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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



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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**

May 2003

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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

The Canadian National Report is prepared in fulfillment of Canada's obligations pursuant to Article 32 of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management coordinated by the International Atomic Energy Agency (IAEA). The report demonstrates how Canada has implemented its obligations under the Joint Convention.

The report follows closely the guidelines, regarding form and structure that were established by the contracting parties under Article 29 of the Joint Convention.

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LIST OF ACRONYMS

AECA	<i>Atomic Energy Control Act</i>
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable
CANDU	Canadian Deuterium Uranium
CCP	CNSC Compliance Program
CEAA	<i>Canadian Environmental Assessment Act</i>
CLEAN	Contaminated Lands Evaluation and Assessment Network
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DRL	Derived Release Limits
DRLs	derived release limits
DSMs	dry storage modules
DUFDSF	Darlington Used Fuel Dry Storage Facility
EA	Environmental Assessment
EIS	Environmental Impact Statement
EP	(emergency preparedness) plans
FNEP	<i>Federal Nuclear Emergency Plan</i>
HEU	high-enriched fuel
IAEA	International Atomic Energy Agency
IC-HX	in-ground heat exchanger
ICRP-60	International Commission on Radiological Protection Publication 60
ICRP	International Commission on Radiological Protection
IP-2 packages	Type 2 Industrial Packages
IRUS	Intrusion Resistant Underground Structures
LEU	low-enriched fuel
LLRWMO	Low-Level Radioactive Waste Management Office
MACSTOR	Modular Air-Cooled Storage System (module)
MAGS	Modular Above-Ground Storage (facilities)
MNR	McMaster Nuclear Reactor
NEA	<i>Nuclear Energy Act</i>
NFWA	<i>Nuclear Fuel Waste Act</i>
NLA	<i>Nuclear Liability Act</i>
NORM	Naturally Occurring Radioactive Material
NPD	Nuclear Power Development
NRU	National Research Universal
NRCAN	Natural Resources Canada
NSCA	<i>Nuclear Safety and Control Act</i>
NTR	Northern Transportation Route
OPG	Ontario Power Generation
PUFDSF	Pickering Used Fuel Dry Storage Facility
QA	Quality Assurance
RCSA	Retube Components Storage Area
SRWMF	Solid Radioactive Waste Management Facility
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 Centre
WUFDSF	Western Used Fuel Dry Storage Facility

SECTION A

1. INTRODUCTION

1.1 Scope of the Section

This section provides general introductory remarks, a survey of the main themes of this report, and any references to matters not covered elsewhere in the content of the report.

1.2 Introduction

Radioactive waste has been produced in Canada since the early 1930s when the first uranium mine began operating at Port Radium in the Northwest Territories. Radium was refined for medical use and uranium was later processed at Port Hope, Ontario. 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:

- uranium mining;
- milling;
- refining and conversion;
- nuclear fuel fabrication;
- nuclear reactor operations;
- nuclear research; and
- radioisotope manufacture and use.

The federal government has funded nuclear research and supported the development and the use of nuclear energy and related applications for several decades. Federal government funds for research and development activities related to CANDU (Canadian Deuterium Uranium) technology are approximately \$100 million annually.

Canadians have benefited in many ways from this investment:

- On average, nuclear energy supplies about 16% 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 results in the creation of more than 26,000 highly skilled jobs.
- Uranium continues to rank among the top 10 metal commodities in Canada for value of production.

The Canadian government gives high priority to the safety and protection of persons and the environment from the various operations of the nuclear industry, including the management of spent fuel and radioactive waste. As a result, the nuclear industry in Canada is strictly regulated. The major federal government organizations involved in the Canadian nuclear industry include the following:

- Natural Resources Canada (NRCan), which develops federal energy policy;
- The Canadian Nuclear Safety Commission (CNSC), which regulates the nuclear industry; and
- Health Canada (HC), which recommends radiological protection standards and monitors occupational radiological exposures.

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), and the *Nuclear Liability Act* (NLA) are the centrepieces of Canada's legislative and regulatory framework to ensure the safety of the nuclear industry in Canada. Complementing these is other legislation which has been enacted in order to provide for environmental protection and radioactive waste management. A detailed description of this legislative and regulatory framework is provided in Annex 2.

1.3 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 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 CNSC:

- 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 contain nuclear substances and therefore are regulated in the same manner as any other nuclear substance. Refer to subsection 2.5 for a description of Draft Regulatory Policy P-290, "Managing Radioactive Waste".

1.4 Canadian Philosophy and Approach to Safety

Canada actively promotes and regulates safety within the nuclear industry. Canada's approach is based upon international recommendations, such as the recommendations on radiological dose limits to the public and workers in International Commission on Radiological Protection Publication 60 *1990 Recommendations of the International Commission on Radiological Protection* (ICRP-60), and protection of the environment.

In Canada, the prime responsibility for safety rests with the person in possession of the nuclear substance or the operator of the facility. For example, it is the licensee's responsibility to demonstrate to the

satisfaction of the regulator 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.

1.5 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
- Defense-in-depth
- Multiple barriers.

1.6 Main Safety Issues

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

- The release of effluents into the environment, primarily from uranium mine and mill tailings and waste rock facilities. The large volume of tailings and waste rock has presented a challenge in the management of the effluents released from these sites.
- Historical and contaminated lands. These lands have presented the Canadian nuclear industry with a challenge to develop and apply consistent and transparent regulatory control to sites where there are nuclear substances.
- Past practices in the early years of the nuclear industry. Such practices have resulted in concerns regarding environmental impacts.

