency (CBSA) assists the CNSC in administering the *Nuclear Non-Proliferation Import and Export Control Regulations*. A valid CNSC licence must be presented to a customs officer for nuclear substance items which are imported or exported. If a valid licence is not available, the movement of the material is not allowed.

I.6 Destination South of Latitude 60 Degrees

Antarctica is the only land mass south of 60 degrees latitude in the southern hemisphere as defined under the *Antarctic Treaty (1959)*. Seven states currently claim unofficial “sovereignty rights” to portions of Antarctica. Canada is not one of the seven states. The procedures for ensuring that radioactive material not be transferred to Antarctica are the same as for other destinations. In addition, this international obligation was incorporated under Canadian national law through the *Canadian Environmental Protection Act*.

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SECTION J

J. DISUSED SEALED SOURCES

J.1 Scope of the Section

This section addresses **Article 28 (Disused Sealed Sources)** of the Joint Convention. Under **Article 28** of the Joint Convention, two requirements must be addressed:

1. Each Contracting Body shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.

2. A Contracting Party shall allow for the re-entry into its territory of disused sealed sources if, in the framework of its national laws, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

J.2 Introduction

Radioisotopes, as sealed or unsealed sources, have industrial, medical, and educational applications. Typical users of sealed sources include universities, hospitals, research organizations, government departments, and a wide variety of large and small industries.

In Canada sealed sources are individually licensed and their use is carefully controlled. Most sealed sources are physically small, though their radioactivity ranges from a few tens to billions of Bq. Once they are no longer useful in their industrial, medical, or research application, sealed sources must be stored, managed, serviced recycled or disposed of. In addition, substantial shielding is often required, which may substantially increase the size of the shipping/storage package.

J.3 Regulatory Authority

A sealed source, as defined in the *Nuclear Substances and Radiation Devices Regulations,* means a radioactive nuclear substance in a sealed capsule or in a cover to which the substance is bonded, where the capsule or cover is strong enough to prevent contact with or the dispersion of the substance under the conditions for which the capsule or cover is designed.

In accordance with Canadian regulatory requirements, a licence is required to possess, transfer, import, export, use, abandon, produce, or service a sealed source. However a licence is not required for the above activities if the sealed source contains less than the exempted quantity of a nuclear substance, and if not more than 10 such sealed sources are possessed by an individual in any calendar year.

The *Nuclear Substances and Radiation Devices Regulations* specify the information required in an application for a licence to import, export, use, abandon, produce, or service a sealed source. However, it should be noted that a particular group of isotopes and activity levels would require a specific import or export licence. This information does not apply with respect to an application for a licence to import or export controlled nuclear substances (for which the information requirements are prescribed by the *Nuclear Non-Proliferation Import and Export Control Regulations*), or with respect to an application for a licence to transport while in transit (for which the information requirements are prescribed by the *Packaging and Transport of Nuclear Substances Regulations*).

J.4 Sealed Sources Used in Canada

Through Canada's regulatory control program, activities involving sealed sources must be licensed by the CNSC. Each licence specifies the isotope and the maximum quantity in Bq of each sealed source.

J.4.1 Disposal of Sealed Sources in Canada

A sealed source may only be transferred, in accordance with a licence or written instructions issued by the CNSC, to the following individuals:

- the manufacturer;
- an approved waste management facility; or
- a person authorized to possess the sealed source.

Once a sealed source is no longer useful, it is shipped directly, or through collection firms or brokerage firms, to a waste management facility or to their state of origin. On arrival at the waste management facility, the sources are often removed from their over-pack and placed for long-term storage in concrete or other approved storage containers.

J.4.2 Sealed Source Tracking System

The Sealed Source Tracking System (SSTS) is a system that will enable the CNSC to maintain an accurate national inventory of radioactive sealed sources as well as facilitate the tracking of all high risk (Category 1 or 2) sealed sources that are transferred.

The SSTS is in the process of being developed and will be operational by December 1, 2005. Any sources which are transferred and which are designated as trackable, namely sources of Category 1, 2 and aggregated 3 according to IAEA TECDOC 1344, will be tracked through the update of the National Sealed Source Registry. A licensee-shipper will provide data on sealed source(s) to the CNSC. Where available, the CNSC will be providing an internet tool to facilitate this process. This requirement is to be met whether the source is useful or disused.

J.4.3 Retention of Records

The *Nuclear Substances and Radiation Devices Regulations* requires every licensee to keep a record of any transfer, receipt, disposal, or abandonment of a nuclear substance, including:

- the date of the transfer, receipt, disposal, or abandonment;
- the name and address of the supplier or the recipient;
- the number of the licence of the recipient;
- the name, quantity, and form of the nuclear substance transferred, received, disposed of, or abandoned;
- where the nuclear substance is a sealed source, the model and serial number of the source; and
- where the nuclear substance is contained in a radiation device, the model and serial number of the device.

J.4.4 Safety of Sealed Sources

The requirement placed on licensees using or possessing sealed sources (pursuant to the *Nuclear Substances and Radiation Devices Regulations*) ensures that during the lifetime of a sealed source, it is possessed, transferred, imported, exported, used, abandoned, produced, or serviced in a safe manner.

Through the Compliance Verification Program (see subsection E.6), the CNSC verifies that the disposal of sealed sources is in accordance with the regulations, licence condition, or written instructions it has issued.

J.5 Sealed Sources in the International Community

The re-entry of disused sealed sources exported from Canada is permitted either by an Import Licence or in accordance with a licence condition.

SECTION K

K. PLANNED ACTIVITIES

K.1 Scope of the Section

This section provides a summary of safety issues of concern identified throughout this report, as well as planned future actions to address those issues. Where appropriate, these include measures of international co-operation.

K.2 Introduction

Canada is currently pursuing several initiatives in order to better manage the spent fuel and radioactive waste produced in Canada and to ensure the continued safety of humans, society and the environment. These initiatives include:

- developing and implementing relevant regulatory documentation;
- developing long-term management options for spent fuel and radioactive waste; and
- addressing historic and legacy issues

K.3 Development and Implementation of Relevant Regulatory Documentation

The Canadian regulatory body has currently embarked on a document improvement initiative which anticipates taking several years (approximately 4 years) to produce the needed regulatory policies, standards and guides.

To assist in this document improvement initiative, the following documents have been developed and issued for use:

1. *CNSC Regulatory Document Framework and High Priority Regulatory Documents (Revision 9)*; and
2. *"Purpose", "Scope" and "Relevant Legislation" Sections for High Priority Regulatory Documents.*

These documents can be viewed at www.nuclearsafety.gc.ca .

The high priority documents of particular interest to the safety of spent fuel management and radioactive waste management are Regulatory Policy P-290, *Managing Radioactive Waste*, draft Regulatory Guide G-320, *Assessing the Long Term Safety of Radioactive Waste Management*; and draft Regulatory Standard S-307, *Disposing of Nuclear Substances in Accordance with a Licence.*

K.3.1 Regulatory Policy P-290

The policy sets out the principles that the CNSC takes into account when making a regulatory decision concerning the management of radioactive waste. These principles are relevant to all waste management phases, practices and considerations, including the generation, handling, processing, controlled releases, storage, disposal and abandonment of radioactive waste. Further information on this policy is provided in Section B.5.

K.3.2 Draft Regulatory Guide G-320

The purpose of this regulatory guide is to guide licence applicants on assessing the long-term impacts that radioactive waste storage and disposal methods have on the environment and on the health and safety of people. Further information on this regulatory guide is provided in Section B.6.

K.3.3 Draft Regulatory Standard S-307

The purpose of this regulatory standard is to help ensure that any disposal of a nuclear substance occurs in accordance with the regulations, a licence, and the purpose of the NSCA. This standard sets out the conditions, in terms of related circumstances, pathways, concentrations, or quantities, under which a licensee may dispose of nuclear substances from their licensed activity when the regulations and a condition of the licence so permit.

K.3.4 Regulatory Policy P-299

This policy describes the principles that underlie CNSC's approach to regulating the development, production, and use of nuclear energy, the production, possession and use of nuclear substances, prescribed equipment, and prescribed information, and the implementation of measures respecting international controls on the non-proliferation of nuclear weapons and nuclear explosive devices.

K.4 Long-term Management of Spent Fuel

The NWMO began its study of long-term management approaches for used nuclear fuel in November 2002, with the passage of Canada's NFWA. Since that time, the NWMO has been undertaking broad-based public engagement and analytical programs on the management options.

In May 2005, the NWMO released its third milestone report, its Draft Study Report, entitled *Choosing a Way Forward*. In this report, the NWMO reports on its synthesis of analysis and engagement with citizens and specialists and the outcome of its comparative assessment of management approaches, and presents its Draft Recommendation.

The NWMO's Draft Recommendation is an "Adaptive Phased Management Approach" for the long-term care of Canada's used nuclear fuel.

The NWMO developed its recommendation following the input of technical specialists and engagement of more than 15,000 interested Canadians, including 2,000 Aboriginal people. The NWMO engaged Canadians in a wide-ranging dialogue on the values, principles and objectives they believe are required of a nuclear waste management approach that is socially acceptable, environmentally responsible, technically sound and economically feasible.

Adaptive Phased Management is proposed by the NWMO as a risk management approach, comprised of:

1) A technical method:

a) Based on centralized containment and isolation of the used fuel in a deep geologic repository in suitable rock formations, possibly in the crystalline rock of the Canadian Shield or other formations such as sedimentary rock, at a nominal depth of 500 to 1,000 metres below surface;

b) Provision for an interim step in the implementation process in the form of shallow underground storage of used fuel at the central site, prior to final placement in a deep repository; and

c) Retrievability potential of the used fuel for an extended period, until such time as a future society makes a determination on the final closure, and the appropriate form and duration of post-closure monitoring.

and

2) A management approach, of which key characteristics include:

a) Flexibility in the pace and manner of implementation through a phased decision-making process, supported by a program of continuous learning, research and development;

b) Three envisaged implementation phases, lasting up to 300 years or more, during which the waste would be monitored and remain retrievable;

c) Continuous monitoring of the used fuel to support data collection and confirmation of the safety and performance of the repository;

d) Financial surety through funding by the nuclear energy corporations (currently Ontario Power Generation Inc., Hydro-Québec and New Brunswick Power Nuclear) and AECL, according to a financial formula as required by the NFWA;

e) Site selection focused on provinces which currently benefit from the nuclear fuel cycle; Saskatchewan, Ontario, Quebec and New Brunswick – although communities in other regions would not be denied the opportunity to be considered; and

f) Siting with the intent of seeking a willing community to host the central facilities. The site must meet the scientific and technical criteria chosen to ensure that multiple engineered and natural barriers will protect human beings, other life forms and the biosphere.

A definitive design, site selection and implementation timetable would be developed following a government decision. The following is an illustrative conceptual description of how Adaptive Phased Management might unfold:

- During Phase I, a period of approximately 30 years, used fuel would remain safely managed at nuclear reactor sites. During this initial phase, working collaboratively with interested citizens, the goals would be to site a centralized facility and build an underground research laboratory to confirm suitability of the site and the technology for a deep repository. A decision would also be taken on whether to build an interim shallow underground storage facility at the same site.

- Throughout Phase II, the program of research and demonstration would continue. Depending on societal direction, used fuel could be moved to the central site for interim storage during the second thirty-year phase.

- In Phase III, used fuel would be transferred from interim storage, re-packaged into long-lived containers, and placed in the deep repository. This is expected to begin during the sixtieth year of the implementation schedule. During Phase III, future generations would decide when to close the repository and what kind of post-closure monitoring would be required.

Adaptive Phased Management is estimated to have cost $24.4 billion (2002). Consistent with the NFWA, nuclear energy owners have begun contributing to trust funds to ensure money will be available for the long-term nuclear waste management approach chosen.

The NWMO would implement this comprehensive approach in compliance with the NFWA. All applicable regulatory standards and licensing requirements of the CNSC and other national and international oversight bodies would be met or exceeded at every stage to protect the health, safety and security of humans and the environment.

In proposing implementation plans, the NWMO has placed an emphasis on the need to respect the social, cultural and economic aspirations of the affected communities. As the implementing agency, the NWMO would seek to sustain the engagement of people and communities throughout the phased processes of decision and implementation. The organization would ensure that implementation is guided by advances in technology, natural and social science research, traditional Aboriginal knowledge, and societal values and expectations.

This recommendation follows on NWMO's comparative assessment of the benefits, risks and costs of the long-term management options. The NWMO developed an assessment framework for assessing the options against citizen values, ethical principles and eight objectives of: fairness, public health and safety, worker health and safety, community well-being, security, environmental integrity, economic viability, and adaptability. Ethical and social considerations were embedded throughout the analysis.

The options were subject to multiple assessment processes. A preliminary assessment of the three options in the NFWA examined the strengths and limitations of each approach through an application of multi-attribute utility analysis. In addition, extensive comparative analysis of the costs, benefits and risks of the three options in the NFWA, and the NWMO's fourth option, provided quantitative and qualitative assessment, taking into account the types of economic regions in which each approach might be implemented. The assessment processes were supported by multi-disciplinary research contributions, workshops, submissions from Canadians, and guidance on values and ethical principles from citizens, Aboriginal traditional knowledge and the NWMO's Roundtable on Ethics.

The NWMO study process began by considering a range of management options that had been considered internationally in recent years. Following this review and screening, the NWMO selected as the basis for its initial assessment the three methods specified in the NFWA: Deep Geological Disposal in the Canadian Shield (modified AECL concept); storage at nuclear reactor sites; and centralized storage, above or below ground. From the insights of the NWMO's analysis and dialogues with Canadians, the NWMO has proposed a fourth option, Adaptive Phased Management, which it believes would best meet the objectives and expectations of Canadians.

The NWMO's recommended approach, Adaptive Phased Management, has been designed to build upon the advantages of each of the other three approaches studied. The NWMO believes that its recommendation performs well against its primary objectives of safety - the protection of humans and the environment, and fairness - for this and future generations.

The full Draft Study Report*, Choosing a Way Forward,* with the detailed recommendation and all of NWMO's supporting assessment findings and research, is available at www.nwmo.ca

The NWMO has sought to propose a path for a risk management approach that is comprised of deliberate stages and periodic decision points.

- It commits this generation of Canadians to take the first steps to manage the used nuclear fuel we have created;
- It will meet rigorous safety and security standards through its design and process;
- It allows sequential decision-making, providing the flexibility to adapt to experience and societal change;
- It provides genuine choice by taking a financially conservative approach, and by providing for capacity to be transferred from one generation to the next;
- It promotes continuous learning, allowing for improvements in operations and design that would enhance performance and reduce uncertainties;
- It provides a viable, safe and secure long-term storage capability, with the potential for retrievability of waste, which can be exercised until future generations have confidence to close the facility; and

- It is rooted in values and ethics and engages citizens, allowing for societal judgments as to whether there is sufficient certainty to proceed with each following step.

The NWMO has published its recommendations in draft for comment and review. The proposal will be the subject of further public dialogue before the Organization finalizes and submits its study report to the Minister of Natural Resources in November 2005. On behalf of the Minister, the Nuclear Fuel Waste Bureau (www.nfwbureau.gc.ca) within NRCan will manage a government-wide review to develop a recommendation for a Governor-in-Council decision, expected in 2006.

K.5 Long-term Management of Low-Level Radioactive Waste

All Canadian low-level radioactive waste is currently in storage. There are no low-level radioactive waste disposal facilities under construction or operation in Canada. Although many other countries have put disposal facilities into service, there has been no pressing need in Canada for early disposal since the radioactive waste is being safely stored on an interim basis. However the continued indefinite interim storage of low-level radioactive waste is not a desirable solution—not only for the current generation but for future generations.

According to the *Radioactive Waste Policy Framework*, waste producers and owners are responsible for the funding, organization, management, and operation of disposal facilities and other facilities required for their wastes. This recognizes that arrangements may be different for nuclear fuel waste, low-level radioactive waste, and uranium mine and mill tailings. The CNSC is responsible for ensuring that the disposal of radioactive waste does not pose undue risks to workers, members of the public, or the environment. Applications for the siting, construction and operation of long-term waste management facilities will be reviewed by the CNSC according to health, safety, and environmental criteria. The following initiatives described below are currently underway in Canada to address the long-term management of low-level radioactive waste.

K.5.1 The Port Hope Area Initiative

The bulk of Canada's low-level radioactive waste is in the form of contaminated land sites, including two closed waste management facilities, in the Port Hope area of Eastern Ontario. This contamination resulted from the operation of a refinery in Port Hope that began in the 1930s. The facility was first used to refine pitchblende ore for radium for medical purposes. Later, the uranium was used for military purposes and then for the production of nuclear fuel.

The results of these operations were extensive contamination at two licensed waste management facilities as well as unlicensed sites – see Annex 8.1.6.1.4 for further details. The problem of low-level radioactive contamination in the town was first discovered in 1974 and the nuclear regulator moved quickly to remove the most serious contamination from the area.

While there is no urgent health or environmental risks, a large amount of material − an estimated 500,000 m^3 in low-level radioactive waste and mildly contaminated soil − remain in the community. Further, waste management problems were also discovered at the two waste management facilities, estimated to contain an additional 1,150,000 m^3 of contaminated material.

The Port Hope Area Initiative (PHAI) is a process the Government of Canada is using to resolve the long standing problem of radioactive waste contamination in the Port Hope Area. The Legal Agreement, establishing the process, was signed by the government and local municipalities on March 29, 2001. It is based on conceptual designs submitted by the communities and is the result of extensive negotiations and consultation.

The initiative has been divided into two projects, along municipal boundaries:

- The Port Hope Project entails the cleanup and long-term management of wastes from various contaminated sites in the Municipality of Port Hope.
- The Port Granby Project entails the long-term management of radioactive wastes and contaminated soils at the existing Port Granby facility in the Municipality of Clarington.

The $260 million, 12-year initiative includes an environmental assessment (EA) and regulatory review phase, an implementation phase, and a long-term monitoring phase.

The PHAI is well into the EA process. Baseline environmental characterization studies, begun in 2002-2003, have been completed. Using the EA process as a planning and consultation tool, alternative means of carrying out each project have been assessed and, with participation of the public, the most highly qualified concept recommended to each municipality.

- For the Port Hope Project, this involves the consolidation of all historic wastes in the Municipality of Port Hope at one long-term waste management facility (WMF) at the present site of the existing Welcome WMF. This option requires an amendment to the Legal Agreement.

- For the Port Granby Project, the option involves the relocation of the existing Port Granby wastes to a new above-ground long-term WMF to be located at a nearby site, north of the current site and away from the Lake Ontario shoreline.

In 2004-2005, with the concurrence of each municipality, detailed EAs were carried out on the recommended option and an Environmental Assessment Study Report (EASR) was drafted for each project. As required by the Legal Agreement, written municipal consent is required before the reports may be submitted to the federal government for review.

- For the Port Hope Project, municipal consent was received in early 2005 and the federal review process began in May, 2005.
- For the Port Granby Project, additional information, as requested by the Municipality of Clarington, is being incorporated into the EASR. As such, Clarington's consent to the Port Granby Project is not expected until mid 2005/06, whereupon the EASR may then be submitted to federal decision makers.

Further information on the EA may be found at http://nuclear.nrcan.gc.ca under "What's New". Also, as required under the *Canadian Environmental Assessment Act (*CEAA), all public records produced by, collected by, or submitted to the federal responsible authorities (NRCan, CNSC, and Fisheries and Oceans) with respect to the EA are in a public registry maintained by NRCan.

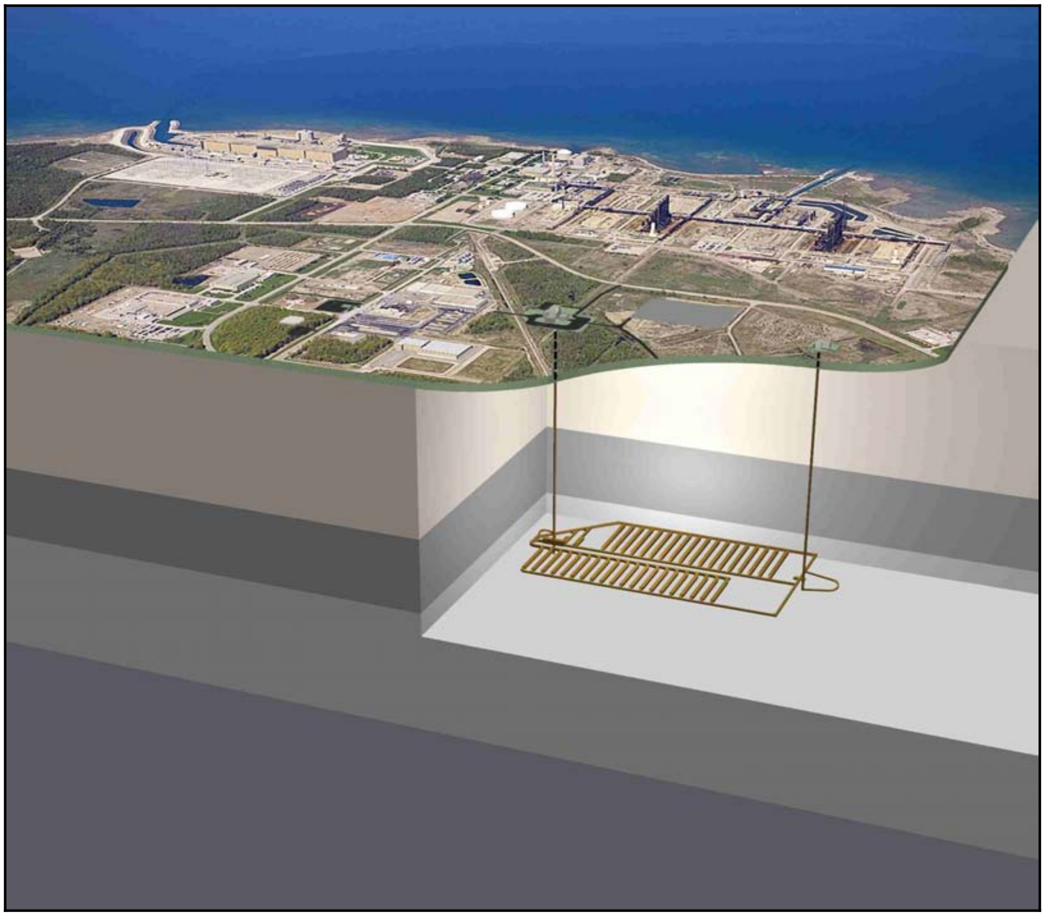
The responsible federal authorities will review the completeness and technical soundness of the reports with the assistance of technical specialists from other federal departments and provincial ministries. Once satisfied, they will prepare screening reports under the CEAA which will contain their conclusions on the assessment. The public review period for these screening reports is expected to move the federal EA decision making process into 2006-2007.

K.5.2 Proposed Low- and Intermediate-Level Waste Deep Geologic Repository at OPG's Western Management Facility

OPG has recognized that while its current approach to radioactive waste management is safe, secure and environmentally responsible, in the long-term, new approaches will be required. A long-term management approach will ensure that the waste can be kept isolated from the environment in the long term without burdening future generations with the caretaking of the waste.

The Municipality of Kincardine currently hosts OPG's Western Waste Management Facility (WWMF), which is the centralized storage site for low- and intermediate-level radioactive waste (L&ILW) arising from the operation of the 20 OPG-owned reactors in Ontario. OPG has safely managed L&ILW for the Pickering, Darlington and Bruce reactors at the Bruce site for 30 years. Currently, an estimated 65,000 m^3 is in storage. Emissions from the facility have been less than one per cent of the regulatory limit throughout the life of the facility.

Figure K.1 -Artist's concept of the Deep Geologic Repository



The concept for the Deep Geologic Repository (DGR) at the Bruce Nuclear site was developed following a request by the Municipality of Kincardine to explore jointly with OPG options within the municipality for the long-term management of L&ILW.

Under the terms of a Memorandum of Understanding, OPG and Kincardine engaged a consulting firm to conduct an Independent Assessment Study (IAS) of the geotechnical feasibility, safety, social and economic feasibility, and potential environmental effects of a proposed long-term management facility at the WWMF.

Three options were studied: enhanced processing and storage, covered above-ground concrete vault, and 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. If implemented, this option would result in expenditures of approximately $800 million. The study report can be accessed at www.opg.com/ops/NwasteIAS1.asp .

In April 2004, Kincardine Council passed a resolution to: "endorse the opinion of the Nuclear Waste Steering Committee and select the "Deep Rock Vault" option as the preferred course of study in regards to the management of low- and intermediate-level radioactive waste" because it had the highest margin of safety and is consistent with best international practice. Other considerations were that:

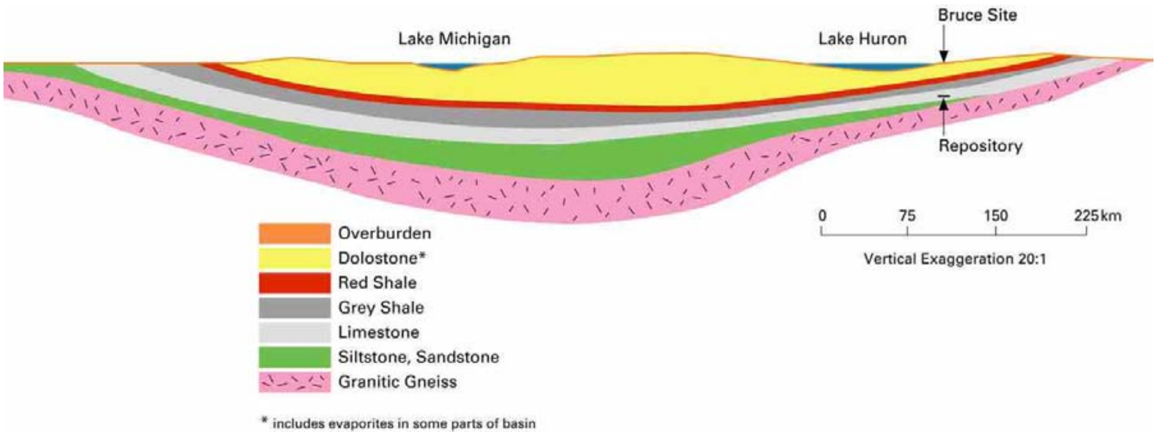
- The DGR concept provides the highest level of safety of any option.
- There will be a rigorous EA and the CNSC regulatory process includes opportunities for public input before construction is approved.
- The DGR will permanently isolate the L&ILW stream, much of which is already stored on site.
- It provides significant economic benefit to the residents of the municipality.
- No high level waste or used nuclear fuel would be allowed in the facility.

The DGR involves the construction of rock vaults within stable, low permeability bedrock using conventional mining techniques. Support buildings would be located on ground surface above the underground workings. Access to the repository would be through a vertical, concrete-lined shaft. A second shaft would be constructed for ventilation and emergency egress purposes. The underground repository would initially consist of a number of caverns or vaults arranged in parallel rows on either side of central access tunnels. A concrete floor would be poured to provide a stable base for stacking of the waste packages. The repository would have a modular design that would allow vaults to be added, as required, to meet OPG's L&ILW disposal needs.

The DGR concept takes advantage of the site-specific geologic conditions beneath the Bruce nuclear site to assure isolation of the L&ILW and protection of ground and surface water resources for many tens of thousands of years, if not longer. In particular, the DGR would be positioned at a depth of 660 metres in relatively flat-lying sedimentary rock formations that have remained tectonically stable and undeformed for hundreds of millions of years.

Further information related to the predictable nature of the bedrock formation stratigraphy or layering, the extremely low permeabilities and saline pore fluids (3-6 times seawater) in the bedrock formations that enclose the proposed DGR, and a geologic setting seismically comparable to the Canadian Shield, all provide evidence of an extremely stable and ancient groundwater flow system (i.e. migration rates 1 mm/year or less). A geologic setting such as this, as is being confirmed internationally, provides favourable characteristics for the safe long-term implementation of the DGR concept. Further information on the geologic conditions and safety of the DGR concept is available at www.opg.com/dgr.

Figure K.2 - Michigan Basin Geology



Following the Council resolution, Kincardine and OPG began to negotiate terms for a hosting agreement. Hosting agreements have been used in a number of jurisdictions in Canada and internationally for communities which support the location of a long-term waste management facility. The model for this agreement is the Port Hope agreement which was negotiated between the federal government and the communities of Port Hope, Hope Township, and Clarington. The Port Hope agreement was negotiated for the long-term storage of more than one million cubic metres of historic radioactive waste, currently existing in the communities.

The Kincardine Hosting Agreement was signed on October 13, 2004. It sets out the terms and conditions under which the project would proceed.

From mid-October 2004 to mid-January 2005, Kincardine, assisted by OPG, undertook a public dialogue on the DGR proposal. In particular an independent consultant undertook a community consultation, consisting of telephoning each residence in Kincardine during the first three weeks of January 2005 to determine the level of community support. The telephone calls were followed up with a mail out. The results of the poll were announced at the Kincardine Council Meeting on February 16, 2005 and were as follows:

- 60% in favour
- 22 % against
- 13 % neutral
- 5 % don't know/refused to answer

Seventy-two per cent of eligible residents participated in the telephone poll − a participation rate which is much higher than most municipal elections. Based on the results of the poll, OPG intends to proceed with the development of plans for the proposed DGR.

The proposed DGR will be subject to a lengthy regulatory review process. This process is expected to take six to eight years. The regulatory approvals process would include preparing an EA, completing site characterization and safety assessment studies, and obtaining a construction licence before construction could begin in 2013. These activities will provide additional opportunities for the public to receive information about the proposed project and to provide feedback on it.

K.5.3 Long-Term Strategy to Decommission Chalk River Laboratories

In March 2005, AECL has recently submitted to the CNSC a long-term, 70-year strategy for the decommissioning and site restoration of its CRL site that includes the construction of the infrastructure required to characterize, treat, store and dispose of all of AECL's low-level radioactive waste. In particular, a Shallow Rock Cavern is envisioned for the disposal of all of AECL's low-level radioactive wastes. Assuming the CNSC finds the strategy acceptable, the Government of Canada will consider how best to implement it. The strategy commences with a 5-year start-up phase involving public consultation, field studies and design work to inform the refinement and finalization of the strategy.

K.5.3.1 AECL Liquid Waste Transfer and Storage Project

AECL has initiated a project at the CRL cited as the Liquid Waste Transfer Storage (LWTS) Project which is part of the Stored Liquid Waste Remediation Project. The LWTS project will provide long-term storage in new tanks for about 280 m^3 of intermediate- and high-level liquid waste currently stored in 21 monitored storage tanks at CRL, including the Fissile Solution Storage Tank (FISST). The LWTS will not include any solidification of the liquid, but AECL's long-term strategy is to convert the liquid into a solid form suitable for long-term management in a storage or disposal facility.

The liquid waste has accumulated over a 50-year period from AECL's medical radioisotope program, fuel processing program, decontamination of test loops in CRL's research reactors, and regeneration of ion exchange resins used to purify water in fuel storage bays at CRL's research reactors. Except for waste streams from the radioisotope program, generation of such wastes has stopped.

The LWTS objectives are as follows:

1. to consolidate the waste from the existing tanks into a storage system that meets current standards for design and construction and that has improved systems for waste monitoring, sampling and retrieval; and

2. to condition the contents of FISST to reduce the criticality risk and related monitoring requirements during storage.

The project is currently going through the EA process. The EA study was submitted to the CNSC on April 26, 2005.

K.6 Contaminated Lands

The Contaminated Lands Evaluation and Assessment Network (CLEAN) program was established by the Canadian regulatory body to deal with sites previously not licensed under the AECL*,* but which now require regulatory control under the NSCA. Under the CLEAN program, these new sites, previously exempted from regulatory control, are being brought under CNSC licences.

The CLEAN program consists of five primary categories of sites that include:

1. Legacy uranium tailings management areas;
2. Historic waste consolidation sites under institutional control;
3. Historic contaminated land sites resulting from past practices in the radium and uranium industries;
4. Landfills permitted by the Crown; and
5. Devices containing radium-luminescent compounds.

K.6.1 Legacy Uranium Tailings Management Areas

At the time the NSCA came into force, there were nineteen tailings management sites resulting from the former operation of uranium mines in Canada that needed to be brought under regulatory control, including fourteen in Ontario, three in Saskatchewan, and two in the Northwest Territories. Of these, fifteen are now licensed and licence applications (or letters of intent) have been received for another two (Bicroft Tailings Management Site and Port Radium). The two other sites (Gunnar and Lorado) are currently being managed safely while negotiations are underway for licensing and long-term ownership/management of the site.

K.6.2 Historic Waste Consolidation Sites under Institutional Control

There are five sites where historic wastes have been consolidated and placed under institutional control. These engineered consolidation mounds are located in Fort McMurray (Alberta), Tulita (NWT), Fort Smith (Northwest Territories), and the Passmore and Lakeshore Road Mound sites in Toronto (Ontario). The Toronto Regional Conservation Authority has submitted a letter of intent to license the Lakeshore Road Storage Mound. The remaining four mounds are monitored and maintained by the Crown.

The Deloro Mine Site, a contaminated land site in Eastern Ontario, is undergoing an Environmental Assessment Process and will be remediated under a CNSC licence. The proponent, the Ontario Ministry of Environment is conducting activities leading to the development of the Environmental Assessment Study Report that is required by the environmental study guidelines approved by the Commission on September 26, 2003.

K.6.3 Historic contaminated land sites resulting from past practices in the radium and uranium industries

Several other historical uranium contaminated land sites in northern Canada have been identified and placed under institutional control to ensure public and environmental safety. These are generally small sites with small volumes of slightly radioactive material. A detailed characterization study was conducted in 2003 on ten sites along the Great Bear River. Only two of these ten sites require the maintenance of institutional controls by the Sahtu Land and Water Board, and Indian and Northern Affairs Canada. Similar characterization studies are being conducted on six sites in the South Slave area.

Seven historic radium contaminated sites in the Toronto area are also being cared for under institutional controls to help ensure public and environmental safety.

K.6.4 Landfills

Beginning January 1, 2005, an indefinite exemption from CNSC licensing for the possession, management and storage of nuclear substances was granted by the CNSC for federally and provincially permitted landfill sites receiving nuclear substances which have been or will be legally released from CNSC licensed facilities. The exemption was based on the safety case that these materials are present in extremely small concentrations, and have been found to pose virtually no hazard to either the public or the environment. In addition, the CNSC concluded that there are sufficient municipal and provincial regulatory measures in place, to identify and address any potential risk at these sites.

K.6.5 Devices containing radium luminous compounds

The largest stockpiles of radium luminescent devices are managed appropriately by the Department of National Defence and by museums. Recognizing that there are devices that are owned by a variety of entities, a study has been completed that investigated the distribution of radium luminous devices in Canada. This information and previous documents will be used to develop risk-informed recommendations on the need and level of future regulatory control.

In the interim, to assure that the public has adequate information concerning the risk and regulatory status of these devices, the regulatory body continues to provide outreach material and information to members of the public about the existing regulatory regime and advice on how to minimize radiological risk should they posses such devices.

K.6.6 Other CLEAN program activities

Apart from licensing and compliance activities, the CLEAN program has also resulted in three workshops on regulating idle uranium mines, 10 presentations at national and international forums, and two working groups which meet regularly to discuss the regulation of contaminated lands (CanRad Waste) and historic/idle uranium mines (Canadian Uranium Regulatory Examination (CURE) Team).

The CanRad Waste group consists of members from the regulatory body, the LLRWMO and NRCan. The CURE team is composed of representative members from the following organizations:

- Saskatchewan government (Saskatchewan Environment and Saskatchewan Northern Affairs);
- Associated communities (Municipal Council of Elliot Lake (Ontario);
- Ontario government (Ministry of Northern Development and Mines);
- Industry (Cameco Corporation);
- Federal government (CNSC); and
- Observers from other interest groups also sit in on meetings.

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ANNEXES

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ANNEX 1

FEDERAL STRUCTURE

1. Introduction

Canada is a confederation, with ten provinces and three territories administered by the federal government. The provinces are self-governing in the areas of legislative power assigned to them by the Canadian Constitution, which is expressed in the *Constitution Acts* of 1867 and 1982. These areas include local commerce, working conditions, education, direct health care, energy and resources in general.

The Constitution gives the Parliament of Canada legislative power over works declared by it to be for the general advantage of Canada. The Parliament of Canada used this declaratory power in the *Atomic Energy Control Act* of 1946 and again in the *Nuclear Energy Act* of 2000 when it declared certain works and undertakings to be works for the general advantage of Canada and therefore subject to federal legislative control. Such works and undertakings are those constructed for the following purposes:

- production, use, and application of nuclear energy;
- research, or investigation, with respect to nuclear energy; and
- production, refinement or treatment of nuclear substances.

Hence, the federal government is responsible for certain aspects of nuclear energy applications that would otherwise have been under provincial jurisdiction. Examples of these aspects include:

- occupational health and safety;
- regulation of boilers and pressure vessels;
- coordination of federal response to nuclear emergencies; and
- environmental protection.

Under the Canadian Constitution, provincial laws may also apply in these areas if they are not directly related to nuclear energy and do not conflict with federal law. Because both federal and provincial laws may apply in some regulated areas, the approach taken has been to avoid duplication by seeking cooperative arrangements between the federal and provincial departments and agencies having responsibilities or expertise in these areas.

Although these cooperative arrangements have been successful in achieving industry compliance, a need exists to provide them with a firmer legal basis. The *Nuclear Safety and Control Act* (NSCA) binds both the federal and provincial governments, and the private sector. Like private companies, government departments and agencies must hold a licence from the regulatory body to perform any of the nuclear-related activities otherwise prohibited by the NSCA. In addition, the NSCA provides authority for the regulatory body and the Governor-in-Council to incorporate provincial laws by reference, and to delegate powers to the provinces in areas better regulated by them or where licensees would otherwise be subject to overlapping regulatory provisions. The major federal government organizations involved in the Canadian nuclear industry are as follows:

1.1 Natural Resources Canada

Natural Resources Canada (NRCan) is responsible for developing Canadian policy on all energy sources. NRCan provides leadership in the development and implementation of Canadian government policy on uranium, nuclear energy, and radioactive waste management. NRCan provides expert technical, policy, and economic information and advice to the Minister and the federal government on issues affecting:

- Canadian uranium exploration and development;
- environmental protection;
- production and supply capability;
- foreign ownership;
- domestic and international markets;
- exports;
- international trade; and
- end uses.

The Government of Canada, through NRCan, is responsible for ensuring that the long-term management (including disposal) of radioactive waste is carried out in a safe, environmentally sound, comprehensive, cost-effective, and integrated manner. Canada's approach to radioactive waste management is that the producers and owners of radioactive waste are responsible for the funding, organization, management, and operation of disposal and other facilities required for their wastes.

NRCan is also responsible for administering the Nuclear Fuel Waste Act (NFWA) on behalf of the Minister. The organizational unit within the department responsible for carrying out this function is the Nuclear Fuel Waste Bureau. The Bureau's mandate is to support the Minister of Natural Resources in discharging his responsibilities under the NFWA, by overseeing, monitoring, reviewing, and commenting on relevant activities of the waste owners and enforcing all requirements of the NFWA. The Bureau's web site address is www.nfwbureau.gc.ca .

NRCan provides policy direction and funding to the Low-Level Radioactive Waste Management Office (LLRWMO). The LLRWMO is described below. It is Canada's agent for the management of historic waste.

1.2 Canadian Nuclear Safety Commission

The Canadian Nuclear Safety Commission (CNSC) is Canada's nuclear regulatory body, created by the Governor-in-Council under the NSCA, and reports to the Canadian Parliament through the Minister of Natural Resources. The CNSC is not part of the Department of Natural Resources;

however the Minister of Natural Resources can seek information from the CNSC on its activities. Under the NSCA*,* the Governor-in-Council may, by order, issue directives to the Commission of general application on broad policy matters with respect to the objects of the Commission. The Governor-in-Council cannot give direction to the Commission on specific licensing matters.

The CNSC is an independent federal regulatory agency and a quasi-judicial administrative tribunal. To serve Canadians, the ultimate outcome of the CNSC is, and must be, safe and secure nuclear installations and processes solely for peaceful purposes and public confidence in the nuclear regulatory regime's effectiveness. Consistent with the federal government's Smart Regulation principles, the CNSC engages in extensive consultation and sharing of information to ensure that the desired results are clearly understood and accepted by stakeholders and licensees.

The CNSC reports to Parliament through the Minister of Natural Resources, but it remains an independent entity. This independence is critical in order to ensure that the CNSC is able to maintain an arm's length relationship with government when making legally-binding regulatory decisions. The CNSC is not an advocate of nuclear science or technology. Rather, its mandate and responsibility is to regulate users of nuclear energy or materials to ensure their operations will not pose unreasonable risks to Canadians. Canadians are the sole clients of the CNSC.

The CNSC's 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.*"* In pursuing its mission, the CNSC is working toward its vision of becoming one of the best nuclear regulators in the world. In carrying out its mandate, the CNSC values quality, integrity, competence, dedication and respect for others.

The CNSC's *Regulatory Fundamentals Policy* (P-299), which was adopted in January 2005 by the Commission states that persons and organizations subject to the NSCA and regulations are directly responsible for managing regulated activities in a manner that protects health, safety, security, and the environment, while respecting Canada's international obligations. The CNSC is responsible to the public, through Parliament, for assuring that these responsibilities are properly discharged.

1.3 Atomic Energy of Canada Limited

Atomic Energy of Canada Limited (AECL) is a Crown Corporation wholly owned by the Government of Canada. AECL designs, markets, sells, and builds Canadian-designed CANDU power reactors, MAPLE research reactors, and MACSTOR Waste Storage Modules.

AECL has developed expertise in the areas of project management, engineering and consulting services, maintenance services, the development of new technologies, and decommissioning and waste management. In addition, AECL has ongoing research and development programs that support operating CANDU stations.

AECL partners for CANDU projects and nuclear services both in Canada and abroad with private sector businesses. AECL is also responsible for the operations of the Chalk River

Laboratories (CRL) and the Whiteshell Laboratories (WL), and the decommissioning of shutdown facilities on those sites and three prototype reactor sites. AECL provides a national service for the storage of nuclear waste at the CRL site, excluding waste from operating nuclear reactors.

1.4 Low-Level Radioactive Waste Management Office

The LLRWMO was established by the Government of Canada 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 established as a separate division of AECL, currently within the decommissioning and waste management business of AECL. While the mandate of the LLRWMO is fairly broad, in practice, its function is to manage historic wastes. In particular, the LLRWMO is the proponent for the Port Hope Area Initiative (PHAI). The LLRWMO also provides public information on radioactive wastes.

1.5 Canadian Environmental Assessment Agency

The Canadian Environmental Assessment Agency (CEAA) is charged with the administration of the *Canadian Environmental Assessment Act* (see Annex 2). The CEAA is a tool for federal decision makers, and establishes an open and balanced process to assess the environmental effects of projects requiring federal action or decision. The CEAA ensures that the environmental effects of projects are considered as early as possible in a project's planning stages. In addition, one of the CEAA's goals is full public participation in the Environmental Assessment (EA) process.

1.6 Foreign Affairs Canada

Foreign Affairs Canada (FAC) is charged with promoting nuclear cooperation and safety bilaterally and multilaterally, and implementing key non-proliferation and disarmament agreements in Canada and abroad.

Implementation of these agreements requires that Canadian domestic law be consistent with Canada's responsibilities under the agreements. It also requires the capacity to ensure effective monitoring to verify that treaty obligations and commitments are being honored. FAC is also responsible for the implementation of the *Chemical Weapons Convention* and the *Comprehensive Nuclear-Test-Ban Treaty*. FAC is also responsible for foreign policy, including global security issues, and is the required interlocutor for dealings with other governments.

1.7 Health Canada

Health Canada (HC) is the federal department responsible for helping the people of Canada maintain and improve their health. HC contributes to maintaining and improving the health of Canadians, in the area of radiation protection, by investigating and managing the risks from natural and artificial sources of radiation. It accomplishes this through:

- maintaining the National Radioactivity Monitoring Network;
- developing guidelines for exposure to radioactivity in water, food, and air following a nuclear emergency;
- providing advice and assistance to EAs and reviews as required by the CEAA;
- providing a full range of dosimetry services to workers through the National Dosimetry Services, the National Dose Registry, the National Calibration Reference Centre, and biological dosimetry services;
- contributing to the control of the design, construction, and function of radiation emitting devices imported, sold, or leased in Canada, under the *Radiation Emitting Devices Act;* and
- administering the Federal Nuclear Emergency Plan.

The National Dosimetry Services, operated through HC, provides occupational monitoring for ionizing radiation to Canadians everywhere. Services offered are whole body and extremity thermo luminescent dosimetry services (TLD), as well as neutron dosimetry services and dosimetry for uranium miners. The National Dosimetry Services is licensed by the CNSC. The National Dose Registry is a centralized radiation dose record system, managed by HC. It contains the occupational radiation dose records of all monitored radiation workers in Canada from the 1940s to the present.

1.8 Environment Canada

Environment Canada's mandate is to preserve and enhance the quality of the natural environment, including water, air and soil quality; conserve Canada's renewable resources, including migratory birds and other non-domestic flora and fauna; conserve and protect Canada's water resources; carry out meteorology; enforce the rules made by the Canada – United States International Joint Commission relating to boundary waters; and coordinate environmental policies and programs for the federal government. Environment Canada administers the *Canadian Environmental Protection Act* (CEPA).

1.9 Transport Canada

Transport Canada's mission is to develop and administer policies, regulations and services for the transportation system for Canada to ensure that it is safe and secure, efficient, affordable, integrated and environmentally friendly. Transport Canada sets policies, regulations and standards to protect the safety, security and efficiency of Canada's rail, marine, road and air transportation systems, including the transportation of dangerous goods and sustainable development. Dangerous goods also include nuclear substances.

ANNEX 2

CANADIAN LEGISLATIVE SYSTEM AND INSTITUTIONAL FRAMEWORK

2. Introduction

Currently five pieces of legislation govern the nuclear industry in Canada: the NSCA; the *Nuclear Energy Act* (NEA); the *Nuclear Fuel Waste Act* (NFWA); the *Nuclear Liability Act* (NLA); and the CEAA. The NSCA is the main legislation dealing with safety considerations.

2.1 *Nuclear Safety and Control Act*

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 provides legislative authority for nuclear industry regulatory developments since 1946. These developments include 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 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.

Section 26 of the NSCA states that, "Subject to the regulations, no person shall, except in accordance with a licence;

(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;
(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;
(c) produce or service prescribed equipment;
(d) operate a dosimetry service for the purposes of this Act;
(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility,; or
(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada"

The NSCA authorizes the CNSC to make regulations; those regulations had to be developed before the NSCA could be implemented. The regulations include:

- *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 Mill 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*.

2.2 *Nuclear Energy Act*

Concurrent with the NSCA, the NEA came into force in 2000. It is a revision of the AECA (1946) to address only the development and utilization of nuclear energy (with the regulatory aspects of the AECA having been removed to the NSCA). The NEA gives the designated government minister the authority to:

"(*a*) undertake or cause to be undertaken research and investigations with respect to nuclear energy;

(*b*) with the approval of the Governor-in-Council, utilize, cause to be utilized and prepare for the utilization of nuclear energy;

(*c*) with the approval of the Governor-in-Council, acquire or cause to be acquired, by purchase, lease, requisition or expropriation, nuclear substances and any mines, deposits or claims of nuclear substances and patent rights relating to nuclear energy and any works or property for production or preparation for production of, or for research or investigations with respect to, nuclear energy; and

(*d*) with the approval of the Governor-in-Council, licence or otherwise make available or sell or otherwise dispose of discoveries and inventions relating to, and improvements in processes, apparatus or machines used in connection with, nuclear energy and patent rights acquired under this Act and collect royalties and fees on and payments for those licences, discoveries, inventions, improvements and patent rights."