1.7 A Survey of the Main Themes

The main themes in this report are summarized as follows:

- The Canadian regulatory approach combined with the practices of the Canadian nuclear industry provide a safety review process that gives ongoing assurance of the safety of spent fuel management and radioactive waste management.
- The Canadian safety philosophy and requirements, applied through the regulatory process, make sure 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.
- The Canadian regulatory agency has sufficient independence, legislative 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.
- The first responsibility for safety rests with the licensees. All major licensees of spent fuel and radioactive waste management facilities in Canada are publicly-owned electric utilities or other agencies of the government (such as AECL) who report to a government body. All take their responsibility for safety seriously and are able to raise adequate revenue to support safe operations.

SECTION B

2. POLICIES AND PRACTICES

2.1 Scope of the Section

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

2.2 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.

2.3 Legislative Instruments

The Canadian Institutional Framework is illustrated in Figure 1.

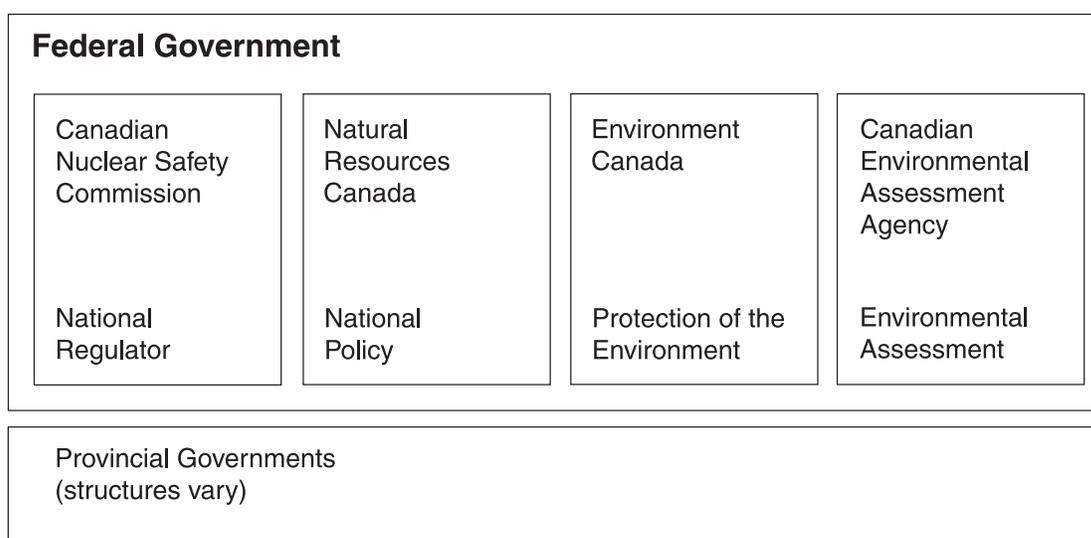


Figure 1 – Canadian Institutional Framework

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 *Nuclear Safety and Control Act* (NSCA), the *Nuclear Liability Act* (NLA), the *Nuclear Energy Act* (NEA), and the *Nuclear Fuel Waste Act* (NFWA).

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). Such legislation is usually administered by other government departments; 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 provinces where nuclear-related activities are carried out. Where there is an overlap of jurisdictions and responsibilities, the CNSC takes the lead in attempts to harmonize the regulatory activities (as well as including provincial regulators in the joint regulatory groups).

2.4 National Framework for Radioactive Waste Management

In addition to the NSCA and associated regulations, which are central to regulating the nuclear industry in Canada, there are several major policies and acts pertaining specifically to radioactive waste. These are described in Annex 2.

Specifically, the 1996 Government of Canada *Policy Framework for Radioactive Waste* provides a national context for waste management. This policy framework sets the stage for institutional and financial arrangements to implement disposal of radioactive waste in a safe, comprehensive, environmentally-sound, integrated, and cost-effective manner. The *Policy Framework for Radioactive Waste* 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
- that waste producers and owners are responsible, in accordance with the “polluter pays principle,” for the funding, organization, management and operation of disposal 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, nuclear fuel waste, low-level radioactive waste, and uranium and mill tailings (these categories are described in Subsection 2.6).

Although the policy framework is directed toward waste disposal, these principles are applied to all radioactive waste management through the CNSC Draft Regulatory Policy P-290 *Managing Radioactive Waste*.

2.5 Policy on Managing Spent Fuel and Radioactive Waste

Draft Regulatory Policy P-290 *Managing Radioactive Waste* was issued by the CNSC for public consultation. Consultations with the public, the nuclear industry, and other affected stakeholders is a formal step in the CNSC’s open and transparent approach to regulating the nuclear industry in Canada.

The policy statement in Draft 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 also expresses the philosophy and principles used by the CNSC to regulate radioactive waste. It indicates that the CNSC, when making regulatory decisions concerning the management of radioactive waste, will seek to achieve its objects 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 should be minimized to the extent practicable by the implementation of design measures and operating and decommissioning practices.