This is the Act under which the work of AECL, a federal Crown corporation, is authorized. It is available at http://laws.justice.gc.ca/en/A-16/index.html.

2.3 *Nuclear Fuel Waste Act*

The NFWA came into force on November 15, 2002. It ensures that the long-term management of nuclear fuel waste is carried out in a comprehensive, economically sound, and integrated manner. It requires that nuclear energy corporations and the AECL set up a trust fund and deposit annual charges for long-term waste management operations. It also requires the creation and maintenance of a waste management organization by the nuclear industry to implement a government-approved approach. The waste management organization has three years to submit general waste management approach options to the Government of Canada for decision. The NFWA is administered by NRCan, and is available at www.nfwbureau.gc.ca .

Key elements of the NFWA include:

- requiring major owners of nuclear fuel waste to establish a waste management organization to carry out the managerial, financial, and operational activities to implement long-term management of nuclear fuel waste;
- requiring the major owners of nuclear fuel waste to establish trust funds and to make annual payments into those trust funds to finance the long-term management of nuclear fuel waste; and
- authorizing the Governor-in-Council to decide on the choice of approach for long-term management of nuclear fuel waste to be implemented by the waste management organization for Canada.

The NFWA also requires the NWMO to carry out public consultations, make its studies and reports public and establish an Advisory Council whose comments on the NWMO's study and reports are made public. The Minister of Natural Resources makes public statements on all of the NWMO's reports.

2.4 *Nuclear Liability Act*

The NLA establishes the legal regime that would apply in the event of a Canadian nuclear accident affecting third parties. The NLA, which entered into force in October 1976, is modeled closely after the Vienna and Paris conventions. NRCan is undertaking a comprehensive review of the legislation, which is being influenced by recent revisions to both these conventions. The NLA is administered by the CNSC, while NRCan has responsibility for policy direction. The NLA can be viewed at http://laws.justice.gc.ca/en/N-28/index.html .

The NLA places total responsibility for nuclear damage on the operator of a nuclear installation. It requires the operator to carry insurance in the amount of $75 million. It also provides for the establishment of a Nuclear Damage Claims Commission in the event of a nuclear incident. This Commission would deal with claims for compensation when the federal government deems that a special tribunal is necessary, for example, if the claims are likely to exceed $75 million.

At present, Canada is not a member of any of the international conventions in the area of third-party nuclear liability. However, Canada has entered into a reciprocity arrangement with the United States in this area.

2.5 *Canadian Environmental Assessment Act*

The *Canadian Environmental Assessment Act* sets out responsibilities and procedures for the EA of projects involving the federal government. It applies to projects for which the federal government holds decision-making authority—whether as proponent, land administrator, source of funding, or regulator. The CEAA can be viewed at http://laws.justice.gc.ca/en/C-15.2/index.html .

The majority of federal projects requiring an EA undergo either a screening or a comprehensive study. Both can be considered self-directed EAs in the sense that the Responsible Authority determines the scope of the EAs and the scope of the factors to be considered, directly manages the EA process, and ensures that the EA report is prepared. The Responsible Authority is the federal decision maker having responsibility under the CEAA. The CNSC is a Responsible Authority for projects that it regulates. NRCan is a Responsible Authority for projects that it funds.

In practice, the project proponent may be delegated to conduct the EA, prepare the report, and design and implement mitigation measures and a follow-up program. The Responsible Authority alone, however, remains directly responsible for ensuring that the screening or comprehensive study is carried out in compliance with the Act, and for deciding on the course of action with respect to the project following the screening or comprehensive study.

The CEAA requires that early on in the project a proponent carry out an integrated EA of the possible impacts of all licensing stages, before any irrevocable decisions are made. The CEAA has four stated objectives:

1. To ensure that the environmental effects of the project receive careful consideration before a Responsible Authority takes an action.
2. To encourage Responsible Authorities to take actions that promote sustainable development, thereby achieving or maintaining a healthy environment and a healthy economy.
3. To ensure that projects to be carried out in Canada or on federal lands do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out.
4. To ensure that there be an opportunity for public participation in the EA process.

ANNEX 3

CANADIAN NUCLEAR SAFETY COMMISSION AND THE REGULATORY PROCESS

3. Introduction

The Canadian nuclear industry is diverse. From radioisotopes to electricity generation to radiation devices and non-proliferation of nuclear substances - all are regulated by an independent federal agency, the CNSC. The CNSC replaced the former Atomic Energy Control Board (AECB) with the implementation of the NSCA on 31 May 2000.

3.1 *Nuclear Safety and Control Act*

The NSCA was passed by Parliament on 20 March 1997. This was the first major overhaul of legislation governing Canada's nuclear regime since the creation of the *Atomic Energy Control Act* (AECA) in 1946 came into force and the Atomic Energy Control Board was created. This legislation is comprehensive and world class. The NSCA provides the legislative authority for many new nuclear industry regulatory developments that have occurred since 1946. These include health and safety standards for nuclear energy workers, environmental protection measures, security regarding nuclear facilities, and public input into the licensing process. A description of this Act is provided in Annex 2.

3.2 Canadian Nuclear Safety Commission

The CNSC's regulatory regime covers the entire nuclear substance life cycle - from production, to use, to final disposition of any nuclear substances. Its mandate, derived from the NSCA, is as follows:

- To regulate the development, production and use of nuclear energy and materials to protect the health, safety, security, and environment;
- To regulate production, possession and use of nuclear substances, prescribed equipment, and prescribed information;
- To implement measures respecting international commitments on the peaceful use of nuclear energy and substances; and
- To disseminate scientific, technical and regulatory information concerning CNSC activities.

3.3 CNSC in the Government Structure

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 NSCA established the CNSC as a departmental corporation, named in Schedule II of the Government of Canada *Financial Administration Act*. The CNSC reports to the Parliament of Canada through a member of the Queen's Privy Council for Canada designated by the Governor in Council as the Minister for purposes of the Act. Currently, this designate is the Minister of Natural Resources. As a departmental corporation, the CNSC is an independent agency and is not part of any government department, nor does it take direction from any government department.

The NSCA requires the Commission to comply with any directives of general application on broad policy matters with respect to the objects of the Commission issued by order of the Governor in Council. It is an accepted constitutional convention in Canada that any political directives given to agencies such as the CNSC are of a general nature and cannot interfere with Commission decisions in specific cases. An example of such a directive might be the government-wide commitment to the "Smart Regulation" initiative.

CNSC staff routinely interacts with management and staff of NRCan in areas of mutual interest. NRCan has general interest in various matters relating to nuclear energy and natural resources. Further information is provided in Annex 1.1.

In keeping with federal policies on public consultation and regulatory fairness, the CNSC routinely consults with parties and organizations that have an interest in its regulatory activities. These include:

- licensees;
- the nuclear industry;
- federal, provincial, and municipal departments and agencies;
- special interest groups; and
- individual members of the public.

As required by federal policies on Access to Information and in accordance with Canada's SMART Regulation principles, formal consultations are conducted in an open and transparent manner.

CNSC licensees include publicly-funded institutions or agents of the federal and provincial governments. These include:

- AECL (the federal nuclear research and development company);
- nuclear operations of provincially-owned electrical utilities (OPG, New Brunswick Power, and Hydro-Québec);
- Canadian universities; and
- hospitals and research institutions.

The CNSC regulates the health, safety, security, and environmental impacts of the nuclear activities of these organizations in the same manner and to the same standards required from privately-owned companies or operations.

3.4 Organizational Structure

The CNSC operates as two separate organizations:

(i) a Commission of up to seven members; and
(ii) a staff organization of approximately 530 people.

3.4.1 Commission

The NSCA provides for the appointment of up to seven Commission members by the Governor-in-Council. Members serve for a term not exceeding five years. One member of the Commission is designated as the President of the Commission. This position is currently held by Linda J. Keen.

The Commission, which is supported by the Secretariat, functions as a quasi-judicial administrative tribunal. It sets regulatory policy direction on matters relating to health, safety, security and environmental issues affecting the Canadian nuclear industry. It makes independent decisions on the licensing of nuclear-related activities in Canada and establishes legally-binding regulations. The Commission takes into account the views, concerns and opinions of interested parties and intervenors. The Commission delegates to Designated Officers the authority to render licensing decisions for certain categories of nuclear facilities and activities in accordance with the requirements of the NSCA and its associated regulations. For its own consideration, the Commission retains licensing matters related to major nuclear facilities, for which it holds public hearings, in accordance with the CNSC Rules of Procedure.

3.4.2 CNSC Staff

CNSC staff is located at headquarters in Ottawa, site offices at each of the five nuclear power plants in Canada, and five regional offices. CNSC staff is permanently located at each nuclear power plant in Canada to assess performance against regulations and specific conditions of operating licences. Regional offices 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 regulatory framework;
- 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.

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.

3.5 Regulatory Philosophy and Activities Areas

3.5.1 CNSC Regulatory Philosophy

The CNSC's regulatory philosophy is based on two principles as outlined in CNSC Regulatory Policy P-299 "Regulatory Fundamentals":

- Persons and organizations subject to the NSCA and associated regulations are directly responsible for ensuring that the regulated activities that they engage in are managed so as to protect health, safety, security, and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy.
- The CNSC is responsible to the public for regulating persons and organizations subject to the NSCA and associated regulations to assure that they are properly discharging their obligations.

The CNSC's strategic framework encompasses the following outcomes areas:

1. A clear and pragmatic regulatory framework
2. Individuals and organizations that operate safely and conform to safeguards and non-proliferation requirements
3. High levels of compliance with the regulatory framework
4. CNSC cooperates and integrates its activities in national/international nuclear programs
5. Stakeholders' understanding of the regulatory program

These outcome areas are achieved by the following activity areas:

1. Regulatory Framework
2. Licensing and Certification
3. Compliance
4. Cooperative Undertakings both domestically and internationally
5. Stakeholder Relations

The CNSC establishes and requires compliance with regulatory requirements, makes independent objective decisions based on regulatory action on the level of risk, and seeks public input.

In performing its responsibilities, the CNSC issues licences (after assessing whether regulatory requirements and international obligations are met), verifies compliance with the licences that have been issued, sets standards for meeting regulatory requirements, and communicates the work of the CNSC to its licensees and other stakeholders.

3.6 Regulatory Framework

The CNSC establishes standards and policies by which safety and environmental protection of licensee operations are judged. 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). These standards and policies, which help licensees to meet regulatory requirements, are established in consultation with stakeholders. Licensees are informed of the standards and policies and are required to apply them to their operations. This information is published as regulatory documents (policies, guides, standards, notices) in print and on the CNSC web site. Other forums to inform other stakeholders include regular licensee meetings, information meetings, and open houses.

3.7 Licensing Process

The CNSC licenses about 3,500 operations across Canada including uranium mines, fuel fabrication facilities, radioisotope production, waste management facilities, nuclear power plants in Ontario, Quebec, New Brunswick, and AECL facilities in Chalk River, Ontario, and Whiteshell, Manitoba. Information about the CNSC's licensing process is available at www.nuclearsafety.gc.ca/eng/licences/index.html .

There are several types of licences issued. A facility (Class I, II, Uranium Mines or Mills) is licensed during its life cycle. Licenses are required for site preparation, construction, operations, decommissioning, and abandonment. An application for a licence (including renewals or amendments) may trigger other legislation and regulations. For example, an EA under the *Canadian Environmental Assessment Act* may be a prerequisite to proceeding with a licence application. The CEAA may require an EA of a project to analyze potential environmental impacts and their severity, possible mitigation measures, and any residual impacts. Both the physical and socio-economic environments must be considered in the EA. The range of stakeholder consultations is determined by the severity of the potential environmental impacts.

In addition, CNSC also licenses the import and export of controlled nuclear substances, equipment, information, and nuclear-related dual-use items. Proposed imports and exports are evaluated by CNSC staff to ensure compliance with Canada's nuclear non-proliferation and export policies, international agreements related to safeguards, health, safety and security, and the NSCA and its Regulations.

3.8 Licensing Hearings

The tribunal considers applications in public hearings, which are usually two days in duration for each applicant or licensee. The first day is reserved to hear the application and CNSC staff recommendations. The second day is reserved to entertain interventions, and is typically held 60 days after the first day to permit stakeholders time to review the application and recommendations.

Hearing Day 1—A *Notice of Public Hearing* is released 60 days prior to the hearing date. Documents can be filed by the applicant and CNSC staff 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. CNSC staff presents its comments and recommendations to the tribunal. Commission members question both staff and applicant regarding the available information. No decision is made during the first day of the hearing.

Prior to Hearing Day 2—anyone wishing to take part in the process can file a request to intervene 30 days prior to Hearing Day 2. If necessary, further documents from both the applicant and CNSC staff can be filed at this time. 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 hearing.

Hearing Day 2—as appropriate, the applicant and CNSC staff presents additional information to the tribunal. Any interveners who filed a request are able to present their views at this time or their intervention document(s) can be tabled without a presentation. 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 Chairperson. Upon the conclusion of Hearing Day 2, there will be no further submissions considered.

Commission Decisions—After Day 2 hearings, the tribunal discusses *in camera* the application and all information submitted during the two day hearing to reach a decision. The *Notice of the Decision* and *Reasons for the Decision* are sent to all participants and published on the CNSC web site (www.nuclearsafety.gc.ca).

3.9 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.

3.9.1 CNSC Compliance Program

Confirmation of compliance with licences is managed within the CNSC Compliance Program (CCP) - a formal compliance verification program that includes promotion, verification and enforcement. These elements of the program are described in Section E.

3.10 Cooperative Undertakings

The CNSC works cooperatively, on an ongoing basis, with a number of other national and international organizations.

At the national level, the CNSC's mandate is clearly outlined in the NSCA, which specifies that nuclear regulatory activities are a federal responsibility. However, there are areas where other federal and provincial departments have legislated parallel or complementary responsibilities. These include security, emergency preparedness and mining.

In addition, to fulfill Canada's international obligations, the CNSC participates with various agencies such as its counterparts in other countries and Foreign Affairs Canada, to ensure that nuclear cooperation is conducted consistently with international agreements. This ensures that there is an effective and comprehensive international nuclear non-proliferation regime.

Also at the international level, the CNSC's cooperation and involvement in international nuclear organizations includes the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organization for Economic Co-Operation and Development (OECD). The CNSC's role is to promote Canadian interests and evaluate international recommendations, standards and guides for adoption in the CNSC's regulatory framework.

3.11 Stakeholder Relations and 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 disseminates objective 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, safety, security, and the environment.

The NSCA establishes a legislative requirement for the Commission to hold public hearings with respect to exercising its power to license. It is also a requirement that applicants, licensees and anyone named in or subject to an order must have the opportunity to be heard. Accordingly, the CNSC *Rules of Procedure* sets out the requirements for notification of public hearings and publication of decisions from public hearings, as described earlier. A communication policy was recently developed relating to CNSC interactions with internal and external stakeholders.

3.11.1 CNSC Outreach Program

3.11.1.1 Introduction

The CNSC operates with a high level of transparency. 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.

3.11.1.2 Framework for Outreach Program

The CNSC will use outreach to communicate information to stakeholders, consult with stakeholders, and be aware of issues and concerns stakeholders have that relate to the CNSC as Canada's nuclear regulator, or its regulatory regime.

3.11.1.3 Stakeholders

In implementing the CNSC's Outreach Program, the CNSC must address two sub-groups of stakeholders within the general stakeholder population.

- Key stakeholders are individuals or groups that the CNSC regularly or periodically interacts with. They have at least a general knowledge of the CNSC and its roles and responsibilities. They would include municipalities and residents near key facilities, licensees, non-government organizations, industry associations and all levels of government, including departments and agencies.

- General stakeholders are individuals or groups from the Canadian public in whose interest the CNSC regulates the Canadian nuclear industry, but who are largely unaware of the CNSC and its roles and responsibilities.

3.11.1.4 Definition of Outreach

The following definition of outreach was developed to apply to both sub-groups of stakeholders:

"Outreach is a coordinated approach to increasing levels of communication with stakeholders on issues or information of mutual interest, listening to the views received, and acting where appropriate. It includes activities that are over and above licensing and compliance activities required by the NSCA and regulations."

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ANNEX 4

SPENT FUEL STORAGE TECHNOLOGIES IN CANADA

4.1 Wet Storage Technology

Spent fuel discharged from a reactor is stored initially in wet bays or water pools. The wet bays, together with cooling and purification systems, provide containment of the used fuel and associated radioactivity, and provide good heat transfer to control fuel temperatures. The water also gives shielding and allows access to the fuel, via remotely-operated and automated systems, for handling and examination. The bay structure and structural elements (such as fuel containers and stacking frames) provide mechanical protection.

The walls and floor of CANDU reactor water pools are constructed of carbon-steel reinforced concrete approximately two metres thick. Inner walls and floors are lined with a watertight liner consisting of stainless steel or a fiberglass-reinforced epoxy compound, or a combination of the two. The bay structure is seismically-qualified so that the structures and bay components maintain their structural form and support function both during and following a design basis event. Other structural design considerations include load factors and load combinations (including thermal loads) for which upper and lower temperature limits have been established.

Figure 4.1 Pool Storage at Pickering NGS

4.1.1 Bay Liners

The bays are designed to prevent bay water leaking through any possible defects in the concrete into the environment. The bay inner liner is the primary barrier against outward leakage. The bays also have a leakage collection system to ensure that any leakage that does occur is captured and conducted to a controlled drainage system. The design has provisions for leak detection and tracing.

4.1.2 Storage Containers

Storage containers are used to hold spent fuel. A number of designs are used. Ontario Power Generation (OPG) has a standardized site-specific storage-transportation module that stores the fuel compactly. To reduce handling, the storage-transportation module is also suitable to hold the fuel during transportation. The containers (baskets, trays, and modules) are stacked vertically in the bays, using seismically-qualified stacking frames.

4.1.3 Water Pool Chemical Control

In all storage bays, water is circulated through cooling and purification circuits. A combination of ion exchange columns, filters, and surface skimmers is used to control water purity within design limits. A typical purification system also includes resin traps, sample points and instrumentation to indicate when filters and ion exchange columns are exhausted, and when resin traps must be cleaned out. Water-pool chemical control has the following objectives:

- Minimize corrosion of metal surfaces;
- Minimize the level of radioisotopes in the water and reduce radiation fields and radioiodine levels in the bay area; and
- Maintain clarity of the bay water for ease of bay operation.

To ensure purity, demineralized water is used for filling and make up.

4.2 Experiences with Wet Storage

Early operating experience at the AECL research reactor spent fuel bays (which have been in operation since 1947) and at the NPD and Douglas Point reactors, provided a basis for the successful operation of the spent fuel bays for the current generation of power reactors. That experience, and the development of high-density storage containers, inter-bay fuel transfers, and remote handling mechanisms, have all contributed towards safe storage.

Good chemical control has been achieved in Canadian used fuel bays. Radioactivity in the water has been kept to very low or non-detectable levels resulting in low radiation levels in the bay area. Overall fuel bundle defect rates are low. During early operations, defective fuel was canned (i.e. stored in a sealed cylinder). With more operating experience, canning has been found to be generally unnecessary due to minimal release of fission products from most defective bundles. In some cases, known defective fuel is held temporarily in the fuel handling system before being passed to the bay. Known defective fuel is generally stored in a designated part of the fuel bay.

As noted above, an epoxy polymer liner is in place at a number of the stations. With extended operating lifetimes and continual exposure to radiation, there has been some radiation-induced deterioration of the liner at the Pickering Nuclear Generating Station-A (Pickering NGS-A) Primary Bay (where the first epoxy liner was used).

Locating and repairing of potential leaks is included in a current program to return Pickering NGS-A to service after an extended shutdown. Techniques have been developed for underwater repairs by using an underwater-curing epoxy. Return-to-service work at Pickering NGS-A will also include replacing heat exchangers (which are at the end of their service life) repairing and, where necessary, replacing the purification system ion exchange columns and filters.

4.3 Dry Storage Technology

There are currently three basic designs used for the dry storage of spent fuel in Canada:

- AECL Concrete Canister
- AECL Modular Air-Cooled Storage System (MACSTOR)
- OPG Dry Storage Container

4.3.1 AECL Concrete Canisters

The AECL Concrete Canister Fuel Storage Program was developed at the Whiteshell Laboratories in the early 1970s to demonstrate that dry storage for irradiated reactor fuel was a feasible alternative to water pool storage. Owing to the success of the demonstration program, concrete canisters were used to store Whiteshell Reactor-1 used fuel. Following the success of the AECL Concrete Canister Fuel Storage Program, the AECL concrete canister design was used at the CRL, the Point Lepreau Generating Station, and the partially decommissioned Douglas Point and Gentilly-1 Nuclear Generating Stations.

The main components of the canister system are:

- the fuel basket;
- the shielded workstation;
- the transfer flask; and
- the concrete canister itself.

The fuel basket is constructed of stainless steel and comes in two sizes, one holding 54 bundles (used for fuel from Douglas Point, Gentilly-1 and Nuclear Power Development) and one holding 60 bundles in use at Point Lepreau. The fuel basket is designed to provide storage for spent fuel that has been in wet storage for six years or more, and consists of two assemblies: the basket and the basket cover.

The shielded workstation is equipped to dry a loaded fuel basket and to weld the basket cover to the basket base plate and central post assembly. It is composed of a number of subassemblies used for lifting, washing, drying, seal welding, and inspecting the spent fuel baskets. The shielding provided by the workstation is sufficient to reduce the radiation fields in contact with the exterior of the shielded workstation to ensure the safety of workers.

The fuel basket transfer flask is used to shield the basket when it is moved from the shielded workstation at the generating station to the dry storage canister at the waste management facility.

The concrete canister is a cylindrical reinforced concrete shell with an internal liner. To provide additional shielding, a two-piece loading plug is used until the canister is filled. Provision is made for IAEA safeguard seals to go over the top of the canister plug so that it cannot be removed without breaking the seals.

Two small diameter pipes allow the air between the liner and the fuel baskets to be monitored in order to confirm the integrity of the confinement barriers. The concrete canisters are supported on reinforced concrete foundations above the water table. Each canister holds 6, 8, 9, or 10 baskets, depending on the specific needs of the station.

The transfer of spent fuel from the storage bays to dry storage canisters always begins with the oldest fuel first. Therefore, the nominal age of the spent fuel in dry storage is usually older than seven years, adding a measure of conservatism to the assumptions and overall safety of the dry storage of irradiated fuel.

Containment of the radioactive products is ensured by three barriers (defence-in-depth):

- The fuel sheath;
- The fuel basket; and
- The internal liner.

Figure 4.2 AECL Concrete Canisters

4.3.2 AECL MACSTOR Module

The AECL MACSTOR module is a variant of the canister storage technique. Currently it is only in use at the Hydro-Québec Gentilly-2 Spent Fuel Dry Storage Facility. Seven modules have been constructed since 1995.

A typical MACSTOR module such as the one used in Gentilly-2 is 8.1 metres wide, 21.6 metres long and 7.5 metres high. It stores 20 watertight galvanized carbon steel cylinders arranged vertically in two rows of 10. Each row holds 10 baskets of 60 spent fuel bundles, for a total of

12,000 bundles per module. Each cylinder is secured to the top slab of the module, and two sampling pipes which extend to the outside of the MACSTOR module are provided at its base. These allow confirmation of the integrity of confinement.

The heat of the spent fuel is dissipated primarily by natural convection through ventilation ports which extend through the concrete walls. The ventilation is provided by 10 large air inlets in each longitudinal wall near the base of the module (five on each side), and by 12 large air outlets located slightly below the top of the module (six on each side). The air inlets and outlets are arranged in a series of baffles to avoid direct gamma radiation.

To enhance cooling, the storage cylinders of the MACSTOR module are directly in contact with the air circulating in the module. To protect the storage cylinders from ambient air, all surfaces of the storage cylinders are hot galvanized.

The loading operations for the MACSTOR module are identical to those of the concrete canister. Both use the fuel basket, shielded work station, and transfer flask concept. The only essential difference is the storage structure itself.

Figure 4.3 MACSTOR at Gentilly-2

4.3.3 Ontario Power Generation Dry Storage Containers

OPG currently operates two spent fuel dry storage facilities - one at the Pickering Waste Management Facility (PWMF) and the other at the Western Waste Management Facility (WWMF). OPG has received a construction licence from the CNSC for a third such facility to be located at the Darlington NGS.

The OPG dry storage facilities employ standard dual-purpose dry storage containers. These are massive, transportable containers, with an inner cavity for fuel containment. Each one is designed to hold 384 fuel bundles, and weighs approximately 60 tons when empty and 70 tons when loaded.

They are of rectangular in design, with walls of reinforced concrete sandwiched between interior and exterior shells which are made of carbon steel. The inner liner constitutes the containment boundary while the outer liner is intended to enhance structural integrity and facilitate decontamination of the dry storage container surface. Helium is used as a cover gas in the dry storage container cavity to protect the fuel bundles from potential oxidation reactions. OPG dry storage facilities are interior storage facilities, while the AECL storage concepts are external. For both, there are no anticipated radiological releases from the dry storage containers under normal operating conditions.

Figure 4.4 DSC Storage at Pickering

4.4 Experiences with Dry Storage

Research programs have assessed the behaviour of spent fuel when stored in dry and moist air conditions, and in a helium environment. It was concluded that CANDU fuel bundles, whether intact or with defects, can be stored in dry storage conditions for up to 100 years or more without losing integrity. Additional research is ongoing.

Operating experience achieved at the licensed dry storage facilities, which has been in operation for several years, provides a high level of confidence that CANDU dry storage facilities can be operated safely and without undue risk to workers, members of the general public, or the environment.

Dry storage containers have been successfully and safely used at the PWMF since 1996. The safety performance of the facility has been excellent over the entire period. Dose rates have remained below regulatory limits. Collective occupational radiation exposures have been less than predicted − by 30% or more. Emissions from the processing area have remained below regulatory limits. The PWMF operates contamination-free, and there have been no effluent releases from the storage area.

Thermal and shielding analyses carried out for design and safety assessment purposes have been found to be conservative. Analysis and measurements carried out at the PWMF indicate that the maximum fuel cladding temperature does not exceed a temperature of 175°C in dry storage. In addition, the results of neutron dose rate calculations have demonstrated that, as expected, the dose rates produced by neutrons are negligible compared to those generated by gamma radiation. This is due to the heavy concrete used as shielding in the dry storage container.

To verify the results of the thermal analysis, an experimental thermal performance verification program was carried out in the summer of 1998. A dry storage container instrumented with 24 thermocouples at various locations on the inner and outer liners was loaded with six-year cooled fuel and placed within an array of dry storage containers containing ten-year cooled fuel. Temperatures were also measured at the interspaces between the dry storage containers, in addition to indoor and outdoor ambient temperature measurements. The results demonstrated the conservatism of the temperatures predicted analytically.

4.5 Spent Fuel Storage Facilities

After a cooling period of six to ten years in the storage bay (the exact cooling period is site-specific), spent fuel is then transferred to an interim dry storage facility. All transfers of spent fuel to dry storage are conducted under the surveillance of IAEA inspectors. All loaded dry storage containers in interim storage are also under the surveillance of the IAEA by the application of a dual sealing system.

4.5.1 Pickering Nuclear Generating Station

Pickering hosts two NGSs (Pickering NGS-A and NGS-B). Both stations consist of four CANDU Pressurized Heavy Water reactors. Pickering NGS-A commenced operation in 1971 and is currently in an approved shutdown state. However, it should be noted that OPG has applied for authorization to restart these reactors. An EA was completed and authorization to restart the reactors has been given.

Pickering NGS-B commenced operation in 1982 and continues to operate today. The nuclear fuel waste generated at Pickering NGS-B is stored in the irradiated fuel bays for a minimum of 10 years before the spent fuel is transferred to the PWMF.

4.5.2 Pickering Waste Management Facility, Used Fuel Dry Storage

OPG’s PWMF is located within the protected area of the Pickering NGS. In operation since 1996, the primary purpose of the PWMF is to store used fuel from the reactors at the Pickering A and B NGS. It is expected that the PWMF will be in operation until at least 10 years after the shutdown of the last Pickering reactor unit.

The used fuel dry storage area of the PWMF is comprised of a dry storage container processing building and two storage buildings. The Pickering used fuel dry storage system is designed to transfer used fuel from wet storage in the Pickering A and B irradiated fuel bays into a dual-purpose (storage and transport) concrete dry storage container designed by OPG. Prior to transfer to the PWMF the loaded dry storage containers are drained and monitored for loose contamination. If necessary, they are decontaminated.

At the processing building in the PWMF, the dry storage container loaded with used fuel is received, the transfer clamp and the temporary IAEA seal are removed, and the lid is seal-welded to the dry storage container body. The lid weld is subsequently inspected for defects using X-ray radiography. The vent port is also welded and a weld dye penetrate inspection is performed. The dry storage container undergoes final vacuum drying and helium backfilling. After the drain port is welded; it is inspected, and helium leak testing is performed. The dry storage container is monitored to ensure that no loose contamination is present, and if there is, the container is decontaminated.

Finally, touch-up paint is applied to scuffs or scrapes on the container's exterior. Prior to being introduced into the storage buildings, IAEA seals are reapplied to each container. The PWMF currently processes approximately two dry storage containers (or 768 spent fuel bundles) per week.

The PWMF can store up to 650 dry storage containers or 249,600 fuel bundles in the two existing storage buildings. An application to expand the facility to include two additional storage buildings for a further 1000 dry storage containers has been approved for construction. While the two storage buildings will be constructed within the Pickering nuclear site but some distance from the PWMF, they will be part of the PWMF licence. The two buildings will be operated within an established protected area.

In 2004, the PWMF (used fuel dry storage area and re-tube components storage area combined) reported releases of less than 0.001 GBq to air and 0.12 GBq to water. It is important to note, however, that activity released from the PWMF is included in the total releases reported for the Pickering NGS.

Figure 4.5 PWMF I and Proposed PWMF II Area

4.5.3 Bruce Nuclear Generating Stations A and B

The Municipality of Kincardine in Ontario hosts the Bruce Nuclear Power Development, which contains two NGSs (Bruce NGS-A and NGS-B). Bruce NGS consists of four CANDU Pressurized Heavy Water reactors. Currently Units 3 and 4 are in operation, having been restarted after more than five years in a shut-down state. Units 1 and 2 are in an approved shut-down state. A study to determine the feasibility of restarting units 1 and 2 is currently underway.

Bruce NGS-B consists of four CANDU Pressurized Heavy Water reactors. This station commenced operation in 1984 and continues to operate today. Bruce Power Inc. leases and operates both Bruce NGS-A and NGS-B.

4.5.4 Western Waste Management Facility - Used Fuel Dry Storage Facility

OPG's used fuel dry storage facility, which is part of the WWMF, began operations in February 2003. The WWMF used fuel dry storage was designed to provide safe storage for the Bruce NGS-A or NGS-B used fuel until all of it is transported to an alternative long-term used fuel storage or disposal facility. It is designed to provide dry storage for about 750,000 fuel bundles produced at Bruce NGS-A and Bruce NGS-B. The spent fuel is stored in dual-purpose concrete dry storage containers identical to those currently in use at the PWMF. The processing of dry storage containers is identical to the PWMF.

The WWMF can process four to five dry storage containers per week. OPG is authorized to store up to 750,000 spent fuel bundles or approximately 2000 dry storage containers, at the facility.

In 2004, the WWMF (used fuel dry storage area and L&ILW storage area combined) released 32,900.3 GBq to air and 20.5 GBq to water. Activity released from the WWMF is typically less than 2% of the total activity released from the BNPD site.

4.5.5 Darlington Nuclear Generating Station

The Darlington NGS, operated by OPG, consists of four CANDU Pressurized Heavy Water reactors. The station commenced operation in 1989 and continues to operate today. All of the spent fuel produced at the Darlington NGS is currently stored in the water filled storage bays.

4.5.6 Darlington Used Fuel Dry Storage Facility

The Darlington Used Fuel Dry Storage Facility (DUFDSF) will be located at the Darlington NGS site. It will provide safe storage for the Darlington NGS used fuel until it is transported to an alternative long-term used fuel storage or disposal facility.

An EA in accordance with the CEAA was completed for the facility in late 2003. This was followed by the delivery, in mid-2004, of a licence to construct the waste facility. The DUFDSF is designed to provide additional storage capacity for about 575,000 fuel bundles produced at the Darlington NGS. The spent-fuel will be stored in dual-purpose concrete dry storage containers identical to those currently in use at the PWMF and WWMF. The processing of dry storage containers is also identical to the PWMF and WWMF. The in-service date for the DUFDSF is forecasted for late 2007.

Figure 4.6 Darlington Reactor Site showing location of proposed Used Fuel Dry Storage Facility

4.5.7 Gentilly-2 Nuclear Generating Station

Gentilly-2 NGS, operated by Hydro-Québec, consists of one CANDU Pressurized Heavy Water reactor.

The station commenced operation in 1982. The nuclear fuel waste produced is initially stored in the irradiated fuel bays. After a cooling period in the storage bay, the irradiated fuel is transferred to the Hydro-Québec Used Fuel Dry Storage Facility. Stored irradiated fuel is transferred into fuel baskets in the fuel storage bay. The loaded basket is then transferred to a shielded workstation where the contents are dried and the basket cover is welded. Upon completion of the basket processing, it is then transported to the Hydro-Québec Used Fuel Dry Storage Facility.

4.5.8 Hydro-Québec Used Fuel Dry Storage Facility

In operation since 1995, the Gentilly-2 Used Fuel Dry Storage Facility provides additional storage capacity for the Gentilly-2 NGS in the MACSTOR module. The Gentilly-2 Used Fuel Dry Storage Facility is authorized to construct a total of 16 MACSTOR modules for a total of 192,000 spent fuel bundles. At present, storage baskets are transferred as needed, normally between April and December of each year. Approximately 5,000 spent fuel bundles are transferred to dry storage each year depending on the status of the Gentilly-2 nuclear reactor.

Samples of surface water run-off from the Used Fuel Dry Storage Facility collected and analyzed in 2004 have shown that tritium concentrations varied between 70 Bq/L and 5,800 Bq/L. The average dose rate for 2004 at the Used Fuel Dry Storage Facility perimeter fence was 0.09 μSv/h.

A proposed reactor refurbishment project will, if carried through, result in a substantial increase in the size of Hydro-Québec's Waste Management Facility. A new Solid Radioactive Waste

Management Facility (SRWMF) will be developed, where four more MACSTOR modules will be constructed. The proposed modification to Hydro-Québec's Waste Management Facility is currently under regulatory review and is undergoing an EA in accordance with the CEAA.

Figure 4.7 Gentilly-2 Used Fuel Dry Storage Facility – bottom right of picture

4.5.9 Point Lepreau Nuclear Generating Station

The Point Lepreau NGS, operated by New Brunswick Power Nuclear Corporation, consists of one CANDU Pressurized Heavy Water reactor. The station commenced operation in 1982 and continues to operate today. The nuclear fuel waste generated at the Point Lepreau NGS is initially stored in the irradiated fuel bay and then transferred to Point Lepreau Used Fuel Dry Storage Facility where it is stored in concrete canisters.

4.5.10 Point Lepreau Used Fuel Dry Storage Facility

In operation since 1990, the Point Lepreau Used Fuel Dry Storage Facility provides additional storage capacity for the Point Lepreau NGS in above-ground concrete canisters.

The Point Lepreau Used Fuel Dry Storage Facility is authorized to construct 300 canisters for a total of 180,000 spent fuel bundles. Approximately 5,000 spent fuel bundles are transferred to dry storage each year depending on the status of the Point Lepreau nuclear reactor.

Samples of surface run-off from the Used Fuel Dry Storage Facility collected and analyzed in 2004 have shown that tritium concentrations varied between 17 and 380 Bq/L. The average dose for the year at the Used Fuel Dry Storage Facility perimeter fence was 875 µSv, which is equivalent to an average dose rate of 0.10 µSv/h.

A proposed reactor refurbishment project will, if carried through, result in a substantial increase in the size of the Used Fuel Dry Storage Facility, where the number of canisters to be built will reach 600. The proposed modifications to the Solid Radioactive Waste Management Facility were subjected to an environmental assessment in accordance with the CEAA in mid-2003. An authorization to construct the additional waste storage structures was delivered in early 2004.

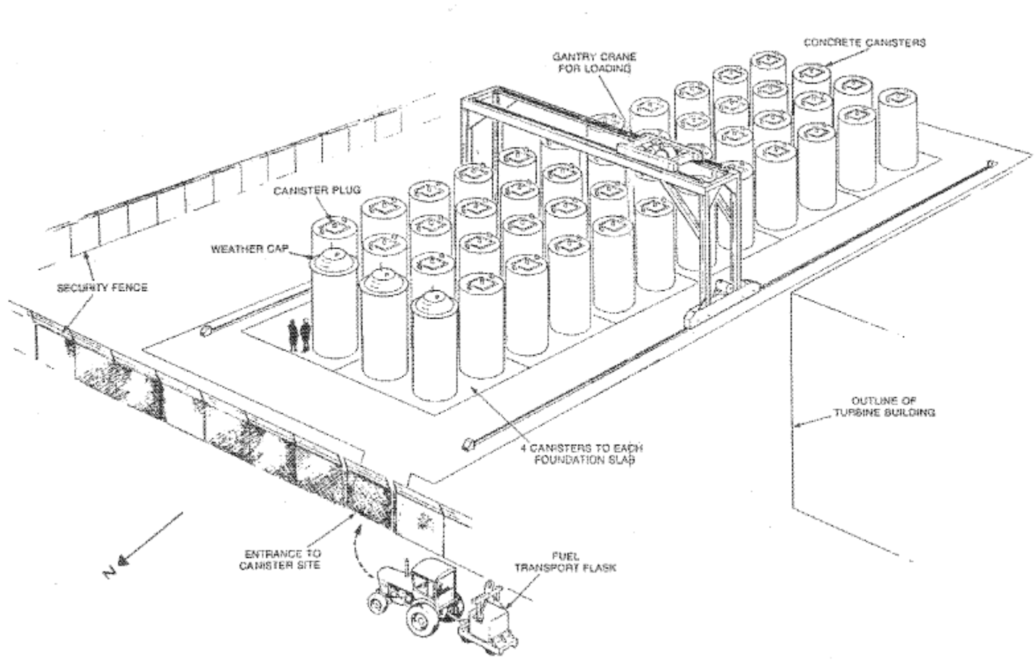
Figure 4.8 Point Lepreau Used Fuel Dry Storage Area

4.5.11 Douglas Point Used Fuel Dry Storage Facility

The AECL Douglas Point Used Fuel Dry Storage Facility is located at the Bruce Nuclear Power Development. The prototype CANDU power reactor at Douglas Point was shut down permanently after 17 years of operation. Decommissioning began in 1986 and approximately 22,000 spent fuel bundles were transported to concrete canisters located externally to the facility building in late 1987. The concrete canisters are currently in a Storage with Surveillance mode.

The tritium sampling program recorded activity between 41.4 and 630 Bq/L from the sumps located near the dry storage facility. The Gross Beta activity levels were in the range 0.16 to 0.43 Bq/L from the same sumps.

Figure 4.9 Douglas Point Storage Silos



4.5.12 Gentilly-1 Used Fuel Dry Storage Facility

The AECL Gentilly-1 Nuclear Power Station became operational in May 1972. It attained full power for two short periods in 1972 and was then operated intermittently, when required, for a total of 183 effective full power days until 1978. In 1984, AECL began a two-year decommissioning program. As part of the program, a total of 3,213 spent fuel bundles were transferred to concrete canisters located internally in a section of the Gentilly-1 Turbine Building. The concrete canisters are currently in a Storage with Surveillance mode.

The Dry Fuel Storage Canister Air Sampling program showed Gross Beta Activity levels per canister in the range of less than 0.08 Bq up to 0.26 Bq for samples of 2.70 m^3/canister.

4.5.13 Chalk River Laboratories – Area G – Used Fuel Dry Storage Area

NPD was a demonstration reactor operated by Ontario Hydro (now OPG) from 1962 until 1987 at which time it was decommissioned. As part of the decommissioning program, the used fuel was transferred to concrete canisters located at the AECL CRL Used Fuel Dry Storage Area. At this site, AECL has stored 68 full and partial spent fuel bundles from Bruce, Pickering and Douglas Point, as well as 4,853 fuel bundles from the NPD reactor, in 12 dry storage concrete canisters. The concrete canisters are currently in a Storage with Surveillance mode.

Two concrete canisters were constructed on the existing concrete support pad to store calcined waste which will be created by the processing of radioisotopes separated in the New Processing Facility at CRL. In 2004, inactive commissioning of the calcine waste canisters continued.

4.5.14 Whiteshell Used Fuel Storage Facility

The WL was established at Pinawa, Manitoba in the early 1960s to carry out nuclear research and development activities for higher temperature versions of the CANDU reactor. The initial focus of research was the Whiteshell Reactor-1 Organic Cooled Reactor, which began operation in 1965. Whiteshell Reactor-1 continued to operate until 1985.

The Concrete Canister Storage Facility or Whiteshell Used Fuel Storage Facility was developed at WL to demonstrate that dry storage was a feasible alternative to water pool storage for irradiated reactor fuel.

Because of the success of the demonstration program, concrete canisters have been used to store all remaining WR-1 used fuel. The facility provides storage for 360 irradiated fuel bundles. Some fuel waste from operations prior to 1975 is buried in standpipes in the Waste Management Area. Further details on the Whiteshell decommissioning program can be found in Annex 7.

Figure 4.10 Whiteshell Laboratories Current Silo Array

4.5.15 NRU Research Reactor

The NRU Research Reactor is a thermal neutron, heterogeneous, heavy water moderated and cooled reactor. It was designed for operation with natural uranium metal fuel rods and converted to operation with enriched driver fuel rods in 1964. Gradual conversion to low enriched uranium fuel began in 1991.

The rod storage consists of water-filled bays. The storage area is divided as follows: General Bay Plug End Bay, Fuel End Bay Inspection Bay, Isolation Bay Trucking Area, and Long Rod Bay Equipment Room. The Bay Cooling System removes the heat generated by the irradiated fuel ends in the bays. The water is circulated through two heat exchangers and is returned to the bottom of the Fuel End Bay. After an appropriate time period for radioactive decay, the spent fuel is generally transferred to tile holes at Waste Management Area 'B' at CRL. The tile holes are also used to store the spent fuel from the National Research Experimental (NRX) Reactor which was shutdown in 1992.

4.5.16 McMaster Nuclear Reactor

The McMaster Nuclear Reactor is a pool-type reactor, with a core of enriched uranium fuel moderated and cooled by light water. The reactor was upgraded to operate at powers up to 5 MW. Plans are in the works to convert to Low Enriched Uranium fuel to ensure continued safe operation and comply with international standards.

The McMaster Nuclear Reactor is the only Canadian medium flux reactor in a university environment. The McMaster Nuclear Reactor's neutrons are used in nuclear physics, biology, chemistry, earth sciences, medicine, and nuclear medicine.

All fuel generated at the McMaster Nuclear Reactor is stored in a water environment.

ANNEX 5

RADIOACTIVE WASTE MANAGEMENT FACILITIES

5.1 Radioactive Waste Management Methods

All radioactive wastes produced in Canada are placed into Storage with Surveillance, pending the establishment of long-term waste management facilities. A variety of storage structures are currently in use at the various waste management facilities:

- In-ground burial;
- Low-level storage buildings;
- Modular above-ground storage buildings;
- Quonset huts;
- Tile holes;
- In-ground containers; and
- Concrete bunkers.

5.1.1 Pickering Waste Management Facility

The Pickering Waste Management Facility consists of the Used Fuel Dry Storage Area and a storage area called the Re-tube Components Storage Area (RCSA), for reactor core component waste from re-tube activities at the Pickering NGS-A. The RCSA is located within the protected area of the Pickering NGSs. The RCSA is operating in a Storage with Surveillance mode, meaning it is closed to new waste without the prior written approval of the regulatory body.

The RCSA uses dry storage modules (DSMs) to store the re-tube components. The RCSA was designed to accommodate 38 dry storage modules (DSMs). They are cylindrical casks made from reinforced heavy concrete. The design of the DSMs provides adequate shielding to meet dose rate requirements outside the facility and to keep worker dose rates as low as reasonable achievable (ALARA). At present the RCSA consists of 34 loaded DSMs, two empty DSMs and empty space for an additional two DSMs.

The RCSA prevents the pooling of rainwater and provides a low-maintenance surface. A drainage system directs the runoff water from the storage area to the Pickering NGS-B outfall. Catch basins permit the periodic sampling of the water.

Figure 5.1 PWMF with RCSA on left and Used Fuel Dry Storage Area on right

5.1.2 Western Low and Intermediate Level Waste Storage Facility

The Western Waste Storage Facility (WWMF) is owned and operated by OPG at the Bruce Nuclear Power Development site, in the Municipality of Kincardine, Ontario. The WWMF consists of two distinct areas:

- Low and Intermediate Level Radioactive Waste Storage Area; and
- Used Fuel Dry Storage Area (refer to Annex 4).

The Low and Intermediate Level Radioactive Waste Storage Area provides safe handling, treatment, and storage of radioactive materials produced at NGSs (Pickering A and B, Darlington, Bruce A and B) and other facilities currently or previously operated by OPG, or its predecessor Ontario Hydro. The Low and Intermediate Level Radioactive Waste Storage Area include various components such as the Waste Volume Reduction Building (WVRB) and the Transportation Package Maintenance Building. The various storage structures used in this facility include low-level storage buildings, quadricells, in-ground containers, trenches, and tile holes.

The Waste Volume Reduction Building provides for the receipt of low-level radioactive wastes and the compaction, shredding, baling and incineration prior to storage. The Waste Volume Reduction Building consists of the following main areas:

- **Radioactive Waste Incinerator Area:** contains the radioactive waste incinerator, shredder, associated equipment and an active drainage sump.

- **Compaction Area:** contains a box compactor and two maintenance shops for repairs, equipment storage, welding and equipment maintenance activities.

- **Material Handling, Storage and Sorting Area:** provides for material movement, sorting, and temporary storage of incoming and processed wastes. Access to the incinerator and compaction areas is included.

- **Control Room:** houses the main work control centre, and all low and intermediate waste storage area systems and services alarms are monitored in this room.

- **Truck Bays:** establishes a weather protected area for the receipt and unloading of wastes.

- **Ventilation Equipment Areas:** these areas contain air intake filters, intake fans, heating coils, air exhaust filters and exhaust fans. Radioactive airborne effluent monitors for building ventilation and radioactive incinerator exhaust are also located in this area.

- **Electrical and Storage Rooms:** these rooms provide for electrical equipment, non-waste storage and records storage.

OPG has developed Derived Release Limits (DRLs) for the airborne radioactive releases from the radioactive incinerator and active ventilation in the WVRB and for releases to surface waters from drainage at the site. With respect to the non-radioactive effluents, they must conform to the provincial air effluent discharge limits. Currently radioactive and non-radioactive effluents are all below regulatory requirements.

The safe handling, processing, and storage of radioactive waste at the WWMF requires a combination of design features, procedures, policies, and monitoring programs, some of which are generic design considerations. Required programs focus radiation protection, occupational health and safety, environmental protection, and monitoring programs for individual areas as well as the overall facility.

The low and intermediate level waste storage area of the WWMF typically receives on the order of about 600 m^3 of radioactive waste per month. The actual amount can vary widely depending on maintenance activities at the various nuclear generating stations. The waste is subsequently processed, where possible, and placed into the appropriate storage structure.