- b) Radioactive waste should be managed in a manner that is commensurate with its radiological, chemical, and biological hazards to the environment and to the health and safety of persons.
- c) The anticipated impacts on the environment and on the health and safety of persons from the future management of the radioactive waste should not be greater than those that are currently permissible in Canada.
- d) The establishment of arrangements to fund any measures needed to protect the environment and persons from the radioactive waste, as well as the implementation of such measures, should not be deferred unduly so as to impose a burden on future generations.
- e) The period over which the future impacts of radioactive waste on the environment and the health and safety of persons are assessed should include the period over which the maximum impacts are anticipated.
- f) The transborder effects on the health and safety of persons and on the environment that could result from the management of radioactive waste in Canada should not be 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 Draft 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 CNSC'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 for the purposes of:

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

2.6 Classification of Radioactive Waste in Canada

Radioactive waste in Canada is informally classified according to its radiological hazard and its mass, and generally falls within three categories:

- **Nuclear Fuel Waste:** Nuclear fuel waste refers to the nuclear fuel bundles discharged from CANDU power reactors, the prototype and demonstration power reactors, and research and isotope production reactors.

In Canada, nuclear fuel waste is synonymous with spent fuel, but is considered to be a more accurate term, reflecting that discharged fuel is considered a waste material but may not be fully spent. In spite of the difference in name, throughout this report the term spent fuel is used to be consistent with the terminology in the Joint Convention.

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

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 Radioisotope Production
 - e) Historic Low-Level Waste.
- **Uranium Mine and Mill Tailings** : Uranium mine and mill tailings are a specific type of low-level 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.

2.7 Management Practices for Spent Fuel

All spent fuel in Canada is currently held in either wet or dry interim storage. Spent fuel discharged from the CANDU reactor is placed into wet storage in spent fuel storage bays. The spent fuel 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 in use in Canada:

- AECL Silos
- AECL MACSTOR
- Ontario Power Generation (OPG) Dry Storage Containers

For a complete description of these dry storage containers refer to Annex 8.

Currently there are no plans for disposal of nuclear fuel waste in Canada. All spent fuel is held in interim storage pending a Government of Canada decision on what long-term management method to implement. The Nuclear Waste Management Office (NWMO), established by the NFWA, has a mandate to perform an options study and to make a recommendation to the Government of Canada on the method for long-term management of the nuclear fuel waste.

2.8 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. 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 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 facility.

To date there has been no pressing need for early disposal as volumes are small and the waste is being safely stored on an interim basis. However, the Canadian nuclear industry has recognized that disposal is a necessary step in responsible long-term waste management, so that future generations are not burdened with managing this waste. The nuclear industry has completed conceptual engineering studies and has

conducted a detail cost study for various options for a low-level radioactive waste disposal facility. The design and operation of such a disposal facility would be overseen 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.

Radioactive waste from activities other than nuclear power generation is shipped to special storage sites, such as that operated by AECL at its CRL. Typical storage facilities for this type of waste involve interim storage in modular above-ground storage buildings, lined concrete bunkers and tile holes. AECL has been developing a prototype belowground concrete vault known as IRUS (Intrusion-Resistant Underground Structure) for disposal of relatively short-lived radioactive waste.

Historically, radioactive waste arose in Canada from the early days of the nuclear industry, when regulatory oversight was not in place. Uranium and radium mining in the early part of the twentieth century in Northern Canada has left a legacy of abandoned mine sites and contaminated land and equipment along transport routes. During that period, refining and use of radioactive material in Southern Ontario has left some contaminated land and buildings. As a result of the coming into force of the NSCA and its regulations, the CLEAN (Contaminated Lands Evaluation and Assessment Network) program was initiated by the CNSC to identify these contaminated properties and bring them under regulatory oversight. At some sites decontamination was technically and economically feasible, with the radioactive waste being consolidated in other licensed sites. The management methods employed included packaging the low-level radioactive waste in drums or consolidating it into mounds on drainage pads and under infiltration covers, on access-controlled sites. Regular inspection and monitoring are used to verify the continued safety of these sites.

The bulk of Canada's historic low-level radioactive waste is located in the southern Ontario communities of Port Hope and Clarington. These wastes arose from the historic operations of a radium and uranium refinery in the town of Port Hope. In March 2001, the Government of Canada and the local municipalities where the wastes are located entered into an agreement for the long-term management of these wastes.

The project involves the cleanup of the wastes and its long-term management in newly constructed above-ground mounds in the local communities. The \$260 million project is funded by the Government of Canada and managed by the Low-Level Radioactive Waste Management Office (LLRWMO). It will take roughly 10 years to complete. The first phase of the project is an environmental assessment and regulatory review that is expected to last five years. Cleanup, construction and waste emplacement activities would take place over the following five years.

2.9 Management Practices for Uranium Mine and Mill Tailings

In Canada, about 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 of these no longer receive waste material; only the operations in Saskatchewan are now active. Both active and historic tailings sites fall under the regulatory responsibility of the CNSC.

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 waterretaining). 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 before discharge to control their mineralogy and placing them in engineered open pits (remaining after the ore has been removed by open pit mining).

In addition to the tailings produced from milling uranium ore, millions of cubic metres of waste rock are excavated in gaining access to mine the ore. Some of this waste rock could actually be 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 harm the 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) in an attempt to keep it in an environment similar to that from which it was excavated.

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 regulations pursuant to the NSCA (see Subsection 5.4.3). 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 much less stringent undertaking. Although it is acknowledged that such sites are tailings disposal areas and facilities, they are kept under licence control with no consideration at this time for abandonment.