An EA is presently underway for OPG's proposed refurbishment waste storage project. This project, if approved, will provide for refurbishment waste storage within the currently developed part of the Low and Intermediate Level Waste Storage Area. The construction schedule for the refurbishment waste storage structures will be based on need, and therefore on the refurbishment plans developed for the nuclear generating stations by the power reactor licensee.

In 2004, the WWMF (used fuel dry storage area and the Low and Intermediate Level Waste Storage Area combined) released 3.3E+13 Bq of tritium, 1.7E+05 Bq particulate beta/gamma, 1.3E+o5 Bq I-131 and 4.0E+08 Bq C-14 to air. A total of 0.02% of the DRL, and 2.1E+10 Bq tritium and 6.2E+06 Bq gross beta to water, a total of 0.006% of the DRL.

Figure 5.2 Western Waste Management Facility

5.1.3 Radioactive Waste Operations Site 1

Radioactive Waste Operations Site 1 (RWOS 1) is owned and maintained by OPG at the BNPD site. The facility provides for the storage of low and intermediate level waste that was produced at the Douglas Point Nuclear Generating Station. Wastes are stored in reinforced concrete trenches with concrete covers.

The facility, which has been operating in a Storage with Surveillance mode since the mid-1970s, is closed to the receipt of new wastes. OPG monitors and maintains the site and structures. No new waste can be added without the prior written approval of the regulatory body.

5.1.4 Hydro-Québec Waste Management Facility

The Hydro-Québec Waste Management Facility consists of the Used Fuel Dry Storage Area and the Low-Level Radioactive WMA. The Hydro-Québec Low-Level Radioactive WMA provides for the safe storage of radioactive materials produced at the Gentilly-2 NGS. The Hydro-Québec Low-Level Radioactive WMA consists of several types of reinforced concrete bunkers.

The Type A bunker is used for the storage of high activity level radioactive waste such as filters. Type B is used for the storage of medium activity level radioactive waste, while Type C is used for the storage of low activity level radioactive waste.

The Hydro-Québec Low-Level Radioactive WMA receives approximately eight cubic metres of radioactive waste per month.

Samples of surface run-off from the Radioactive WMA collected and analyzed in 2004 have shown that the tritium concentrations varied between 460 Bq/L and 1,700 Bq/L. The average dose rate for 2004 at the Radioactive WMA perimeter fence was 0.14 μSv/h.

A proposed reactor refurbishment project will, if carried through, result in a substantial increase in the size of Hydro-Québec's Waste Management Facility. A new Solid Radioactive Waste Management Facility (SRWMF) will be developed, where additional Type A, B, and C concrete bunkers will be constructed.

Furthermore, two new types of concrete structures will be added to this new facility. These two types will consist of Re-tube Waste Canisters for the high activity refurbishment waste and Used Resin Storage Enclosures. The proposed modification to Hydro-Québec's Waste Management Facility is currently under regulatory review and is undergoing an EA in accordance with the CEAA.

Figure 5.3 Hydro Québec Waste Management Facility

5.1.5 Point Lepreau Waste Management Facility

The Point Lepreau Solid Radioactive Waste Management Facility (SRWMF) includes a Phase I Area for the safe storage of radioactive materials produced at the Point Lepreau NGS and a Phase II Area for the storage of spent fuel. The Phase I Area contains the following storage structures:

- **Vaults**—These concrete structures are used to store the bulk of low-level wastes. Almost all the waste stored in the vaults is expected to decay to an insignificant level by the end of the design life of the structure. There are approximately 2,035 m^3 of storage in the four vault structures. Each vault has four equal compartments.

- **Quadricell**—The quadricell structures are designed to contain intermediate activity level waste, such as spent ion exchange resins and filters from reactor systems, and activated system components. Currently there are approximately 144 m^3 of quadricell storage in lines of nine quadricells.

- **Filter**—The filter storage structures are used for storing filters from heat transport purification, active drainage, gland seal supply, moderator purification, spent fuel bay, and fuelling machine D2O systems.

The Phase I Area receives approximately eight cubic metres of radioactive waste per month.

Samples of surface run-off from the Phase I Area collected and analyzed in 2004 have shown that tritium concentrations varied between 170 and 5,330 Bq/L. The average dose for the year at the Phase I Area perimeter fence was 817.5 µSv, which translates to an average dose rate of 0.09 µSv/h.

A proposed reactor refurbishment project will, if carried through, result in a substantial increase in the size of both the Phase I and Phase II Areas. A new Phase III Area within the SRWMF will also be developed. It will include Re-tube Waste Canisters for refurbishment tube waste and concrete vaults for the low activity refurbishment waste. The proposed modifications were subjected to an EA in accordance with the CEAA in mid-2003. An authorization to construct the additional waste storage structures was delivered in early 2004.

Figure 5.4 SRWMF at Point Lepreau

5.1.6 Radioactive Waste Management at Decommissioned Reactor Sites

The reactors that have been partially decommissioned have become storage facilities for radioactive wastes produced from the decommissioning activities. Annex 7 provides further information on the decommissioning activities at each of these sites.

5.1.6.1 Douglas Point Waste Management Facility

The AECL Douglas Point Waste Management Facility (DPWMF) is located on the Bruce Nuclear Power Development site in the Municipality of Kincardine, Ontario. The prototype CANDU power reactor was shutdown permanently in 1984 after 17 years of operation. Decommissioning began in 1986 and the spent fuel bundles were transported to concrete canisters in the late 1987.

Stored waste consists of activated corrosion products and fission products. The waste is stored in the Reactor and Service buildings. The sources of each waste type are as follows:

- induced radioactivity in reactor components and the biological shield;
- radioactive corrosion products and fission products deposited on the drained heat transport and moderator surfaces;

- ion exchange resin from both the heat transport and moderator systems stored in underground tanks;
- contaminated soil stored in the service building;
- drums of contaminated steel from fuel storage trays; and
- intermediate level waste stored in the fuel transfer tunnel leading from the reactor building to the receiving bay.

In 2004, DPWMF released 1.74E+11 Bq of tritium from the HEPA-filtered ventilation system for the reactor building during 279 hours of operation. Total liquid tritium release was 4.36E10 Bq from the reactor building and the total beta/gamma release was 4.43E+07 Bq.

5.1.6.2 Gentilly-1 Waste Management Facility

The AECL Gentilly-1 Waste Management Facility (G1WMF) is situated within Hydro-Québec's Gentilly-2 Nuclear Generating Station boundary. The CANDU-BLW-250 Gentilly-1 Nuclear Power Station began operating in May 1972 and attained full power for two short periods during that same year. It was operated intermittently for a total of 183 effective full power days until 1978 when it was determined that certain modification and considerable repairs would be required. Consequently it was in a lay-up state from 1980 to 1984. In 1984, a decommissioning program was initiated to bring the Gentilly-1 station to a safe sustainable shutdown state allowing Storage with Surveillance.

The G1WMF consists of specified areas within the Turbine and Service Buildings, the whole Reactor Building, the Resin Storage Area and the Spent Fuel Storage Canister Room.

Stored waste consists of activated corrosion products and fission products. The sources of each waste type are as follows:

- induced radioactivity in reactor components and the biological shield;
- radioactive corrosion products and fission products deposited on the drained heat transport and moderator system surfaces;
- contaminated soil;
- ion exchange resin from the heat transport and moderator systems; and
- containers of dry low-level contaminated equipment and material that resulted from operation and earlier decommissioning activities.

There are no airborne releases from the G1WMF. In 2004, 13.21E+04 Bq of beta/gamma activity were released from the facility liquid sump to the Hydro-Québec Power Reactor Active Liquid Discharge System.

Figure 5.5 Gentilly-1 Waste Management Facility

5.1.6.3 Nuclear Power Demonstration Waste Management Facility

The AECL Nuclear Power Demonstration Waste Management Facility (NPDWMF) contains the decommissioned NPD Nuclear Generating Station and is located in Rolphton, Ontario.

The station operated from 1962 until 1987 when it was decommissioned to a "Static State" interim storage condition by Ontario Hydro (now OPG), with AECL assistance. After the "Static State" was achieved, Ontario Hydro turned over control of the NPDWMF to AECL in September of 1988. Subsequent to 1988, various non-nuclear ancillary facilities such as the Administration Wing, Training Centre, Pump House and two large warehouses were demolished and refuse was removed from the site for reuse, recycling or waste. The fuel bundles were transferred to Area G at the CRL Waste Management Area.

The NPDWMF is divided into a nuclear and non-nuclear area. Stored waste consists of induced radioactive, activated corrosion products and some fission products. The confined residual radioactivity in NPD after removal of the irradiated fuel and heavy water consists of:

- induced radioactivity in the reactor components and biological shield (i.e. the concrete walls surrounding the reactor);
- radioactive corrosion products in the drained heat transports and moderator systems; and
- small amounts of radioactivity in auxiliary systems and components and materials stored in the Zone 3 area.

In 2004, the airborne effluent releases were 4.1E+10 Bq, and 2.47E+11 Bq of liquid effluent for tritium, carbon-14, and gross beta.

Figure 5.6 NPDWMF in March 2001

5.1.7 AECL Nuclear Research and Test Establishment Facilities

AECL currently has two research facilities in Canada—one at the AECL CRL in Ontario which is operational and the other at the AECL WL in Manitoba which is currently undergoing decommissioning. Radioactive wastes produced at these two sites are stored in waste management facilities at each site.

5.1.7.1 Chalk River Laboratories

The CRL site is located in Renfrew County, Ontario on the shore of the Ottawa River, 160 km northwest of Ottawa. The site, which has a total area of about 4000 Ha, is situated within the boundaries of the Corporation of the Town of Deep River. The Ottawa River, which flows northwest to southeast, forms the northeasterly boundary of the site, the Petawawa Military Reserve abuts the CRL property to the southeast, and the Village of Chalk River in the Municipality of Laurentian Hills lies immediately to the southwest of the site.

The CRL site was established in the mid 1940s, and has a history of various nuclear operations and facilities, primarily related to research. Most of the nuclear and associated support facilities and buildings on the site are located within a relatively small industrial plant site area adjacent to the Ottawa River near the southeast end of the property. Various waste management areas for radioactive and non-radioactive wastes are located within the CRL property, along the southwest to northeast corridor. The CRL WMAs not only manage wastes produced from CRL operations but also operate a fee-based national waste management service for institutions which do not manage their own wastes, such as universities, hospitals, and industrial users.

The CRL WMAs manage eight types of waste:

- **CRL Nuclear Reactor Operation Wastes**, which include fuel and reactor components, reactor fluid clean-up materials (e.g. resins and filters), trash and other materials contaminated with radioactivity as a result of routine operations;

- **CRL Fuel Fabrication Facility Wastes**, which include zirconium dioxide and graphite crucibles used to cast billets, filters, and other trash such as gloves, coveralls, and wipes;

- **CRL Isotope Production Wastes**, which include general radioactive wastes contaminated primarily with cobalt-60 and molybdenum-99;

- **CRL Isotope Usage Wastes**, which include general radioactive wastes contaminated primarily with cobalt-60 and molybdenum-99;

- **CRL Hot Cell Operations Wastes**, which include cleaning materials, contaminated air filters, contaminated equipment, and discarded irradiated samples;

- **CRL Decontamination and Decommissioning Wastes**, which includes a variety of contaminated waste which have highly variable physical and chemical properties as well as radiological properties;

- **CRL Remediation Wastes**, which include solidified waste arising from the treatment of contaminated soil and groundwater; and

- **CRL and Off-site Miscellaneous Wastes**, which include radioactive wastes that do not readily fall within the other classes of wastes described above. For example, contaminated soil would be classified as a miscellaneous waste.

Liquid wastes such as scintillation cocktails, radiological contaminated lubricating oils, and polychlorinated biphenyl (PCB)-contaminated waste and isotope production wastes are also stored at the CRL WMAs. Approximately 1,500 m^3 are added to the WMAs per year, including wastes received from off-site waste generators.

In addition, active aqueous wastes generated at the CRL site are treated at the Waste Treatment Centre (WTC). After treatment through a Liquid Waste Evaporator, the treated effluent is released to the Process Sewer which eventually discharges to the Ottawa River.

5.1.7.1.1 Waste Management Area A

The first emplacement of radioactive waste at the CRL site took place in 1946 into what is now referred to as Waste Management Area A(WMA A). These emplacements took the form of direct disposal of solids and liquids into excavated sand trenches. The scale of operations was modest and unrecorded until 1952 when the cleanup from the NRX accident generated large quantities of radioactive waste (which included the NRX Calandria) that had to be quickly and safely managed. At this time, approximately 4,500 m^3 of aqueous waste containing 330 TBq (9,000 Ci) of mixed fission products were poured into excavated trenches. This was followed by smaller dispersals (6.3 TBq and 34 TBq of mixed fission products) in 1954 and 1955 respectively. The active liquid disposal tank received bottled liquids and, based on recorded observations; it is assumed the bottles were intentionally broken at the time of emplacement. The active liquid disposal tank was estimated to have received about 3.7×10^{13} Bq of Sr-90 and about 100 g of plutonium.

WMA A is on the western flank of a sand ridge. Three aquifers have been identified in the vicinity of WMA A: a Lower Sand, a Middle Sand, and an Upper Sand. Groundwater flow is initially to the south, and then as the aquifer sands thicken, the flow direction bends to the south-southeast. The wastes are believed to be above the water table in WMA A, but infiltration has transported contaminants into the groundwater thereby creating a contaminated plume which covers an area of 38,000 m^2. Groundwater monitoring data collected to date have encountered total beta, gross alpha, and ^{90}Sr in some of the samples wells.

5.1.7.1.2 Waste Management Area B

Waste Management Area B (WMA B) was established in 1953 to succeed WMA A as the site for solid waste management. The site is located on a sand covered upland approximately 750 m west of WMA A. Early waste storage practices for Low Level Radioactive Waste (LLRW) were the same as those used in WMA A, namely emplacement in unlined trenches capped with sandy fill in what is now the northern portion of the site. Additionally, numerous special burials of components and materials such as the NRX calandria occurred.

Asphalt-lined and capped trenches were used for solid Intermediate Level Radioactive Waste from 1955 to 1959 when they were superseded by concrete bunkers constructed below grade but above the water table in the site's sand. Use of sand trenches in WMA B for LLRW was discontinued in 1963 in favour of concrete bunkers and WMA C.

Concrete structures were used to store solid waste packages that did not meet sand trench acceptance criteria but, as well, did not require a significant amount of shielding. Early concrete bunkers were rectangular in shape. These were superseded in 1977 by cylindrical structures which are currently used.

Cylindrical bunkers are formed with corrugated reinforced concrete walls on a concrete pad by using removable forms. The maximum volume of a cylindrical concrete bunker is 110 m^3, but typical volumes of stored waste average about 60 m^3.

High level wastes are also stored in WMA B in engineered facilities known as tile holes. Tile holes are used to store radioactive materials that require more shielding than can be provided in concrete bunkers. Stored materials include irradiated fuel, hot cell waste, experimental fuel bundles, unusable radioisotopes, spent resin columns, active exhaust system filters and fission product waste from the molybdenum-99 production process.

There are two groundwater contaminant plumes extending from WMA B. The plume on the east side contains tritium as the predominant contaminant. Tritium concentrations have been declining steadily since 1976 when a peak concentration of 19,000 Bq/L was observed.

The second plume emanates from the northwest corner and is dominated by strontium-90. This plume is treated at the Spring B Treatment Plant. This automated treatment facility removes strontium-90 from the surface water and groundwater plume that emanates from the northwest corner of WMA B. The current inventory in the sand and till beneath WMA B is estimated at about 7.5 TBq. In 2003, the Spring B Treatment Plant treated 3.1 million litres of groundwater, removing 8 GBq of Sr-90, reducing input concentrations from 2580 Bq/L (avg.) to 21 Bq/L (avg.).

5.1.7.1.3 Waste Management Area C

Waste Management Area C (WMA C) was established in 1963 to receive low-level wastes with hazardous lifetimes less than 150 years and wastes that could not be confirmed to be uncontaminated. Early operations consisted of emplacements in parallel trenches separated by intervening wedge shaped strips of undisturbed sand. In 1982, this was changed to the method of a Continuous Trench method to make more efficient use of available space. Part of the original parallel trenches was covered with an impermeable membrane of High Density Polyethytlene in 1983.

The WMA C extension was constructed adjacent to the south end of WMA C in 1993 and began accepting wastes in 1995. As the Continuous Trench and/or its extension is backfilled and landscaped, material from the suspect soil stockpile is used for grading purposes to ensure that the surface of WMA C is suitable for travel by heavy equipment. Material placed in the stockpile must satisfy specific acceptance criteria. In addition, some waste materials are held in surface storage at WMC, which include items like the NRX stack sections and some wastes contained in 200-litre drums. WMA C and its extension are planned for closure in 2006.

In addition to sand trench waste, inactive acid, solvent and organic liquid waste were also placed in specific sections of the trenches or in special pits located along the western edge of the area This practice was ended in 1982. Contaminated sewage sludge was also emplaced in the sand trenches until late 2004.

Groundwater monitoring data at WMA C indicates that a plume is emanating from this area. The primary contaminant is tritium. Releases of tritium into the nearby streams appear to be declining slightly.

5.1.7.1.4 Waste Management Area D

Waste Management Area D (WMA D) was established in 1976 to store obsolete or surplus equipment and components that are known or suspected to be contaminated but do not require enclosure (pipes, vessels, heat exchangers, etc.). It also stores closed marine containers holding drums of contaminated oils and Liquid Scintillation Cocktails. These latter items pose more of a short-term chemical hazard than a radiological hazard. The site consists of a fenced compound enclosing a gravel-surfaced area in which the components are placed. If the components have surface contamination they must be appropriately packaged such that the package is free of surface contamination. The LLRWMO maintains two buildings for the storage of slightly contaminated material from non-AECL sites.

All storage in WMA D is above ground. No burials are authorized in this area.

5.1.7.1.5 Waste Management Area E

WMA E is an area that received suspect and slightly contaminated soils and building materials and other bulk soils and building debris from approximately 1977 to 1984. The waste materials were used to construct a roadway to a site, which was intended to become a waste management area for suspect contaminated materials to be used in place of WMA C for this type of waste. The plan for the creation of this site was terminated when concerns were raised about the location.

5.1.7.1.6 Waste Management Area F

A new area was established in 1976 to accommodate contaminated soils and slags from Port Hope, Albion Hills and Ottawa, Ontario. This site was designated Waste Management Area F (WMA F). The stored materials are known to contain low levels of ^{226}Ra, uranium and arsenic. Emplacement was completed in 1979 and the site is now considered closed, although it is subject to monitoring and surveillance to assess possible migration of radioactive and chemical contaminants.

5.1.7.1.7 Waste Management Area G

Waste Management Area G (WMA G) was established in 1988 to store the entire inventory of irradiated fuel from the NPD prototype CANDU power reactor in above-ground concrete canisters.

5.1.7.1.8 Waste Management Area H

Waste Management Area H (WMA H), better known as the Modular Above-Ground Storage Facility, began operating in 2002. The facility consists of two components: the Waste Handling Building which prepares compactable and other low-level radioactive waste for storage in the second component, namely WMA H. The site has the capacity to store the volume of compacted and packaged low-level radioactive waste that will be generated for the next 20 years.

5.1.7.1.9 Liquid Dispersal Area

Development of the Liquid Dispersal Area commenced in 1953 when the first of several infiltration pits was established to receive active liquids via pipeline from the NRX Rod Bays. The pits are located on a small dune, in an area bounded on the east and south by wetlands and by WMA A to the west.

Reactor Pit #1 was a natural closed depression used between 1953 and 1956 for radioactive aqueous solutions. Dispersals included an estimated 74 TBq of Sr-90, along with a wide variety of other fission products and approximately 100 g of Pu (or other alpha emitters expressed as Pu). Between 1956 and 1998, the pit was backfilled with solid materials that included contaminated equipment and vehicles previously stored in WMA A plus potentially contaminated soils from excavations in the Active Area.

Reactor Pit #2 was established in 1956 to succeed Reactor Pit #1. A pipeline was used for transfers of NRX Rod Bay water. Samples of water from the holding tank are analyzed for soluble and total alpha, soluble and total beta, Sr-90, tritium, Cs-137 and uranium.

The Chemical Pit was also established in 1956 to receive radioactive aqueous wastes from active laboratories on site (other than the reactors). Its construction is similar to that of Reactor Pit #2, namely an excavation backfilled with gravel and supplied by a pipeline.

The last facility in the Liquid Dispersal Area is the Laundry Pit which was installed in 1956. As its name implies, it was used for wastewater from the active area laundry and the Decontamination Centre, but was only employed for that purpose for a year. The recorded inventory is 100 GBq of mixed fission products and 0.1 g Pu-239.

The Liquid Dispersal Area has not been used since 2000 and there are no plans for future use of this area.

There are groundwater plumes emanating from the Liquid Dispersal Area. The plume from the reactor pits contains tritium as the only nuclide released in significant quantities. With regard to other contaminants, limited subsurface sampling has shown the presence of Sr-90 which has traveled at least 100 m from pit.

The second plume emanates from the Chemical Pit. The radionuclide of primary concern is Sr-90. This plume is treated via a Treatment Plant. In 2003, this plant treated approximately 4 million litres of groundwater, removing approximately 7 Gbq of Sr-90.

5.1.7.1.10 Acid, Chemical & Solvent Pits

A series of three small pits are located north of WMA C and are collectively known as the Acid, Chemical & Solvent Pits. The pits were constructed in 1982 and remained in operation up to 1987. The pits were individually used for inactive chemical, acid and solvent wastes. The acid pit received on the order of 11,000 litres of liquid wastes (hydrochloric, sulphuric and nitric acids) and a small amount of solid wastes (potassium carbonate powder, acid batteries and citric acid). The solvent pit received approximately 5,000 litres of mixed solvents, oils, varsol, acetone, etc. The chemical ACS pit received smaller volumes of wastes.

5.1.7.1.11 Waste Tank Farm

The Waste Tank Farm contains seven underground stainless steel tanks for the storage of high-level radioactive waste. The first series of three tanks contain rod storage ion exchange regeneration solutions. One of the three tanks is empty and provides a transfer destination for the contents of either of the other two tanks should they develop a leak.
The second series of four tanks contain acid concentrate mainly from fuel reprocessing done between 1949 and 1956. The last transfer of solutions to any of the storage tanks at the Waste

Tank Farm occurred in 1968. There have been no additions since that time. One of the four tanks is empty and serves as a backup in the event that one of the other tanks leaks.

5.1.7.1.12 Ammonium Nitrate Decomposition Plant

The ammonium nitrate plant was built in 1953 and was used to decompose the ammonium nitrate in liquid wastes from the fuel processing plant. The plant was shut down in 1954 and was subsequently dismantled with much of the equipment being buried *in situ*.

The plume emanating from the ammonium nitrate plant is treated to recover Sr-90. The treatment system captures 99% of the Sr-90. Contaminated groundwater enters the treatment system with an average Sr-90 activity of 85 Bq/L and exits the system with an average between 0.4 and 0.6 Bq/L. Since 1998, the treatment system has prevented the discharge of 5.17E+09 Bq of Sr-90.

5.1.7.1.13 Thorium Nitrate Pit

In 1955, about 20 m^3 of liquid waste from a uranium-233 extraction plant on the CRL site was discharged into a pit. The solution contained 200 kg of thorium nitrate, 4600 kg of ammonium nitrate, 10 g of uranium-233, and 1.85 x E+11 Bq each of strontium-90, cesium-137, and cerium-144. The pit was filled with lime to neutralize the acid and precipitate the thorium. The pit was covered with soil.

5.1.7.1.14 Glass Block Experiments

In 1958, as part of a program to investigate methods for converting high-level radioactive liquid solutions into a solid, a set of 25 hemispheres of glass (2 kg each) of mixed fission products was buried below the water table. A second set of 25 blocks of aged fission products was buried in 1960. The burials were designed to test how well the glassified wastes would retain the incorporated fission products if exposed to leaching in a natural groundwater environment.