Financial responsibility for the tailings in the Northwest Territories resides with the federal government; in the province of Saskatchewan, an agreement between the CNSC and the province has been signed that will lead to greater administrative efficiency in regulating the uranium industry. Financial responsibility for abandoned uranium tailings in the province of Ontario is shared by both levels of governments (federal and provincial) per the January 1996 Canada-Ontario agreement on cost-sharing for the management of abandoned uranium mine tailings.

SECTION C

3. SCOPE OF APPLICATION

3.1 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 waste, and military or defence programs.

3.2 Introduction

There is no definition for radioactive waste in the NSCA and associated regulations. Draft 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
- Military or defence programs

3.3 Reprocessing of Spent Fuel

Canada's nuclear industry uses natural uranium. As a result of Canada's large natural resource of uranium, there is no need for reprocessing of spent fuel at this time.

Therefore, pursuant to **Article 3(1)** of this Joint Convention, Canada declares that reprocessing activities is not part of Canada's spent fuel management program. Consequently, it is not included as part of this report. However reprocessing waste is 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.

3.4 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 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 Regulations are not part of this report.

3.5 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.

SECTION D

4. INVENTORIES AND LISTS

4.1 Scope of the Section

This section addresses **Article 32 (Reporting) (2)** of the Joint Convention. This section 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.

4.2 Inventory of Spent Fuel in Canada

4.2.1 Spent Fuel Wet Storage Inventory

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. Table 4.1 provides an inventory of spent fuel bundles in wet storage in Canada.

Table 4.1 CANDU spent fuel in wet storage at Canadian power reactor sites as of December 31, 2001

Site	Number of Fuel Bundles in Wet Storage	Kilograms of Uranium
Bruce A	354,567	6,756,508.4
Bruce B	337,637	6,513,896.5
Darlington	191,522	3,693,989.9
Gentilly-2	32,525	627,553.7
Pickering	400,534	8,026,400.4
Point Lepreau	40,814	782,147.6
TOTAL	1,357,599	26,400,496.5

4.2.2 Spent Fuel Dry Storage Inventory

Spent fuel dry storage facilities in Canada include two decommissioned reactor stations at which the spent fuel is housed in a dry storage state. Table 4.2 provides an inventory of spent fuel in dry storage.

Table 4.2 Candu spent fuel in dry storage at Canadian used fuel dry storage facilities as of December 31, 2001

Site	Number of Fuel Bundles in Dry Storage	Kilograms of Uranium
Pickering	79,266	1,594,816.8
Gentilly-2	48,000	917,980.0
Point Lepreau	48,600	931,584.7
Gentilly-1	3,213	67,595.5
Douglas Point	22,256	299,827.4
CRL (NPD fuel)	4,853	97,060.0
WRL	360	7,210.0
TOTAL	206,548	3,916,074.4

4.3 Radioactive Waste Inventory

4.3.1 Radioactive Waste Management Facilities

Table 4.3 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 4.3: Radioactive waste in storage at Canadian nuclear facilities as of December 31, 2001

Site	Type of Waste	Status	Storage Structures	Volume (M ³) in Storage
Western Waste Management Facility	Low-level reactor waste	Operating	In-ground containers Concrete trenches Quadricells Storage buildings	63,500
Pickering Waste Management Facility	Pressure tubes End fittings	Operating	34 Dry Storage Modules	945
Gentilly-2 Waste Management Facility	Low-level reactor waste	Operating	Concrete bunkers	625
Pointe Lepreau Waste Management Facility	Low-level reactor waste	Operating	Concrete bunkers	1,563
Gentilly-1 Waste Management Facility	Decommissioned reactor waste	Partially decommissioned	Reactor Building	934
Douglas Point Waste Management Facility	Decommissioned reactor waste	Partially decommissioned	Reactor Building	120
Whiteshell Laboratories	Various types of reactor, liquid waste, decommission waste	Undergoing decommissioning	Concrete trenches, above-ground storage buildings, tile holes	20,500
Chalk River Laboratories	Various reactor and isotope production wastes	Operating / storage with surveillance	Concrete trenches, above-ground storage buildings, tile holes	98,900
RWOS1	Reactor waste	Partially decommissioned	Concrete trenches	638
NPD	Decommissioned reactor waste	Partially decommissioned	Reactor Building	14
TOTAL ACCUMULATION				186,033

4.3.2 Historic Sites

Table 4.4 provides an inventory of radioactive waste at historic waste storage areas and contaminated sites in Canada. Note that radium-luminescent devices are considered historic waste. These sites are currently in a storage-with-surveillance mode.

Table 4.4: Historic waste accumulation as of December 31, 2001

Site	Type of Waste	Method of Storage	Volume (M ³)
Port Hope	Contaminated soils	Above-ground mounds	495,000
Welcome and Port Granby	Contaminated soils	Burial	870,000
Other locations across Canada	Contaminated soils	Above-ground mounds	65,000
Total Historic Waste			1,430,000

“Other locations across Canada” refer to interim storage mounds, contaminated sites, landfill sites, and long-term management sites across Canada.

4.4 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. Recently, mineralized “special waste rock” has been put under regulatory oversight. Tailings are managed in engineered Tailings Management Facilities (TMFs).

4.4.1 Tailings Inventory at Operational TMFs

TMFs currently receiving tailings are listed below:

- Cluff Lake TMF at Cluff Lake
- 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 4.5 provides an inventory of the uranium tailings in storage at operational mine sites in Canada.