5.1.7.1.15 Bulk Storage Area

The Bulk Storage Area was used prior to 1973 for the storage of large pieces of equipment from the Control Area.

The operation of the CRL WMAs results in the release of radioactive and non-radioactive contaminants into the environment. Most of the existing releases are historical in nature. They result from discontinued practices (dispersal of intermediate-level liquid waste and sand trench disposal of intermediate solid and liquid wastes). The contaminant releases have contaminated on-site land, groundwater, surface water and vegetation.

However, the resultant contaminant concentrations in off-site water bodies are well below the standards set for both drinking water and the protection of aquatic life. DRLs have been established for airborne and liquid effluents released from the CRL site. CRL has developed administrative levels which are set at a fraction of the DRL and close to the normal operating levels. These administrative levels are used to provide timely warning that a higher-than-expected release has occurred and that the situation will be investigated promptly.

5.1.7.1.16 CRL Waste Treatment Centre

The Waste Treatment Centre (WTC) functions in the treatment of solid and liquid wastes from CRL facilities that are contaminated or suspected of being contaminated by radioactivity. The WTC also treats radioactive waste received by CRL from off-site waste generators.

Solid wastes are baled (after compacting if possible) and are transferred for storage in concrete bunkers in WMA B. The number of 0.4 m^3 bales produced per year range between 200 and 300. The solid waste generated internally by the WTC are additional to those quantities, and include disposable clothing, paper and cleaning materials which are compacted where possible, baled and stored in WMA B bunkers. Slightly contaminated and suspected wastes of WTC waste are also sent for storage in WMA H.

Liquid waste is treated in variable amounts per year, ranging between 2,000 and 6,000 m^3. These wastes consist of Decontamination Centre Waste, Chemical Active Drain System Waste, Reactor Active Drains Waste and DIF Waste. Treatment facilities include a Liquid Waste Evaporator (LWE) which concentrates the waste, and a Liquid Waste Immobilization System which immobilizes the concentrate in bitumen, which is drummed and stored in WMA B.

Atmospheric releases of radionulcides from the WTC occur via roof vents. Monitoring of the roof vents includes particulate gross alpha activity, particulate gross beta activity, tritium oxide and I-131. Treated liquid effluent from the WTC is discharged to the process sewer after sampling for gross alpha, gross beta and tritium oxide. The liquid effluent is also regularly monitored for suspended solids, total phosphorus, nitrates, pH, conductivity, organic carbon, chemical oxygen demand, solvent extractable, metals, volatile organics and semi-volatiles.

5.1.8 Monserco Limited

Monserco Limited, in operation since 1985, operates a radioactive waste processing facility in Brampton, Ontario. In this facility, radioactive wastes, typically from hospitals, universities, research institutes and private firms are sorted, compacted, packaged and shipped to AECL’s CRL radioactive waste facility.

The service also includes the handling and disposal of spent sealed sources and disposal of used liquid scintillation vials and cocktails. Monserco Limited also operates a radioactive waste and source pickup service in Montreal, Quebec. These wastes and sources are transported to the Brampton facility for processing and shipment. The Monserco Limited Waste Management Facility handles and transfers to CRL approximately 30 m^3 of radioactive waste per month.

Monserco Ltd. typically does not release any effluents into the environment.

5.1.9 Cameco Port Hope Conversion Facility Waste and By-Product Management

Conserving and recycling waste materials is an important part of operations for both environmental and economic reasons. Ongoing recycling programs include in-plant recycling of hydrofluoric acid and the sale of ammonium nitrate byproduct for use as commercial fertilizer.

There are several process streams in the conversion process which result in low levels of natural uranium materials. These materials are suitable for use as alternate feed for uranium mills and are sent on for further processing to recover the uranium.

Port Hope's waste management program attempts to collect, clean, monitor and, if necessary, cut to acceptable sizes all scrap material before releasing it to commercial recycling agencies. Material that cannot be recycled, or does not meet strict release guidelines, is either incinerated, drummed, stored on site or, in some instances, processed further and combined with a uranium-bearing product. The material being stored is primarily insulation, sand, soil, and scraps metal and will remain in storage until a future recycle or disposal route is identified.

Cameco is the licensee for two large waste management facilities it owns in the Port Hope area. These are the Welcome Waste Management Facility in the Municipality of Port Hope and the Port Granby Waste Management Facility in the Municipality of Clarington. These facilities were established in 1948 and 1955 respectively. The two facilities together contain roughly 1,150,000 m^3 of low-level radioactive waste and contaminated soils. Both facilities are now closed to any additional waste emplacements. The long-term management of these facilities will be addressed through the PHAI. In addition, the Government of Canada has agreed to accommodate 150,000 m^3 of Cameco wastes from its early operations within the PHAI. These wastes include barreled radioactive wastes, contaminated soils, and decommissioning wastes.

ANNEX 6

URANIUM MINE AND MILL FACILITIES

6.1 Background

The first radium mine in Canada began operating in 1933 at Port Radium in the Northwest Territories and was owned by Eldorado Gold Mines (a private company). Uranium ore concentrate was sent to Port Hope, Ontario, where radium was extracted. At that time, uranium had little or no commercial value and the focus was on the ore's Radium-226 content. The Port Radium Mine produced ore for radium until 1940, and reopened in 1942 to supply the demand for uranium from the British and US defence programs.

In 1943, Canada, the United Kingdom, and the United States instituted a ban on private exploration and development of radioactive materials. The Government of Canada also nationalized Eldorado Gold Mines in 1943 and established the federal Crown corporation Eldorado Mining and Refining. Eldorado Mining and Refining had a monopoly on all uranium prospecting and development. Canada subsequently lifted the ban on private exploration in 1948.

In 1949, Eldorado Mining and Refining began developing a uranium mine in the Beaverlodge area of northern Saskatchewan, and in 1953, milling the ore on-site commenced. The Gunnar and Lorado uranium mines and mills began operating in the same area in 1955 and 1957, respectively. Several other small satellite mines also opened in the area in the 1950s, sending ore for processing to either Eldorado or the Lorado mills.

In Ontario, 15 uranium mines began production between 1955 and 1960 in the Elliot Lake and Bancroft areas. Ten of the production centers in the Elliot Lake area and three in the Bancroft area, produced tailings.

At present, all active uranium mines are located in Saskatchewan. Mining is ongoing at Rabbit Lake, McClean Lake, and McArthur River, with Cluff Lake currently carrying out decommissioning activities and Cigar Lake currently under construction. Uranium mills and tailings exist at Cluff Lake, McClean Lake, and Rabbit Lake as well at Key Lake, where on-site deposits were mined out in 1997. Tailings deposition continues at Key Lake since all McArthur River ore is being processed.

6.2 Province of Saskatchewan

Saskatchewan is the only province in Canada with operating uranium mines. In the past, mine and mill operators have requested harmonization in areas such as inspections and reporting requirements involving Saskatchewan Environment, Saskatchewan Labour, and the CNSC. An agreement currently exists that will lead to greater administrative efficiency in regulating the uranium industry between the CNSC and the Province of Saskatchewan. The agreement lays the groundwork for the two groups to coordinate and harmonize their respective regulatory regimes.

6.3 Operational Tailings Management

6.3.1 Overview

About one third of the world's primary uranium production comes from the uranium deposits of the Athabasca Basin in northern Saskatchewan. These deposits include:

- the current production sites of Rabbit Lake, Key Lake, McClean Lake, and McArthur River;
- the Cluff Lake site where production was terminated at the end of 2002; and
- sites of planned future production at Cigar Lake and Midwest.

The newer sites include the highest grade uranium ore bodies in the world (at McArthur River and Cigar Lake) with averaging about 20% uranium. Some of these ores in the Athabasca Basin ores have high arsenic and nickel content (up to one and five per cent, respectively), which introduces additional considerations into the management of tailings and waste rock resulting from the mining and milling of these ores.

Mills with tailings management facilities (TMFs) are located at Rabbit Lake, Cluff Lake, Key Lake, and McClean Lake. There is no mill at the McArthur River mine since the ore is transported to Key Lake for processing. Similarly, mills are not planned at either Cigar Lake or Midwest, since the ores will be transported to McClean Lake for processing, with some processing activities for Cigar Lake uranium solution also planned for Rabbit Lake.

With the termination of production resulting from the depletion of the economically attractive ore bodies at Cluff Lake, milling and tailings management activities will be continued at only three sites (Key Lake, McClean Lake and Rabbit Lake). All three sites currently use the same basic approach of in-pit engineered disposal systems for tailings. Although there are certain differences in detail, two basic principles underlie containment of the tailings and their potential radionuclide and heavy metal contaminants:

(i) **hydraulic containment during the operational phase**—as a result of dewatering during mining, the water level in the pit at the start of tailings placement is well below the natural groundwater level in the area. This dewatering creates a cone of depression in the groundwater system, so that groundwater flow is towards the pit from all directions. This hydraulic containment feature is maintained throughout the operational life of the tailings facility by maintaining the pit in a partially dewatered state. To the extent that water has to be pumped from the pit, the operational experience at all of the sites is that current water treatment technology results in high quality effluent suitable for discharge to the surface water environment.

(ii) **passive long-term containment using the hydraulic conductivity contrast between the tailings and their surrounding geologic materials**—long-term environmental protection is achieved through passive physical controls on groundwater movement that exist in the system.

The tailings contain a significant fraction of fine-grained materials (from precipitates to processing reactions); consolidation occurs during operation and will be completed during the initial decommissioning steps. The outcome is that the consolidated tailings have a very low hydraulic conductivity. When surrounded by a material with a much higher hydraulic conductivity, the natural groundwater path is around the impermeable “plug” of tailings.

Potential contaminant transport from the tailings is controlled by diffusion from the outer surface; this is a slow process with minimal contaminant flux and consequently a high level of groundwater protection.

The permeable zone around the tailings may be installed (in the form of sand and gravel) as the tailings are placed, as is done at Rabbit Lake. Alternatively, the permeable zone may exist naturally, as is the case at McClean Lake and Key Lake, which allows subaqueous placement of tailings. At McClean Lake, the sandstone formation surrounding the tailings has a hydraulic conductivity contrast of more than a factor of 100 relative to the tailings.

Extensive characterizations of the natural geological formations and groundwater system, and of the tailings properties, are used to acquire reliable data for the computer models used to predict long-term environmental performance based on the simple principles governing the system. This performance will be confirmed by post-decommissioning monitoring, which will be continued until stable conditions for the long-term are achieved, and for as long as desired, thereafter.

The following sections provide site-specific details for the Athabasca Basin tailings facilities. The development of these facilities began nearly 30 years ago, and their favourable operational experience and the design evolutions which have been based on that experience, provide confidence in both their performance to date and into the future.

6.3.2 Key Lake

6.3.2.1 Tailings Management

The purpose of tailings management at Key Lake is to isolate and store the waste residue from the milling process, so that the public and the environment are protected from any future impact. Conceptually, this involves containing the solids and treating the water to quality standards acceptable for release to the environment. The waste metals removed from the water are disposed of as solids in the TMF.

From 1983 to 1996, waste from the Key Lake mill was deposited in an above-ground TMF which covered 36 hectares and was 15 metres deep. The TMF was constructed five metres above the groundwater table and used a modified bentonite liner to seal the bottom and isolate the tailings from the surrounding soil infrastructure.

Since 1996, the mined-out Deilmann open pit has been used as the TMF. Commissioned in January 1996, it is used to store tailings produced by milling low-grade stockpiled Key Lake ore and McArthur River ore. This TMF has a bottom drainage layer constructed in the basement rock of the mined-out pit. Tailings are deposited on top of this drainage blanket and water is continually pumped out to promote solid consolidation of overlying tailings. Tailings were initially deposited into the pit by sub-aerial deposition with the water extracted from the tailings mass through the bottom drain layer and raise well pumping system. The facility was changed to subaqueous deposition by allowing the pit to partially flood. Through the use of a tremie pipe system, tailings are deposited below the tailings surface under the water cover providing benefits in terms of tailings placement and the attenuation of radon emissions. In this system, tailings are placed in the mined-out pit using what is termed “a natural surround” containment strategy. Tailings and residual water on the surface are removed during tailings placement, both by the drainage blanket and by surrounding groundwater wells. The residual water extracted from the tailings mass is collected for treatment. The consolidated tailings form a low-permeability mass relative to the higher permeability area surrounding the tailings.

After decommissioning, groundwater will follow the path of least resistance (i.e. around the tailings, rather than through them), thereby minimizing environmental impacts.

6.3.2.2 Waste Rock Management

Waste rock management facilities include two special-waste storage facilities and three waste-rock storage areas. The waste-rock disposal areas comprise primarily benign rock and, therefore, do not have containment or seepage collection systems. The special waste contains low (uneconomic) levels of uranium, so this material is contained in engineered facilities that consist of underliners and seepage collection systems. Material from one of the special waste areas is being reclaimed for mill feed whereas all other waste rock and special waste areas are inactive.

6.3.2.3.1 Contaminated Industrial Wastes

Contaminated industrial wastes are either recycled or landfilled in the above-ground tailings management facility (AGTMF). Leachates from these materials are collected by the AGTMF’s seepage collection system and returned to the mill for process make-up water or treated and released to the environment. Typically 5,000 m^3 per year of industrial wastes are disposed of in this facility.

6.3.3 Rabbit Lake

6.3.3.1 Tailings Management

The Rabbit Lake Above-Ground Tailings management Facility (AGTMF) is about 53 hectares in area and contains approximately 6.5 million tonnes of tailings which were deposited between 1975 and 1985. These tailings were all derived from the processing of the original Rabbit Lake ore deposit. The tailings within the AGTMF are confined by earth-filled dams at the north and south ends and natural bedrock ridges along the east and west sides. The AGTMF is currently undergoing long-term stabilization and progressive reclamation.

The Rabbit Lake open-pit mine was converted to a tailings management facility in 1986, utilizing pervious surround technology. Since its commissioning, the Rabbit Lake in-pit tailings management facility (ITMF) has been used as a tailings repository for ore from the Rabbit Lake, B-zone, D-zone, A-zone and Eagle Point mines. At the end of 2004 the Rabbit Lake ITMF contained 5.8 million tonnes of tailings.

The pervious surround, consisting of sand and crushed rock, is placed on the pit floor and walls in advance of the tailings deposition. This pervious material allows drainage of excess water contained in the tailings to an internal seepage collection system and it also allows water contained in the surrounding host rock to be collected, thereby maintaining a hydraulic gradient toward the facility. The collected water is treated prior to its release to the environment. Upon final decommissioning and return to normal hydrogeological conditions, groundwater will flow preferentially through the pervious surround rather than the low permeability tailings. Discharge of contaminants will be limited to diffusion across the tailings/pervious surround interface.

6.3.3.2 Waste Rock Management

The Rabbit Lake site contains a number of clean and mineralized waste rock stockpiles produced over the course of mining various deposits at Rabbit Lake since 1974. Some of the waste rock has been used for construction material. For example, waste rock was used to construct the road and pervious surround for the Rabbit Lake ITMF. Eagle Point special waste is stockpiled on a lined storage pad until it is returned underground as backfill. Some waste rock piles were used as backfill and cover material in their respective pits. One rock pile, consisting primarily of Rabbit Lake sediments, has been contoured and vegetated.

Current projections are that no waste rock will remain on surface at Eagle Point after mining and backfilling of mined-out stopes is complete. The D-zone waste rock pile consists of 0.2 million m^3 of primarily lake bottom sediments and organics. This material may eventually be used as cover material for the B-zone waste rock pile. The A-zone waste rock pile (28,307 m^3 of clean waste) has been flattened and contoured. The B-zone waste pile contains an estimated 5.6 million m^3 of waste material stored on a pile covering an area of 25 hectares. Contaminated runoff and seepage from this pile is collected and treated prior to release to the environment. All the special waste from the A-zone (69,749 m^3), B-zone (100,000m^3) and D-zone (131,000 m^3) open-pit mines was returned to the pits, covered with layers of waste rock and/or clean till before the mined-out pits were allowed to flood. There are approximately 6.7 million m^3 of predominantly sandstone, with some basement rock and overburden tills, stored on the West #5 waste rock pile adjacent to the Rabbit Lake ITMF. Mineralized waste is stored on four piles (1.8 million m^3) adjacent to the Rabbit Lake Mill. Runoff and seepage from these areas are collected in the Rabbit Lake ITMF.

6.3.3.3 Contaminated Industrial Wastes

Radioactive and other contaminated materials from the Eagle Point Mine and Rabbit Lake Mill are disposed of in the contaminated landfill site which is located on the west side of the Rabbit Lake AGTMF. It is estimated that 1,570 m^3 of un-compacted waste was placed at this site in 2004.

6.3.4 McClean Lake

6.3.4.1 Tailings Management

McClean Lake was the first new uranium mill constructed in North America in 15 years. The mill and TMF represent state-of-the-art in worker and environmental protection for processing high grade uranium ore. Open-pit mining of the initial ore body (JEB) began in 1995. After the ore was removed and stockpiled, the pit was developed as a TMF. The design of the TMF has been optimized for the protection of workers and the environment during operation and in the long-term by employing key features such as:

- Production of thickened tailings within the mill process (addition of lime, barium chloride, and ferric sulphate) to remove potential environmental contaminants from solution and yield geotechnically and geochemically stable tailings.
- Transport of the tailings from the mill to the TMF through a continuously monitored pipe-in-pipe containment system.
- Final subaqueous tailings placement within the mined-out JEB pit for long-term, secure containment in a below-ground facility.
- Use of natural surround as the optimum approach for long-term ground water diversion around the consolidated tailings plug.
- Subaqueous tremie placement of the thickened tailings below a water cover in the pit, from a floating barge. This minimizes segregation of fine and coarse material, prevents freezing of the tailings, and enhances radiation protection due to the attenuation of radon emissions by the water cover.
- Use of dewatering wells around the entire pit perimeter to minimize clean groundwater inflow while maintaining hydraulic containment during operations. That is, the water levels are maintained such that groundwater flow is toward the pit.
- A bottom filter drain feeding a dewatering drift and raise wells to allow collection and treatment of discharged pore water during tailings consolidation.
- Recycling of pit water by a floating barge and a pipe-in-pipe handling system.
- Complete backfilling of the pit, upon decommissioning, with clean waste rock and a till cap.

6.3.4.2 Waste Rock Management

Material excavated from the open pits is classified into three main categories namely, waste (both overburden and rock wastes), special waste, and ore.

The categorization of these materials is as follows:

Waste	Any material grading less then 0.025% U and having low acid generating potential
Special Waste	Any waste having a uranium content of 0.025% U or greater but less than 0.085% any strongly altered rock identified as having a high acid generating potential.
Ore	All material grading greater than 0.085% U is classified as ore and stockpiled to be the JEB mill.

The cut-off grade of the mill may vary depending on market conditions for uranium.

The majority of the waste removed from the JEB and Sue C open pits were overburden material or sandstone. The overburden and waste rock stockpiles are located near the pits. The pad for the waste rock stockpile has been constructed using removed overburden and un-mineralized waste rock.

Special waste, stockpiled while mining the Sue C and JEB pits, has been back-hauled into the Sue C pit. All wastes (exclusive of the overburden) from the future Sue A and Sue B pits will also be deposited into the mined out Sue C pit. Special waste from Sue E will be placed into the mined out Sue C pit while clean waste will be placed into a separate Sue E waste rock stockpile.

6.3.4.3 Contaminated Industrial Wastes

Chemically or radiologically contaminated waste materials will originate from the mining, milling and water treatment areas of the McClean Lake Operation. All contaminated material is collected in yellow dumpsters distributed around the site and deposited in the landfill, or for chemically and radiologically contaminated materials at the perimeter of the TMF. This landfill is within the hydraulic containment area of the JEB TMF. During final site decommissioning, these materials will be excavated and deposited into the JEB TMF.

6.3.5 Cigar Lake

6.3.5.1 Tailings Management

Cigar Lake does not have a mill and does not produce tailings.

6.3.5.2 Waste Rock Management

There are two waste rock storage pads in operation at Cigar Lake. The current inventories result from test mining activities conducted at the site. Waste rock volumes are expected to increase substantially over the next few years as the construction of the operating mine is completed.

The first stockpile has an unlined pad without seepage collection that is used for the storage of clean or benign waste rock. When possible, this rock is used as fill or construction material onsite. The current stockpile contains approximately 47,000 m^3 of clean waste rock.

A second stockpile is used to store potential acid generating waste rock from underground. Similar to the second stockpile, containment is provided by an impermeable liner and all drainage and decant waters are collected for treatment in the mine water treatment plant. The current inventory for this waste rock stockpile is approximately 71,000 m^3.

While some potentially acid reactive waste rock may be used as backfill in the mine, the majority of this material is eventually expected to be transported to the McClean Lake mine site for disposal in a mined-out pit.

6.3.5.3 Contaminated Industrial Wastes

A third storage pad is used at Cigar Lake to store radiological or trace metal contaminated special wastes including filter cake from the mine water treatment plant and drill cuttings obtained while drilling through the ore zone. Containment is provided by an impermeable liner and all drainage and decant waters are collected for treatment in the mine water treatment plant. Approximately 2,500 m^3 of special waste are stored on this pad.

6.3.6 McArthur River

6.3.6.1 Tailings Management

McArthur River does not have a mill and does not produce tailings.

6.3.6.2 Waste Rock Management

The McArthur River Operation generates waste rock from production mining, development mining and exploration drilling. The waste rock is classified as either clean waste rock, potentially acid generating (PAG) waste rock or mineralized waste rock.

The potentially acid generating and mineralized waste rock are temporarily stored on engineered lined containment storage pads. Leachate from these pads is contained and pumped to the effluent treatment facilities. The segregated clean waste rock is disposed of on a pile which does not include the leachate containment and control systems.

The mineralized waste rock is shipped to the Key Lake Operation and used as blend material for the ore feed to the Key Lake mill. The potentially acid generating waste is crushed and screened and the coarse material is used as aggregate for underground concrete backfilling operations. The clean waste is used for general road maintenance on site and the haul road between McArthur River and Key Lake.

6.3.6.3 Contaminated Industrial Wastes

A transfer area located adjacent to the mine headframe is used to sort and temporarily store contaminated material. The contaminated material is shipped to the Key Lake Operation where it is disposed in the AGTMF.

ANNEX 7

DECOMMISSIONING ACTIVITIES

7.1 AECL Whiteshell Laboratories

The Whiteshell Laboratories (WL) has provided research facilities for the Canadian nuclear industry since the early 1960s. In 1997, the AECL decided to discontinue research programs and operations at the WL. In 1998, the Canadian federal government concurred with the decision to decommission the facility. In 1999, AECL began to prepare plans for the safe and effective decommissioning of the WL.

The WL facility is a nuclear research and test establishment located in Manitoba on the east bank of the Winnipeg River about 100 km northeast of Winnipeg, about 10 km west of Pinawa and 9 km upstream of Lac du Bonnet. It comprises a number of nuclear and non-nuclear facilities and activities. The major facilities located on the site include WR-1 Reactor, the shielded facilities, research laboratories, liquid and solid radioactive waste management areas and facilities, including the concrete canister storage facility for the dry storage of research reactor fuel.

The Whiteshell Laboratories facility is currently licensed under a Nuclear Research and Test Establishment Decommissioning Licence. This licence authorizes the AECL to operate and undertake decommissioning activities at the facility until December 31, 2008.

The Canadian regulatory body has approved a Detailed Decommissioning Plan that provides information as required under the *Class I Nuclear Facilities Regulations.* The decommissioning licence covers Phase 1 of a planned three-phase decommissioning program for the site. The activities planned in each phase are:

- Phase 1 (approximately 6 years)—activities directed toward nuclear and radioisotope buildings and facilities to place them in a safe, secure, interim end state. The Van de Graaff Accelerator and the Neutron Generator have been completely decommissioned.

- Phase 2 (approximately 10 years)—regular monitoring and surveillance of all buildings and facilities. Most project activity will be focused on the WMA. Most waste management facilities will be placed in a passive operational state and interim processing, handling and storage facilities, required during monitoring and surveillance and decommissioning project activities, will be established.