Table 4.5: Uranium tailings accumulation at operational mines as of December 31, 2001

Site	Method of Storage	Accumulation (tonnes)
Cluff Lake	Surface	3,840,000
Key Lake	Open pit	2,465,588
Rabbit Lake	Open pit	5,140,000
McClean Lake	Open pit	257,922
Total Tailings		11,703,510

4.4.2 Uranium Tailings at Idle TMFs and Inactive/Decommissioned Mine Sites

Table 4.6 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 4.6: Uranium tailings accumulation at inactive/decommissioned mines as of December 31, 2001

Site	Method of Storage	Accumulation (tonnes)
Key Lake	Above-ground tailings	3,549,778
Rabbit Lake	Above-ground tailings	6,500,000
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
Lacnor	Above-ground tailings	2,700,000
Nordic	Above-ground tailings	12,000,000
Pronto	Above-ground tailings	2,100,00
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		201,750,778

4.4.3 Waste Rock Inventory

Table 4.7 provides an inventory of mineralized and non-mineralized waste rock.

Table 4.7: Mineralized and Non-Mineralized Waste Rock Inventory December 31, 2001

Site	Mineralized (tonnes)	Non-Mineralized (tonnes)
McClellan Lake	300,820	15,328,389
Key Lake	1,984,893	64,800,000
Rabbit Lake	1,380,191	13,993,756
Cluff Lake	n/a	10,180,000
McArthur River	43,073	961,314
Cigar Lake	n/a	117,000
Total	3,708,977	105,380,459

SECTION E

5. LEGISLATIVE AND REGULATORY SYSTEMS

5.1 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 regulatory framework, regulatory body, and approach to licensing radioactive material.

5.2 A Comprehensive Description of the Canadian Regulatory Systems

Under the current Canadian Legislative Framework, NRCan has been charged with setting Canadian policy with respect to the nuclear industry, as described in the *Policy Framework for Radioactive Waste*. Canada established regulatory authority over the use of nuclear materials in the NSCA, which outlines the authority and responsibilities of the CNSC under Section 9. The authority and responsibilities of the CNSC include the issuance of licences, 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 CNSC, its structure, operations, and regulatory activities is provided in Annex 3.

5.3 National Safety Requirements

As previously stated, under the NSCA spent fuel and radioactive waste are both considered to be nuclear substances. As a result, spent fuel and radioactive waste are subject to the same policies. The national safety requirements for nuclear substances are defined in the NSCA and associated regulations. The NSCA incorporates stringent regulations to ensure that public health and safety are protected. For example, the NSCA includes:

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

5.4 Regulations Issued under the Nuclear Safety and Control Act

The regulations under the NSCA allow licensees considerable 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 criteria and lists of information that they must supply. Acceptable information may be referred to in the licence, thus making it a legal requirement for the licensee in question.

There are nine regulations issued under the NSCA:

- *General Nuclear Safety and Control Regulations* (provided in Annex 4);
- *Radiation Protection Regulations* (provided in Annex 5);
- *Class I Nuclear Facilities Regulations* (provided in Annex 6);
- *Class II Nuclear Facilities and Prescribed Equipment Regulations*;
- *Uranium Mines and Mills Regulations* (provided in Annex 7);
- *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*

Detailed information on the regulations is provided in Annexes 4 through 7. The regulations not annexed to this report may 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, but set out the rules of procedure for public hearings to be held by the CNSC and for certain proceedings conducted by Designated Officers of the CNSC. The Rules of Procedure apply to the public, licensees, and CNSC staff and commissioners with respect to the conduct of licensing and other decisions.

The regulations also recognize the need for transparency. For example, the security provisions for transport of certain nuclear material reflect a balance between the public's right to know about the movement of nuclear material in Canada, and the need to ensure the physical security of the shipments. The NSCA and 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 certain nuclear material.

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.

5.4.1 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.

The *General Nuclear Safety and Control Regulations* also exempt naturally occurring radioactive materials that have not been associated with the development, production or use of nuclear energy. As authorized by the NSCA, a requirement to provide information on any proposed financial guarantees is also included under these regulations.

The *General Nuclear Safety and Control Regulations* are provided in Annex 4.

5.4.2 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 Commission. 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 described in Annex 5.

The dose limits are based on the 1991 recommendations of the International Commission on Radiation Protection (ICRP):

- for nuclear energy workers – 100 millisievert (mSv) for five years with a maximum of 50 mSv in any given year;
- for pregnant nuclear energy workers – 4 mSv/year; and
- for members of the public – 1 mSv/year.

The *Radiation Protection Regulations* are provided in Annex 5.

5.4.3 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, the facility and any system for the management, storage, or disposal of a nuclear substance.

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 persons and records to be kept and retained.

The *Class I Nuclear Facilities Regulations* are provided in Annex 6.

5.4.4 Nuclear Substances and Radiation Devices Regulations

The *Nuclear Substances and Radiation Devices 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 using tritium.

In general, the *Nuclear Substances and Radiation Devices Regulations* reflect international practice with minor variations based on Canadian policy and circumstances (e.g., exemption quantities and audible alarming dosimeters).

5.4.5 Packaging and Transport of Nuclear Substances Regulations

The Canadian requirements in the *Packaging and Transport of Nuclear Substances Regulations* are based on the 1985 IAEA recommendations, as amended in 1990. Many countries and international organizations have already adopted the 1990 recommendations; most Canadian exporters and shippers are already in compliance with the packaging requirements. Under the IAEA recommendations, carriers are required to have a radiation protection program, the expansion of those activities that require quality assurance programs and the use of Type 2 Industrial Packages (IP-2 packages).

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. The *Packaging and Transport of Nuclear Substances Regulations* can be viewed at www.nuclearsafety.gc.ca.

5.4.6 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.

The *Nuclear Security Regulations* can be viewed at www.nuclearsafety.gc.ca.

5.4.7 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.

The *Uranium Mines and Mills Regulations* are provided in Annex 7.

5.4.8 Class II Nuclear Facilities Regulations

The *Class II Nuclear Facilities Regulations* specify the requirements for nuclear facilities that pose a lower risk than Class I facilities. These include low-energy accelerators, irradiators, radiation therapy installations, and equipment containing only sealed sources. These regulations specify the information required in applications for the various licences for Class II facilities: construction, operation, and decommissioning. They also introduce new requirements for servicing licences and therapy room interlocks.

The *Class II Nuclear Facilities Regulations* can be viewed at www.nuclearsafety.gc.ca.

5.5 Comprehensive Licensing System

The general philosophy adopted in Canada in the regulation of the nuclear industry is that the licensee has the prime responsibility for safety and that CNSC staff perform an oversight 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. The CNSC issues licences to permit the activities otherwise prohibited by the NSCA. These licences 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 are set by provincial authorities, or have been based on codes established by organizations like the Canadian Standards Association (CSA) or the American Society of Mechanical Engineers (ASME).

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 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 extremely complex, covering a very wide range of possible occurrences.

CNSC staff review these submissions in detail, 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 during the licensing process may result in defining additional programs and criteria as part 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 make 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 judgment. 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. The responsibilities of these departments are considered in 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 are continually met.

5.6 Compliance Verification Program

CNSC regulatory requirements with respect to spent fuel and radioactive waste management facilities are specified in the NSCA and associated regulations, CNSC licences, CNSC regulatory Policies, Guides and Standards, and in licensee programs submitted in support of their application. In order to verify that licensees and other affected persons comply with these requirements, CNSC staff:

- apply the regulatory requirements in a manner that is fair, predictable, and consistent;
- use 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;
- establish 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;
- ensure that its compliance activities are conducted by trained and qualified staff; and,
- develop and implement a compliance promotion strategy and a compliance enforcement strategy.

Maintaining regulatory oversight and assessment of the licensees' safety performance is done by CNSC staff primarily through compliance verification activities. Compliance activities are grouped into the Program as: inspections, evaluations, and audits. The CNSC Compliance Program aims to provide a balance between proactive incentives to encourage compliance and reactive control measures to enforce compliance.

5.6.1 Compliance Promotion

The objectives of the compliance 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. Promotion 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.

5.6.2 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;
- evaluates the licensee's remedial action and the action taken to avoid incidents in the future; and
- examines licence conditions for evidence that suitable licensing action could avert similar incidents.

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.

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 inspections or unscheduled, but all 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.

Evaluations are usually done according to pre-planned inspection guides prepared for the specific occasion. Results are normally 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.

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 assess the contents of submitted operations reports. Spent fuel and radioactive waste management licensees are required to submit operating reports to the CNSC on a regular basis. This is a normally scheduled event defined in the licence conditions. 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 carry out a detailed review of only the most safety-significant events.

5.6.3 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,
- publicity,
- 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.

5.7 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. Draft 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.

Draft 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 2.5.

SECTION F

6. OTHER GENERAL SAFETY PROVISIONS

6.1 Scope of the Section

This section addresses **Article 21 (Responsibility of the Licence Holder)** to **Article 26 (Decommissioning)** of the Joint Convention. It provides information on the steps Canada's regulatory body takes to meet obligations regarding general safety provisions at either the national level or, more appropriately, at the facility level.

6.2 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.

Historically, the CNSC has recruited experienced personnel from universities and industry. However, the CNSC is facing the same human resources issues that the utilities and research and development organizations are facing, due in part to the aging demographics of the Canadian population. The CNSC is in the process of establishing human resource strategies that promote workforce sustainability through improvements in recruitment, retention, and succession planning. In addition, the CNSC has also developed and initiated a pilot internship program.

6.2.1 Network of Excellence in Nuclear Engineering

To address the issue of long-term capability maintenance, Canadian nuclear utilities have proposed the establishment of a Network of Excellence in Nuclear Engineering at Canadian universities to maintain expertise within university programs. Stronger industry support will address the need to provide undergraduate and graduate level training in nuclear engineering, and provide funding for development of programs that can be carried out at the university level. The CNSC is also contributing to this program.

6.2.2 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.

6.2.3 CANTEACH

The CNSC has committed to contributing information to the CANTEACH program. The CANTEACH program was established by AECL, OPG, CANDU Owners Group, Bruce Power, McMaster University, École Polytechnique, and the Canadian Nuclear Society. CANTEACH is an initiative being developed in an effort 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.

6.3 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 reaffirmed in the 1996 Government of Canada *Policy Framework for Radioactive Waste* (see Section B).

With respect to so-called abandoned mine sites where no owner can be held responsible, the Government of Canada 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, this Memorandum of Agreement has never been activated, since there have been to date no “abandoned” uranium mine sites in the province.