- Phase 3 (approximately 45 years)—activities directed to bringing the site to a final end state that will fulfill regulatory and national policy requirements. The timing and sequence of decommissioning activities will be determined largely by the availability of disposal facilities and by the age and condition of engineered structures and buildings.

Following the completion of Phase 3, part of the site, namely, the WMA will remain under institutional control for an additional 200-year period.

It is expected that Phase 2, the next significant stage of the decommissioning process, will be considered in detail by the regulatory body during the review of the application for licence renewal in 2008.

7.2 AECL Gentilly-1

The Gentilly-1 WMF consists of a permanently shut down, partially decommissioned prototype reactor and associated structures and ancillaries. This facility is presently in the long-term Storage with Surveillance phase of a deferred decommissioning program.

This facility is located within the Gentilly Complex, on the south bank of the St. Lawrence River, about 15 km east of Trois-Rivieres in the Province of Quebec. The Gentilly Complex accommodates both the Gentilly-1 WMF and the Gentilly-2 NGS, a CANDU 600 Megawatt unit.

The Gentilly-1 NGS consisting of a CANDU-BLW-250 reactor was put into service in May 1972. It attained full power for two short periods in 1972, and was operated intermittently for a total of 183 effective full power days until 1978 when it was determined that certain modifications and considerable repairs would be required. The station was put into a lay-up state in 1980 and the decision not to rehabilitate the station was made in 1982.

The main components of Gentilly-1 NGS were the reactor core, heat transport system, turbines and shielding. The reactor was heavy water moderated, cooled by light water and fuelled with natural uranium in the form of Zircaloy clad UO_2 pellets. The reactor vessel was a vertical cylindrical vessel that contained the heavy water moderator and was traversed by 308 pressure tubes and surrounding calandria tubes. The heat produced by the reactor fuel (mostly by boiling) was removed by the light water coolant that was pumped through inlet and outlet headers and feeder pipes in a closed circuit. The steam generated by the reactor core was separated from the liquid coolant in the steam drum before being delivered to the turbine generator.

The decision to permanently shut down the reactor was made in 1984 and a two-year decommissioning program began in April of that year to bring the Gentilly-1 NGS to an interim safe and sustainable shutdown state that is equivalent to Storage with Surveillance.

Following the decision to permanently shut the reactor down, the moderator was drained and shipped to other operating sites. Non-radioactive hazardous materials (e.g. explosive, combustible and flammable materials; laboratory supplies; oils) were identified and removed. The transfer of used fuel from wet storage in the reactor pool to dry storage in the Canister Storage Area, constructed for that purpose, was completed in 1986. Major and minor decontamination activities (disassembly, decontamination, and consolidation activities) were completed as required. All major radioactive, or radioactively contaminated components not shipped to other facilities licensed were consolidated on site in either the Reactor Building or the Turbine Building. Areas possessing significant residual contamination or radioactive materials have been reduced to a few locations. Radiological surveys were performed at the completion of each decommissioning activity.

7.3 AECL Douglas Point Waste Management Facility

The Douglas Point Waste Management Facility (DPWMF) is located at the site of the former Douglas Point Nuclear Generating Station (DPNGS) situated on the Bruce Nuclear Power Development site. The DPNGS which consists of a 200 MW CANDU reactor was put into service in 1968. It was owned by the AECL and operated by the then Ontario Hydro until 1984. During this operational period, the station generated 17 x 10^9 kWh of electricity and attained an 87.3% capacity.

The main components of DPNGS were the reactor, heat transport system, turbines and power generating equipment. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The reactor core contained 306 horizontal fuel-containing pressure tubes and was surrounded by the heavy water moderator. The heat transport system pumps circulated the pressurized heavy water through the reactor coolant tubes to eight boilers where the heat is transferred to the boiler steam and water system. The reactor primarily used heavy concrete, steel and water as shielding to protect the surrounding area from radiation during operation. Steam generated in the boilers was transferred to the turbine for power generation.

The DPNGS was permanently shutdown on May 5, 1984, and placed into an interim, safe and sustainable shutdown state. This interim state was referred to as the Storage with Surveillance state. The DPNGS then became the Douglas Point Waste Management Facility.

Following the shutdown of the reactor, the primary heat transport and moderator medium (heavy water) was drained and shipped to other operating sites. “Booster rods” were removed and shipped to the CRL in February 1985. Non-radioactive hazardous materials (e.g. explosive, combustible and flammable materials; laboratory supplies; oils) were identified and removed. The transfer of used fuel from wet storage in the reactor pool to a dedicated dry storage facility was completed in 1987. Major and minor decontamination activities (disassembly, decontamination, and consolidation activities) were completed as required. All major radioactive, or radioactively contaminated components not shipped to other facilities licensed to receive them were consolidated on site. Areas possessing significant residual contamination or radioactive materials have been reduced to a few locations. Radiological surveys were performed at the completion of each decommissioning activity.

The DPWMF is presently in the long-term Storage with Surveillance phase of a deferred decommissioning program. For decommissioning purposes, the DPWMF is divided into three Planning Envelopes. Envelope A primarily consists of nominally uncontaminated buildings and structures which may be decommissioned at any given time, with health, safety and environmental concerns taken into account. Envelope B consists of primarily contaminated buildings which will be decommissioned after allowing for a period of radioactive decay and after radioactive waste disposal facilities become available. Envelope C includes the used-fuel canister area.

A three-phased approach has been established for reactor decommissioning. Phase 1 brings the facility to a safe, sustainable shutdown state. Phase 2 is a period of Storage with Surveillance. Final decommissioning occurs in Phase 3.

The DPWMF has already gone through Phase 1 activities and is currently in Phase 2. The length of Phase 2 may be less than Planning Envelope A, due to a lack of significant radiological concerns.

7.4 AECL Nuclear Power Demonstration Waste Management Facility

The Nuclear Power Demonstration Waste Management Facility (NPDWMF) consists of a permanently shut down, partially decommissioned demonstration CANDU reactor and associated structures and ancillaries. The facility is presently in the interim Storage with Surveillance phase of a deferred decommissioning program.

The Nuclear Power Demonstration facility is located adjacent to the west bank of the Ottawa River, in the Province of Ontario, some 25 km upstream from the AECL CRL and 15 km from the Town of Deep River.

The Nuclear Power Demonstration Nuclear Generating Station (NPDNGS), consisting of a 20 MW CANDU PWR, was placed in-service in October 1962 and was operated by Ontario Hydro (now OPG) on behalf of the owners until May 1987. The facility produced electrical power for the Ontario Hydro grid, trained people for the commercial nuclear generating stations of Ontario Hydro, and performed experiments in process systems concepts to be incorporated in the design of the commercial nuclear generating stations. During this operations period, the station generated 3 x 10^9 kWh of electricity, at 65.0% net electrical capacity factor.

The main components of the NPDNGS were the reactor, heat transport system, turbine and electrical power generator equipment. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The reactor core contained 132 horizontal fuel-containing pressure tubes and was surrounded by heavy water moderator. The heat transport system pumps circulated the hot pressurized heavy water through the reactor coolant tubes to a heat exchanger/boiler unit where the heat was transferred to the boiler steam and water system. The reactor, boiler and auxiliary systems were installed below ground and were surrounded by concrete as shielding to protect the surrounding accessible areas from radiation during operation. Steam generated in the boilers was transferred to the turbine/generator for electrical power generation.

The NPGNGS was permanently shut down on May 24, 1987 and placed into an interim, safe and sustainable shutdown phase. This interim storage period is referred to as the Storage with Surveillance phase.

Following the shutdown of the reactor, the primary heat transport and moderator systems heavy water was drained and shipped off site. The reactor was defueled and the fuel bundles were transferred to Chalk River Laboratories. Demineralizer system equipment was removed from the various nuclear process systems and transferred to Chalk River Laboratories. Major and minor decontamination activities were completed as required. The facility was functionally divided into a Nuclear Area and Non-Nuclear Area with any equipment or structures either radioactive or radioactively contaminated confined to the Nuclear Area. All cross connections between the two areas were blocked off, sealed or permanently locked.

In 1988, the operating and compliance responsibilities were transferred from Ontario Hydro to the AECL and the facility became the NPDWMF.

7.5 AECL Chalk River Laboratories Decommissioning Activities

7.5.1 Pool Test Reactor

The Pool Test Reactor (PTR) was a type of reactor whose fuel elements were suspended in a pool of water that serves as the reflector, moderator and coolant. It was a low-power research reactor (less than 100 W) designed and built to conduct reactivity studies on irradiated fuel samples and to determine the cross-section of fission products.

PTR usage then shifted to testing and calibration of self-powered flux detectors on a commercial basis. PTR began operating in 1957 and was permanently shut-down in 1990. The fuel was removed and placed in a tile hole at the CRL. PTR has been kept under monitoring and surveillance since then and is currently in a safe shutdown state. The decommissioning objective is to return the area to the site landlord for use as general active laboratory space at CRL.

The PTR consists of a pool that is approximately 4.5 metres square by six metres deep and contains about 125,000 litres of water. The specific decommissioning activities are as follows:

- Removing the PTR equipment: aluminum-graphite reflectors, fission chamber, core plate and support, oscillator mechanism, core tube support brackets, control rod drive system, and control rod support;
- Draining and drying of the pool;
- Removing the de-ionized water supply and purification system from the pool;
- Removing all electrical components associated with the facility, including meters, switches, panels, etc. Wiring will be removed to clear termination points;
- Removing all signs and fixtures associated with the facility from walls, floor and ceiling; and
- Segregating and transferring all waste generated by the decommissioning project to Waste Management Operations for storage and disposal as appropriate.

The decommissioning is scheduled to begin following regulatory approval and is expected to be a few months in duration. This project is currently undergoing an EA pursuant to the *Canadian Environmental Assessment Act.*

7.5.2 Plutonium Recovery Laboratory

The Plutonium Recovery Laboratory was constructed in 1947 and was in operation from 1949 to 1957. It was designed to extract plutonium isotopes from enriched fuels used in research reactors during that period. It is currently in a Storage with Surveillance state. Following shut down in 1957, the majority of the processing equipment was flushed, decontaminated and removed. Only the fuel dissolver tanks, rod lifting mechanisms and basement sumps remain.

This facility has a footprint of about 514 m^2. Actual decommissioning activities are expected to be initiated in the next ten years following regulatory approval to decommission. Decommissioning is to be carried out in three phases.

Phase I, expected to be carried out over a one and a half year period, consists of the following activities:

- Performing confirmatory radiological surveys of all rooms in the building;
- Isolating process and service lines entering the building;
- Removing all remaining process equipment and piping;
- Decontaminating concrete rooms;
- Removing the steel frame, cedar planks, asbestos shingles, roof and footing foundation;
- Segregating solid wastes and transferring them to appropriate waste management facilities at the CRL; and
- Constructing covers for exposed areas of the shielded concrete enclosure and a wall to separate associated buildings.

Phase II will last for a period of no less than ten years and consist of the following activity:

- Maintaining and monitoring the remaining structure during the Storage with Surveillance period.

Phase III of decommissioning will be completed within an estimated two-year period and consist of the following activities:

- Performing a confirmatory radiological survey to update the hazard status;
- Demolishing the shielded concrete enclosure and its footings/foundations;
- Removing any contaminated soils within the boundary of the original building footprint;
- Segregating solid wastes and transferring them to appropriate waste management facilities at the CRL; and
- Backfilling the site and releasing it for future use within the CRL facility.

7.5.3 Plutonium Tower

The Plutonium Tower was used to develop means to extract plutonium from fuel rods irradiated in the NRX reactor and was operated for a few years in the late 1940s. The building was permanently shutdown in 1954. All process equipment was removed from the building, and an initial clean-up was carried out. Further clean-up and dismantling was carried out in the 1980s.

The Plutonium Tower building has a footprint of about 28 m^2 and is 19.2 m high. All process equipment was removed from this building.

Decommissioning activities include:

- Conducting a confirmatory radiological survey of the concrete tower interior, annexes and underground pipe chase to update the hazard status;
- Isolating process and service lines entering the building from neighbouring interconnected buildings;
- Demolishing the annexes, concrete tower, building structure and footings/foundations;
- Segregating solid wastes and transferring them to appropriate waste management facilities at the CRL; and
- Removing any contaminated soil and backfilling from the area as required.

Decommissioning activities are expected to begin once regulatory approval has been granted. The removal of the Plutonium Tower is expected to take approximately one year. An EA pursuant to the *Canadian Environmental Assessment Act* is currently being conducted.

7.5.4 Waste Water Evaporator

The Waste Water Evaporator was constructed in 1952 and was used to process and treat radioactive liquid wastes produced by the NRX fuel reprocessing work conducted between 1952 and 1958. Some evaporation activities were also sporadically carried out between 1958 and 1967 to concentrate about 450 m^3 of stored process wastes remaining from earlier fuel processing. The facility was finally shut down in 1971.

The Waste Water Evaporator has a footprint of about 130 m^2. One of the seven tanks is suspected to hold about 100 litres of radioactive liquid waste while two other tanks are suspected to contain a small quantity of dried contaminated sludge.
Decommissioning activities for this building include:

- Isolating process and service lines entering the building from neighbouring interconnected buildings;
- Removing, treating and storing any liquid wastes from the tank, process lines and equipment;
- Decontaminating process equipment, processing cells and other components in the building to remove contamination;
- Removing process equipment, processing cell, building structure, and footing/foundations;
- Segregating solid wastes and transferring them to appropriate waste management facilities at the CRL; and
- Removing any contaminated soil surrounding the building to a distance of one metre from the building footprint and backfilling the area as required.

Actual decommissioning activities are expected to be initiated in the next ten years following regulatory approval to decommission. The removal of the Waste Water Evaporator is expected to take approximately one year. An EA pursuant to the *Canadian Environmental Assessment Act* is currently being conducted.

7.5.5 National Research Experimental Reactor

The National Research Experimental (NRX) reactor, Canada's first large-scale research reactor, commenced operation in 1947 and played a major role in developing the CANDU reactor. The reactor was used extensively for the testing of fuels and materials and for nuclear physics research in support of the Canadian Nuclear Power program.

The reactor is a vertical assembly of permanent tubes kept in a calandria, which contain the reactor fuel assemblies. The reactor is heavy water-moderated and light water-cooled and has a power rating of 42 MW.

After approximately 250,000 hours of operating time, the NRX reactor was shutdown on January 29, 1992. On April 8, 1993, it was decided that the reactor would be permanently shut down.

The NRX reactor facility is divided into three planning envelopes:

- The NRX Reactor
- The Fuel Storage Bays
- The Ancillary Buildings

The decommissioning of the NRX reactor is planned in three phases.

- Phase 1 will bring the facility to a safe sustainable shutdown state suitable for an ensuing period of Storage with Surveillance.
- Phase 2 is the Storage with Surveillance Period.
- Phase 3 is the removal of the NRX reactor through a series of Decommissioning Work Packages and achievement of the final end state.

The NRX decommissioning process began with the permanent shutdown of the NRX reactor facility. Shutdown Operations for the NRX reactor and Ancillary Buildings are already completed. The Phase 1 activities to establish a safe sustainable Storage with Surveillance state for the Fuel Storage Bays are currently in progress.

7.6 Dalhousie University Slowpoke Reactor

The Dalhousie University Slowpoke Reactor is a pool type reactor with a light water moderated, 93% enriched uranium core. The core is surrounded by a beryllium reflector and is cooled by natural convection from the moderator water. The core and reflector are installed at the bottom of a long cylindrical water filled container which is suspended in a below grade pool.

Dalhousie University has indicated that they intend to shut down the reactor during the period 2006 to 2008. It is currently preparing a Detailed Decommissioning Plan and supporting documentation, including an EA, for submission to the regulatory body in late 2005.

7.7 Cluff Lake Tailings Management

The first of its generation of Northern Saskatchewan uranium mines to move into decommissioning, the Cluff Lake mine received a decommissioning licence in July 2004. The granting of this licence by the Commission Tribunal followed five years of EA, public consultation and regulatory review, and marked the initial phase of efforts to return the Cluff Lake site to a natural state.

Uranium production started at Cluff Lake in 1981, and was completed at the end of 2002, with more than 62 million pounds of U3O8 produced over its 22-year life. Site facilities include the mill and Tailings Management Area (TMA), four open pit and two underground mines (that have all been mined out), the camp for workers, and site infrastructure.

Site staff and contractors are now carrying out the approved decommissioning work following a comprehensive and lengthy assessment and approval process. Close-out and decommissioning will be accomplished through the implementation of several approved decommissioning packages. Additional decommissioning work will be finalized once regulatory approval has been granted on the remaining work packages.

The TMA at Cluff Lake is a surface impoundment, constructed using a series of engineered dams and dikes and extending over about 70 hectares. It consists of four major components—the solids containment area, water decantation area, water treatment facilities, and diversion ditches. Thickened tailings are pumped to the solids containment area where consolidation and liquid decantation occurs. Barium Chloride and Ferric Sulphate are added to precipitate radium-226 (generally greater than 100 Bq/L in inflow). Settling ponds allow precipitates to settle prior to the water being fed to the second stage water treatment plant where reagents are again added to precipitate residual radium-226. The treated water is pumped to the final settling ponds prior to final discharge to the surface water environment. At discharge, water quality is generally in the range of ≤0.005-0.04 Bq/L of radium-226, well below the surface water quality objective of 0.11 Bq/L established by the regulatory agencies.

As of December 2004, decommissioning of the TMA was initiated by covering the tailings in stages to promote consolidation. Final topographical work is slated for completion in the fall of 2005 and re-vegetation of the area is expected to be completed in the summer of 2006.

Surrounding the solid and liquid ponds are two diversion ditches. These ditches divert uncontaminated water from the upstream drainage basin surrounding the TMA to the downstream water body. This minimizes infiltration of clean water into the TMA and ensures that runoff from a major precipitation event, including the Maximal Probable Precipitation event, can be safely diverted around the tailings area.

7.7.1 Decommissioning

The objective is to return the site as closely as possible to its original state, in a manner that both protects the environment and allows traditional uses such as fishing, trapping, or hunting to be safely carried out.

The Cluff Lake site is currently undergoing decommissioning following the assessment and licensing process. The licensee has submitted five of six decommissioning work packages of which four been approved by the regulatory agencies.

In addition to dismantling and disposing of the mill and other industrial facilities, and landscaping and re-vegetating disturbed areas, the TMA and mining area will be closed and reclaimed.

7.7.2 Tailings Management Area

The TMA will be re-contoured to provide positive drainage, covered with a layer of locally available till (minimum thickness of 1 metre) and vegetated. The surface re-contouring and vegetated cover will promote runoff of rainfall and snowmelt, as well as evapo-transpiration of moisture to the atmosphere, thus minimizing net infiltration through the tailings material. Extensive characterization of the tailings, the adjacent geological formations, and the site hydrogeology has been performed to acquire reliable data on which to base the assessment of long-term performance.

7.7.3 Mining Area

Mining involved four open pits and two underground mines. One open pit ("D" pit) and its associated waste rock pile were reclaimed in the mid 1980s. Water quality data from the flooded pit show no further work is required, and native species of vegetation have been re-established on the waste rock pile.

As part of the decommissioning effort, the "D" pit area was surveyed for residual radioactivity and, as a result, a small area was reclaimed to reduce gamma emanation to below-accepted decommissioning objectives. Two open pits have been used for waste rock disposal during mining and one of these two pits has also been used to accept industrial waste during decommissioning. This waste includes the mill infrastructure. The major decommissioning activities consist of:

- Dismantling and disposal of all above-ground structures.
- Securely sealing all access openings (ramps, ventilation shafts) to the two underground mines and allowing them to flood naturally.
- Relocating waste rock to complete the backfilling of one open pit (Claude pit), then re-contouring and establishing vegetation on these areas.
- Removing a portion of and re-contouring the waste rock within another open pit and then allowing this pit and a contiguous pit to flood to the natural level, eventually forming a small lake meeting surface water quality criteria.

- Reclaiming the remaining Claude waste rock pile by re-sloping for long-term stability, compacting the waste rock surface, covering with till and establishing a vegetation cover.
- Re-contouring and establishing native vegetation on all disturbed areas.

Extensive characterization of the waste rock, the geologic formations in the area, and the site hydrogeology has been performed to acquire reliable data for the assessment of long-term performance.

ANNEX 8

LEGACY MINES AND TAILINGS MANAGEMENT AREAS

8.1 Legacy Mines and Tailings Management Areas

There are nineteen tailings management sites resulting from the former operation of uranium mines in Canada. This includes fourteen in Ontario, three in Saskatchewan, and two in the Northwest Territories.

8.1.1 Saskatchewan

There are three inactive uranium sites in Saskatchewan: Beaverlodge, Lorado and Gunnar.

8.1.1.1 Beaverlodge

Cameco was recently issued a WFOL licence from the CNSC, to replace the previous AECB Decommissioning Licence, for the Beaverlodge decommissioned uranium mine located near Uranium City in the northwest corner of Saskatchewan.

The mining of ore started in 1950, and milling began in 1953, with both activities continuing until closure in 1982. Decommissioning began in 1982 and was completed in 1985. Since that time, the site has been in a monitoring and maintenance phase. All mine structures have been removed from the site, all but one of the open pits has been completely backfilled, and mine shafts have been capped and decommissioned according to Joint Regulatory Group (JRG) requirements.

There are no major active physical works associated with the site today. There are three small water level control structures, but no effluent treatment plants. There are roads, waste-rock piles, and tailings management areas that are subject to inspection programs and local and area-wide environmental monitoring programs.

The Beaverlodge site has three tailings management areas that contain 5.8 million tonnes of tailings, along with uranium tailings which were disposed of underground (4.3 million tonnes), for a total of 10.1 million tonnes of lower grade uranium mine tailings. There are approximately 5.1 million tonnes of waste rock on the site.

The site consists of 73 separate properties covering approximately 744 hectares. There were 17 different mining areas, and 10,161,000 tonnes of ore were recovered averaging 0.25% uranium (0.10 to 0.43 % ranges).

Figure 8.1: Beaverlodge – Aerial View

8.1.1.2 Lorado

The Lorado Uranium Mining Ltd. mill site is located north of Lake Athabasca in the northwest corner of Saskatchewan. It is approximately 8 km southwest of Uranium City.

EnCana Corporation has been identified as the owner of the land on which a portion of the unconfined tailings from the Lorado milling operation exists. The remainder of the site is Provincial Crown Land. EnCana has initiated a site characterization and an assessment of the risks associated with the whole site, including the Crown land.

EnCana has met with the community twice since the project began in 2004 and plans on bringing the result of the site characterization back to the community by 2005.

Once they have completed the characterization work and defined their preferred option for site remediation, they will work with all responsible parties at the site to develop the most efficient and appropriate approach to site remediation. EnCan still needs to discuss long-term management of the site with the Province of Saskatchewan.

Work related to the remediation of the Lorado site will require CNSC licensing and joint regulatory approvals.

Figure 8.2 – Lorado Tailing Site – Aerial View

8.1.1.3 Gunnar

The Gunnar mine site is located on the southern tip of the Crackingstone Peninsula, along the North shore of Lake Athabasca approximately 25 km southwest of Uranium City, Saskatchewan. The Gunnar mine site, closed since 1964, has not been adequately decommissioned.

The Government of Saskatchewan has been identified as the remediator of last resort of the Gunnar idle mine site. Saskatchewan is currently characterizing and assessing the risks associated with the site.

Saskatchewan meets regularly with the community and will bring the results of the site characterization work back to the community.

Once they have completed the characterization work and defined their preferred option for site remediation, they will work with all responsible parties to develop the most efficient and appropriate approach to site remediation.

Work related to the remediation of the Gunnar site will require CNSC licensing and joint regulatory approvals.

Figure 8.3: Gunnar Mine Site – Aerial View

8.1.2 Northwest Territories

There are two inactive uranium mine and tailings sites in the Northwest Territories − the Port Radium Mine and the Rayrock Mine site.