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

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

Sections 24(5) and 44(j) 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.” *Financial Guarantees for the Decommissioning of Licensed Activities, June 2000* (Regulatory Guide G-206) covers the provision of financial guarantees for decommissioning activities. The *Decommissioning Planning for Licensed Activities* (Regulatory Guide G-219) 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 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 and guides is met; and
- enable credible estimates of financial guarantees amounts.

Financial guarantees must be sufficient to fund all approved decommissioning activities. 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.

6.4 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.

6.4.1 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 facility;
- control changes and program interactions; and
- internal self-assessment and corrective action.

6.4.2 QA Program Assessment

To assess licensee QA programs, CNSC staff examines the results from the internal reviews and audits carried out by the licensees, and performs 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 5.6.3 provides further information on the CNSC Enforcement Policy.

6.5 Operational Radiation Protection

6.5.1 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 Is Reasonably Achievable Principle (ALARA Principle). The ALARA Principle is implemented through radiation protection programs that focus on the use of time, distance, and shielding for radiation exposure. The ALARA Principle is encouraged throughout the nuclear industry in Canada, and is supported internationally by the ICRP. Guidelines on How to Meet the Requirements to Keep All Exposures As Low As *Reasonably Achievable* (Regulatory Guide G-129) is issued by the CNSC 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 of 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.

6.5.2 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., contaminated ground 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, often 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. In addition, 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.

6.5.3 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 limit for effective dose is described in the *Radiation Protection Regulations* (see Annex 5). The CNSC requires that every licensee ascertain and record the magnitude of exposure of 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.

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

6.5.4 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 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 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.

6.5.5 Protection of the Environment

Protection of the Environment (Regulatory Policy P-223) describes the principles and factors that guide the CNSC 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 its 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.

6.5.6 Canadian Nuclear Safety Commission Activities

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

- review documentation and operational reports submitted by licensees;
- conduct radiation protection evaluations; and
- conduct evaluations of licensee environmental protection programs, EP programs, and other programs as required.

A detailed description of the Compliance Verification Program is provided in subsection 5.6.

6.6 Emergency Preparedness

The CNSC requires applicants to assess the implications of their proposed activities. Based on the risk involved, the CNSC may request an applicant to submit proposed measures to prevent or mitigate the effects of accidental releases of nuclear or hazardous substances. Once the plans have been reviewed and accepted by the CNSC, they become binding upon the licensee. Due to the variance in risk associated with radioactive waste facilities in Canada, some facilities require detailed EP plans while others require internal emergency procedures only.

Nuclear EP and response in Canada is a multi-jurisdictional responsibility shared by all levels of government and the licensee. The provinces have the primary responsibility for off site nuclear EP and response; they designate municipalities within their jurisdictions to carry out nuclear emergency planning. The Government of Canada also coordinates federal actions in support of the provinces during a nuclear emergency and has procedures to respond to emergencies with international or inter-provincial implications. Potentially, this collective responsibility encompasses a wide range of contingency and response measures to prevent, correct, or eliminate accidents, spills, abnormal situations, and emergencies.

6.6.1 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 pursuant to the NSCA and associated regulations.
- Off-site nuclear emergencies are those that require support from the site and all levels of government, provided under Health Canada's *Federal Nuclear Emergency Plan* (FNEP) to a Canadian province or territory as a consequence of a domestic, transboundary (for example, Canada and the United States), or international incident.

6.6.2 Federal Government Responsibilities

The federal government is responsible for:

- managing nuclear liability;
- coordinating with, and providing support to provinces in their response to a nuclear emergency;
- liaison with the international community;
- liaison with diplomatic missions in Canada;
- assisting Canadians abroad; and
- coordinating the national response to a nuclear emergency occurring in a foreign country.

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 EP 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. This allows the various jurisdictions and organizations that have responsibilities for aspects of nuclear emergency preparedness to discharge their responsibilities in a co-operative, complementary and coordinated manner.

6.6.3 International Arrangements

Canada is a signatory of the following three international emergency response agreements:

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 peacetime radiological events involving Canada, the United States, or both countries. Co-operative measures contained in the FNEP are consistent with this plan.

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1986) — Canada is a signatory of this international assistance agreement which was developed under the auspices of the IAEA. The purpose of the agreement is to promote co-operation between signatories and facilitate 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. This agreement has yet to be ratified pending a review of domestic implementing legislation.

Convention on Early Notification of a Nuclear Accident (1987) — Canada is a signatory of this international convention, which was developed under the auspices of the IAEA. This convention defines when and how the IAEA should be notified of an event with potential transboundary consequences, or when and how the IAEA would notify the signatories of an international event which could have an impact in their respective countries.

6.7 Decommissioning

Sections 24(5) and 44(j) of the NSCA provide 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 6.3.