8.1.2.1 Port Radium

The Port Radium site is located in the Northwest Territories at Echo Bay on the eastern shores of Great Bear Lake, about 265 km east of the Dene community of Déline at the edge of the Arctic Circle.

Mining at the Port Radium site occurred from 1932 to 1940, from 1942 to 1960, and finally from 1964 to 1982 to recover silver. The site covers approximately 12 hectares and is estimated to contain 1.7 million tons of uranium and silver tailings. The site was partially decommissioned in 1984 to the standards of the day. In 2002, the federal government signed a partnership agreement with the local community to discuss further measures to be taken at the site.

Due to the nature and extent of past mining operations, community concerns exist with respect to potential contamination of the environment and with respect to potential health exposure of Déline residents. To address these concerns, the Joint Canada-Déline Uranium Table (CDUT) process, led by Indian and Northern Affairs Canada (INAC) has initiated a program for the assessment of potential impacts on human health and the environment.

The CDUT was established by Canada and Déline in 1999 to resolve issues surrounding the Port Radium site. The CDUT includes representatives from the community of Déline and from INAC. INAC is supported by an interdepartmental committee composed of representatives from INAC, Health Canada, NRCan, and the Government of Northwest Territories Health & Social Services.

INAC is expected to submit a licence application to the CNSC in the fall of 2005.

8.1.2.2 Rayrock

Uranium mining and milling occurred at the Rayrock site from 1957 until 1959, at which time it was abandoned. Following an EA Study and the issuance of a CNSC licence, INAC decommissioned and rehabilitated the Rayrock site, and capped the tailings, in 1996. Performance monitoring and reporting of the results has been ongoing since 1996.

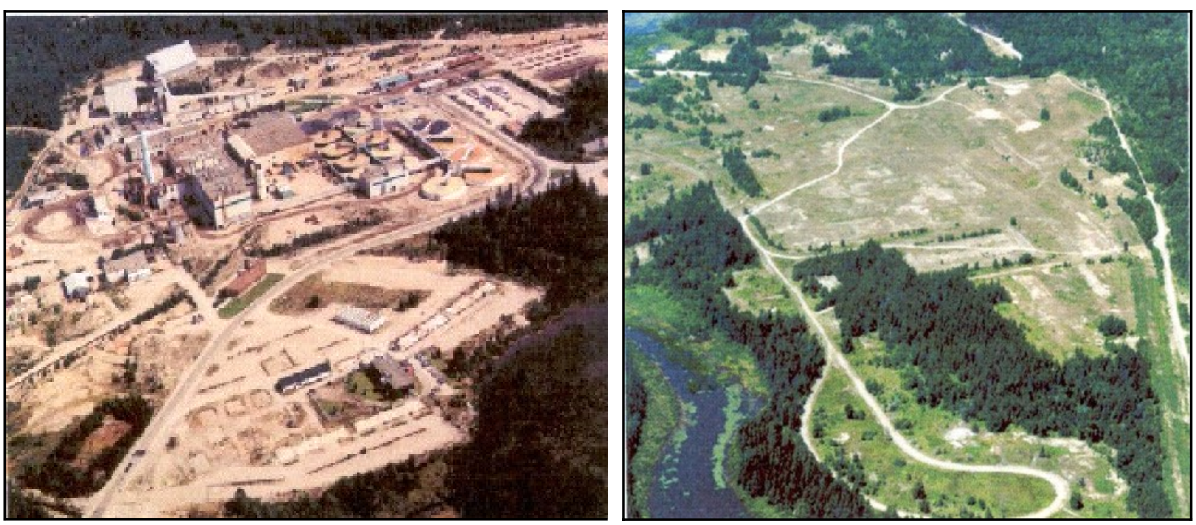
8.1.3 Ontario

8.1.3.1 Elliot Lake Area

There are twelve inactive uranium mine sites and ten uranium tailings management areas (TMAs) in and around Elliot Lake, Ontario.

All of the Elliot Lake uranium mines were brought into production between 1955 and 1958. By 1970, five of the mines had been shut down; by 1992 most had ceased operations. The last of the Elliot Lake uranium mines to be decommissioned − Stanleigh, Quirke, Panel, Stanrock and Denison mine sites − were essentially complete by the end of 1999. Currently, all of the sites have been substantively decommissioned with all mine features capped or blocked, all facility structures demolished, and all sites landscaped and revegetated.

Figure 8.4 – Quirke Mine Site Before and After Decommissioning



The uranium ore in the Elliot Lake area is classified as low grade (containing less than 0.1% U_3O_8) and it also contains pyrite and uranium decay products such as radium-226. When exposed to oxygen and water, the tailings become acid generating and thus may mobilize contaminants. Therefore, all of the Elliot Lake TMAs have some degree of effluent treatment system associated with each site. All of the TMAs have been closed and all construction activities related to the containment structures have been completed. Currently, the mining companies conduct site specific and regional environmental monitoring programs, operate the effluent treatment plants and inspect and maintain the sites.

Rio Algom Ltd. is responsible for the Quirke, Panel, Spanish American, Stanleigh, Lacnor, Nordic, Buckles, Pronto and Milliken mine sites and their associated TMAs, while Denison Mines Inc. is responsible for the Denison, Stanrock and Canmet mine sites and their TMAs.

Figure 8.5 – Nordic Dry Cover TMA

In Elliot Lake, there is a mixture of both dry and wet covers being used at the TMAs. Four of the TMAs − Lacnor, Nordic, Pronto and Stanrock − are engineered with dry covers, and vegetation has been established over the tailings at all of these sites. Active water treatment is required at all of the dry tailings management areas to correct for acid generation and radium dissolution in the effluent streams, this being predicted performance for the dry tailings covers. It is expected that water treatment will be required for many more years to come at these sites, as the acid generating potential of the tailings is slowly exhausted due to surface water infiltration and oxidation of the tailings.

Figure 8.6 – Denison Wet Cover TMA

The other TMAs − Quirke, Panel, Stanleigh, Spanish American and Denison − are all water covered and also require some form of active water treatment. However, the extent of treatment required is greatly reduced over that of the effluents resulting from the dry cover TMAs (the water covers attenuate radon emissions, minimize exposure to oxygen and the resulting generation of acid). Many of these sites currently require only minimal treatment, and it is expected that the effluent treatment plants will not be required for the length of time predicted for the dry covers sites.

Decommissioning of uranium mines and mills is governed by the *Uranium Mine and Mills Regulations* under the NSCA. Two of the mine sites − Denison and Stanrock − currently have CNSC uranium mine decommissioning licences in effect.

In 2004, Rio Algom Limited consolidated all of their Elliot Lake mine sites under one CNSC licence, being a waste facility operating licence governed by the Class 1 Nuclear Facility Regulations under the NSCA.

With respect to environmental monitoring, both licensees have each implemented two programs called the TMA Operational Monitoring Program and the Source Area Monitoring Program. The first collects data that tracks TMA performance and supports decisions regarding the management and discharge compliance of the TMAs. The second program was developed to monitor the nature and quantities of contaminant releases to the watershed.

In addition, both Rio Algom Ltd. and Denison Mines Inc. have jointly implemented two watershed-wide programs referred to as the Serpent River Watershed Monitoring Program (SRWMP) and the In-Basin Monitoring Program.

The SRWMP is designed to evaluate the effects of all mine discharges and water level changes on the receiving watershed focusing on water and sediment quality, benthos, fish health and radiation and metal doses to humans and wildlife. The Serpent River watershed is comprised of more than 70 lakes and nine sub watersheds which cover an area of 1,376 km^2 and drain into

Lake Huron via the Serpent River. Results for Cycle I indicate that decommissioning has been successful, since fish, benthic invertebrates and wildlife residing in the watershed display no adverse effects.

The In-Basin Monitoring Program is a companion program to the SRWMP that focuses on the risks to biota feeding at the TMAs by monitoring the physical, chemical and ecological conditions at the TMAs, including the tracking of ecological changes over time. Both programs run in five-year cycles, with the first cycle completed in 1999 and the second cycle summary report expected in 2005.

With respect to community involvement, the mining companies maintain a public presence in Elliot Lake, offering facility tours, a web site, and a public information program that keeps the community and city council updated with respect to ongoing activities at the sites. The Serpent River Region Environmental Committee (SRREC), a local environmental committee, attends facility inspections along with the CNSC and the Joint Review Group (other federal and provincial regulators that have an interest in the Elliot Lake operations). Over the last several years, CNSC staff has conducted outreach activities in Elliot Lake, hosted an open house and attended a public forum hosted by the SRREC.

These sites will continue to require monitoring and active management until effluents meet discharge criteria without treatment. After this, it is likely that these sites will require some form of ongoing permanent care and maintenance for the foreseeable future.

8.1.3.2 Agnew Lake

The Agnew Lake Mine about 25 km northwest of Nairn Centre, Ontario, ceased operation in 1983. The uranium mine site was decommissioned and monitored by Kerr Addison Mines from 1983 until 1988. Shortly after that, the site was turned over to the Province of Ontario in the early 1990s. The Ministry of Northern Development and Mines holds a CNSC Waste Nuclear Substance Licence for the Agnew Lake idle tailings site.

8.1.3.3 Bancroft Area

Uranium tailing management sites also exist in the Bancroft, Ontario area at the Madawaska, Dyno and Bicroft Mines. The Madawaska Mine has been inactive since 1983, while operations at the Dyno and Bicroft sites ceased in the early 1960s.

The Dyno Idle Mine property is located at Farrel Lake, about 30 km southwest of Bancroft, Ontario. The mill circuit at Dyno operated between April 1958 and April 1960. The property comprises of an abandoned sealed underground uranium mine, a mill which has largely been demolished, a tailings area, two dams, and various roadways. The site is managed and monitored by EnCana Corporation which holds a CNSC Waste Nuclear Substance Licence for the Dyno Idle mine site.

The Madawaska Mine property is located 6 km south-west of the town of Bancroft, Ontario on Highway 28. Initial mining and milling operations at Madawaska (Faraday) Mine ran from 1957 until 1964 and again from 1976 to 1982. Reclamation activities were carried out from 1983 to 1992. The Madawaska site has a decommissioning approval licence from the CNSC. The licence is held by Madawaska Mines Limited and the site is monitored and managed as part of a joint venture by EnCana Corporation.

The uranium tailings stored in the Bicroft Tailing Storage Facility resulted from processing low grade uranium ore mines that were processed at the Bicroft mine from 1956 to 1962. Remediation work has included establishing vegetation on the exposed tailings in 1980 and upgrading dams in 1990 and 1997. The Bicroft Tailing Storage Facility is being brought under a CNSC licence. The Bicroft licence will be held by Barrick Gold.

8.1.4 Contaminated Land Under Institutional Control

8.1.4.1 Consolidated Mounds

Five historic waste management consolidation sites are under institutional control. These engineered consolidation mounds are located in Fort McMurray (Alberta), Tulita (Northwest Territories), Fort Smith (Northwest Territories), and Passmore and Lakeshore Road in Toronto (Ontario).

8.1.4.1.1 Fort McMurray

The Lower Town site and Waterways sites in Fort McMurray, Alberta, (located at the junction of the Athabasca and Clearwater Rivers) were the southernmost terminals of the Northern Transportation Route (NTR). It was at these sites that the uranium ore was off-loaded from water barges and transferred to trains for transport to Port Hope, Ontario, for processing. The contaminated soils associated with these sites were cleaned up between 1992 and 2002 and consolidated into a purpose-specific engineered containment cell constructed adjacent to the municipality's landfill site. The long-term management cell, which contains approximately 42,500 m^3 of contaminated soils, is fenced and monitored by the LLRWMO. The cell is under institutional control, and approaches for placing it under regulatory control are being considered.

8.1.4.1.2 Tulita

The Hamlet of Tulita is located in the Northwest Territories on the east bank of the Mackenzie River, just south (upstream) of the Great Bear River confluence (the Great Bear River is the water link between Great Bear Lake and the Mackenzie River). Tulita was a staging point along the NTR where the uranium ore from the Port Radium mine was transferred from small-river to large-river barges. Most cargo transfers occurred directly from barge to barge; however, on one occasion the bags of ore were off-loaded from the barges and temporarily stored over the winter on private properties in the community. In 1992, 1999 and 2001 the LLRMWO conducted cleanups of the private properties and consolidated the contaminated soils into a temporary storage mound constructed on Hamlet-owned land near the airport. The covered mound, which contains approximately 500 m^3 of contaminated soils, is signed and fenced, and monitored by the LLRMWO. The temporary storage mound is under institutional control, and approaches for placing it under regulatory control are being considered.

8.1.4.1.3 Fort Smith

The Town of Fort Smith is located on the west bank of the Slave River, just north of the border between Alberta and the Northwest Territories. Fort Smith was a staging point along the NTR where cargo (including the uranium ore from the Port Radium Mine) was portaged around four sets of rapids on the Slave River. In 1998 and 2001, contaminated soil and building material discovered on private and public lands in the town were cleaned up and transferred to a temporary storage mound constructed near the town's landfill site. The covered mound, which contains approximately 350 m^3 of contaminated soils, is signed and fenced, and monitored by the LLRMWO. The temporary storage mound is under institutional control, and approaches for placing it under regulatory control are being considered.

8.1.4.1.4 Passmore Storage Mound

The Passmore Storage Mound is located in the Malvern Community of Toronto, Ontario (northeast part of Toronto). Malvern is a planned community that involved the redevelopment of agricultural lands into residential, light industrial and commercial uses.

One of the farms that was redeveloped was used in the late 1940s and early 1950s as the site of a radium recovery operation. During the course of redevelopment activities, residual pieces of radium bearing materials and contaminated soils originating from the recovery operation were deposited on residential lots. In 1993 the Malvern Remedial Project was established as a joint Canada-Ontario initiative to address the radium contamination in the Malvern community.

Under the management of the LLRMWO a clean up program was conducted that involved the excavation and transportation of the contaminated soil to the Passmore Avenue site where it was sorted into licensable, mildly contaminated, and clean fractions. The licensable material (approximately 50 m^3) was transferred off-site to an existing licensed facility. The mildly contaminated fraction was consolidated into a purpose-specific engineered containment mound constructed on the Passmore Avenue site. The mound, which contains approximately 10,000 m^3 of contaminated soils, is fenced and monitored by the LLRWMO. The cell is under institutional control, and approaches for placing it under regulatory control are being considered.

Figure 8.7 – Lakeshore Road Storage Mound

8.1.4.1.5 Lakeshore Road Storage Mound

In the mid-1990s, mildly contaminated soils at 1400 Lakeshore Road East in Mississauga were remediated as part of environmental investigations conducted by the LLRWMO in conjunction with the Toronto and Region Conservation Authority (TRCA). The soil was segregated and any licensable soil was transferred to a licensed facility. The remaining mildly contaminated soil was placed in an engineered storage mound on the southwest portion of the property. The mound is monitored by the LLRWMO. The TRCA has submitted a letter of intent to licence the mound.

8.1.4.1.6 Deloro

The Deloro Mine Site Cleanup Project is an initiative of the provincial Ontario Ministry of the Environment (MOE) to clean up the abandoned mining, refining, and manufacturing site located at Deloro, Ontario. The MOE assumed responsibility for this site in 1979 when the site owner failed to comply with ministry orders to control contamination leaving the site.

Although not a uranium mine, the 202-hectare property was the location of former mining, refining and manufacturing activities for more than 100 years. The site is located along the banks of the Moira River, beside the eastern boundary of the Village of Deloro (pop. 180).

Figure 8.8 – Deloro Mine Site

The environmental legacy at the Deloro mine site includes contamination of soils, sediments, groundwater and surface water, with arsenic, cobalt, copper, nickel and low-level radioactive waste. Only two to six per cent of the waste material on the Deloro Mine Site consists of low-level radioactive wastes − arsenic remains the contaminant of main concern.

The overall objective of the Deloro Mine Site Cleanup Project is to remediate the abandoned mining and industrial complex by isolating and containing the wastes, and engineering the site to protect people and the environment.

The draft cleanup plan is intended to isolate and contain the various contaminants, totaling about 650,000 m^3 in volume, within the boundaries of the Deloro Mine Site. None of the existing waste materials will be taken off-site.

In general terms, the draft cleanup plan proposes to:

- excavate and consolidate the most contaminated materials under engineered covers made of clay, sand, topsoil, loam and clay liner;
- use engineered clay caps to cover the less contaminated materials;
- manage surface and groundwater to minimize contact with the wastes; and
- treat contaminated surface water leaving the site

The cleanup will focus on four main areas where different industrial, mining and manufacturing activities took place. These include the;

- Industrial Area
- Tailings Area
- Young's Creek
- Mine Area

The project will be implemented in three phases. The first phase includes the conduct of the EA and decisions related to the EA, regulatory technical review of the project and licensing. Subsequent phases will include the clean-up and consolidation of materials at the site, followed by a phase of long-term inspection, monitoring and maintenance.

The CNSC determined that a Screening Level EA was required for this project. The CNSC delegated the responsibility of conducting the studies and preparing the EA study reports and the associated public consultation to the MOE, as the proponent.

The EA commenced in 2003 with the issuance of the EA guidelines by the CNSC. In accordance with the *Canadian Environmental Assessment Act*, decisions on the project are expected to be made by the end of 2006 by the project's responsible authorities (CNSC and Fisheries and Oceans Canada). The MOE is expecting to submit the EA Study Report to the responsible and federal authorities by September 2005.

With respect to public consultation, the MOE conducts public meetings and open houses, has a project specific dedicated area on the MOE web site, and meets regularly with three liaison committees to keep them informed and to gather input and comments.

8.1.6 Historic contaminated lands

8.1.6.1 Fort Fitzgerald

From the early 1930s to the 1950s uranium ore was transported by the NTR from Port Radium on Great Bear Lake, Northwest Territories to the railhead at Waterways (now Fort McMurray), Alberta. Suspected sites at Fort Fitzgerald exist within 100 metres of the river's edge. As part of the NTR, the sites were used as docks and boat launches. Radiological surveys were conducted in 2004 and additional characterization work is planned.

8.1.6.2 Sahtu Region

The Sahtu Region contaminated sites exist in isolated locations along the Great Bear River and at one remote end of Great Bear Lake in the Northwest Territories. Clean-up activities conducted by the LLRWMO at one site removed the highest grade material and brought readings down to below background. In 2003, the ten sites along the Great Bear River were characterized; only two sites require the care of institutional controls by the Sahtu Land and Water Board and INAC. The results of the characterization were communicated to the communities of Déline and Tulita.

For the above Northwest Territories sites, the land owners and administrators have been informed of the radiological contamination and are aware of the requirement for restrictions on construction activities at the sites. They also know about the process to contact the CNSC if construction activities were to occur.

8.1.6.3 Toronto, Ontario

Toronto area contaminated sites include radium contaminated soils on lands owned by the Province of Ontario, the TRCA, Ontario Realty Corporation (ORC) and private landowners. Contaminated sites also included radium contamination fixed to structural elements in privately owned buildings.

The contaminated soils are generally covered or occur in areas of low use (primarily open space). One former scrap metal yard is fenced and is undergoing characterization by ORC for both radiological and non-radiological contaminants. The contaminated material in buildings is isolated behind double wall and ceilings.

The owners of the properties are aware of these control measures and the tenants are restricted from construction activities that would compromise these safeguards. Furthermore, the owners are aware of the process that requires the CNSC to be contacted and given the opportunity to assess any proposed construction or land use changes. The CNSC maintains contact with the owners/managers of the sites through site visits and phone conversations.

8.1.6.4 Port Hope Area Initiative for the Long-Term Management of Historic Low-Level Radioactive Wastes

On March 29, 2001, an agreement was signed between the Government of Canada, as represented by the Minister of Natural Resources and the communities of Port Hope, Hope Township and Clarington for the construction of long-term waste management facilities for historic low-level radioactive wastes and for the cleanup of contaminated sites in the Port Hope area.

The wastes consist of about two million cubic metres of low-level radioactive wastes and contaminated soils containing radium-226, uranium and arsenic as the primary contaminants.

With this agreement, the Government of Canada began a 12-year, $260-million initiative to evaluate and implement a long-term solution for the management of the wastes from the Port Hope area sites. The initiative has been divided into two projects, along municipal boundaries. The Port Hope Project entails the cleanup and long-term management of wastes from various contaminated sites in the Municipality of Port Hope – formerly Town of Port Hope and Hope Township. The Port Granby Project involves the implementation of a long-term management approach for radioactive wastes at the existing Port Granby Waste Management Facility in the Municipality of Clarington.

A single purpose built facility is being planned to manage the wastes from each cleanup project: the Port Hope Long-Term Low-Level Radioactive Waste Management Facility (PHWMF) and the Port Granby Long-Term Low-Level Radioactive Waste Management Facility (PGWMF).

The PHWMF, with an estimated design capacity of 1.8 million m^3, is planned to accept a variety of wastes from the area. These include wastes from the major unlicensed sites in the Municipality of Port Hope such as the Alexander Street ravine, the waterworks, the viaducts area, the Mill Street south site, the landfill, and the harbour.

Figure 8.9 – Existing Welcome Waste Management Facility

Other wastes, such as contaminated roadways and soils from private properties, will also to be included, as will wastes from Cameco's Welcome Waste Management Facility and specified historic wastes from the Cameco conversion facility. Wastes from consolidation sites and temporary storage sites within the community which are being temporarily managed by the LLRWMO are also to be included as are certain non-radiological contaminated industrial wastes, as requested by the municipality and provided for in the agreement.

The PHWMF is planned to be constructed on an expanded site at the existing Welcome Waste Management Facility, located in the Municipality of Port Hope, which currently contains an estimated 500,000 m^3 of low-level wastes and contaminated soils. The operational phase of the project is expected to last for seven years pending successful completion of the EA and licensing processes.

Figure 8.10 – Existing Port Granby Waste Management Facility

The PGWMF, with an estimated design capacity of 600,000 m^3, is being planned to only accept wastes from the PGWMF currently owned and operated by Cameco Corporation and located in the Municipality of Clarington. The site being considered for these wastes is immediately northwest of the existing facility, away from the Lake Ontario shoreline. The operational phase of this project is expected to last for six years once the review and licensing processes are concluded.

8.1.6.5 Port Hope Contaminated Sites

A number of contaminated sites have been identified in the Municipality of Port Hope. Some of these sites are known as major unlicensed sites, others are known as the small scale sites and there are also licensed and unlicensed temporary storage and consolidation sites. Although many of these sites are not currently licensed by the CNSC, they are safe for casual access pending resolution of the project known as the PHAI that will remediate these sites once the waste management facilities for the project have been developed.

The major sites are generally well known by the community and municipality and will not be further developed until the historic waste deposits can be removed to an appropriate storage facility.

Figure 8.11 – Pine Street Extension Temporary Storage Site

However, small pockets of contaminated soils can also exist in areas of the community, in roadways, municipal road allowances, on other municipal properties and on private or commercial properties. These tend to be known collectively as the small-scale sites.

Development of these sites, which may include common activities such as road repair, infrastructure repair or maintenance property re-grading/landscaping and private or commercial property development or renovation, is accommodated under the Construction Monitoring Program, an administrative program between the LLRWMO and the Municipality of Port Hope.

Projects requiring municipal building permits are forwarded to the LLRWMO for review and action. This often results in the radiological monitoring of excavated materials in construction areas. If contaminated soils which need to be removed are identified, they are accepted at the Pine Street Extension Temporary Storage Site, a CNSC licensed storage facility. The project may then continue as planned. The LLRWMO also accepts applications to the program directly from residents, for projects that do not require building permits.

Larger projects that may negatively impact upon the LLRWMO's ability to receive wastes at its temporary storage site (it currently has a receiving capacity of about 6,000 m^3) are accommodated through the construction of small purpose built consolidation or storage sites. For example, small storage cells have been developed on sites specific to road and park reconstruction projects and a 17,500 m^3 storage site was recently developed in relation to the development of a new municipal water treatment plant. In the long-term, through the PHAI, the objective is to consolidate this material within the purpose-built Port Hope Long-Term Waste Management Facility.