SECTION G

7. SAFETY OF SPENT FUEL MANAGEMENT

7.1 Scope of the Section

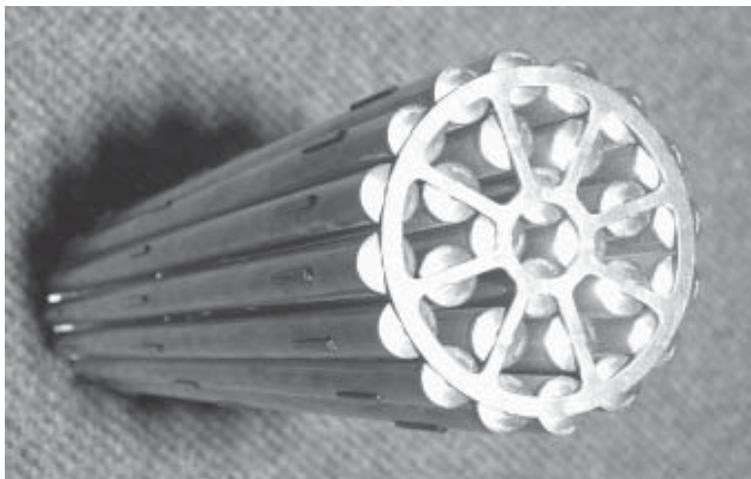
This section addresses **Article 4 (General Safety Requirements)** to **Article 10 (Disposal of Spent Fuel)**. This section provides a comprehensive description of spent fuel management in Canada. At all stages of spent fuel management, there are effective defences against potential hazards that protect 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.

7.2 Introduction

Used fuel in Canada is stored in wet or dry states (or both) 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. Such 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 cubic metres of used fuel per year.

7.3 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.



Standard CANDU Fuel Bundle

Photo courtesy of CNSC.

7.4 Research Reactor Fuel

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), 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 RERTR (reduce enrichment for research test reactors) 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.

7.4.1 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 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 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 such time as 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 for prototype testing of fuel to determine fuel characteristics. Once the fuel is tested, it is then in a reactor, so ZED-2 does not produce spent fuel waste directly.

McMaster Nuclear Reactor (MNR) has both HEU and LEU. Some of the LEU comes from France. All MNR used fuel (HEU and LEU) is sent to Savannah River, located in the United States, irrespective of its origin. All solid and liquid radioactive waste is handled in the same way as at other research facilities.

7.5 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)**.

7.6 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 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. The research reactor fuels are stored in both dry storage facilities and in tile holes at the CRL waste management facility.

7.7 Spent Fuel Management Methods

The fuel cycle in Canada is a once-through process (i.e., there is at present 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 7.17.

7.7.1 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 provisions; and
- physical stability and resistance to extreme site conditions.

The CSA 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 the standard as a guide to facilitate the licensing process.

7.8 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.

7.8.1 General Safety Requirements

Canada ensures that, at all stages of spent fuel and radioactive waste management, individuals, society, and the environment are adequately protected. This is accomplished through the Canadian regulatory regime.

Canada's approach to the safety of spent fuel and radioactive waste management are in line with the guidelines provided by the IAEA *Safety Guides and Practices*.

7.8.2 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 5.5.

7.8.3 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 risk 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.

7.8.4 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 by tests, analyses, monitoring programs, records, data and relevant reports, and so on.

7.8.5 Generic Design and Operational Principles

There are two main principles for generic design and operations:

- The use of engineered barriers to ensure adequate containment and isolation of the spent fuel and radioactive waste from humans and the environment; and
- Reliance on continuous human intervention, including administrative controls and procedures, to maintain containment and isolation.

7.8.6 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 meter 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.

7.8.7 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.

7.8.7.1 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).

7.8.7.2 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 NCSA, 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.

7.8.7.3 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 are 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.

7.8.7.4 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.

7.9 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.

7.10 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.

7.10.1 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.

7.11 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. A complete list is provided in Annex 4 and Annex 6.

7.12 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. A complete list of the required information is provided in Annex 4 and Annex 6.

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

- the 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.

7.13 Monitoring of Spent Fuel Dry Storage Facilities

All of the dry storage facilities presently operating in Canada and those under consideration must 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.

7.13.1 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. 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.

7.13.2 Leak Tightness Verification Experience

Leak tightness verification of the fuel baskets and concrete canister consists of connecting a pump to the liner cavity and recirculating 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.

7.13.3 Environmental Monitoring Experience

Each nuclear generating station has in place an environmental monitoring program. Spent fuel dry storage facilities at a nuclear generating station form part of this environmental monitoring program. The environmental program:

- provides an early indication of the appearance or accumulation of any radioactive material in the environment;
- verifies the adequacy and proper functioning of effluent controls and monitoring programs;
- provides an estimate of actual radiation exposure to the surrounding population;
- provides assurance that the environmental impact is known and within anticipated limits; and
- provides 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.

7.13.4 Effluent Monitoring Experience

7.13.4.1 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 into the shielded workstation, 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 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 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.

7.13.4.2 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 hazard if loose surface contamination on the dry storage container becomes airborne, or through 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 High Efficiency Particulate Air (HEPA) filters in the active ventilation system. Monitoring results to date with the Pickering 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 and vacuum dried 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 originate in the storage area from the occasional ingress of precipitation through the louvres. 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.

7.14 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.

7.15 New Facilities

The only new spent fuel management facility to begin operations in 2003 was the Western Used Fuel Dry Storage Facility (WUFDSF). The objective of the WUFDSF is to provide safe storage for used fuel produced at the Bruce A and B nuclear generating stations until all the used fuel is transported to an alternative long-term used fuel storage or disposal facility. The storage operation will ensure the protection of workers, the public, and the environment.

7.16 Proposed Facilities

At present the only proposed spent fuel management facility currently undergoing assessment is the Darlington Used Fuel Dry Storage Project. The project consists of the transfer of used fuel bundles from the water-filled fuel bays at the Darlington Nuclear Generating Station into dry storage containers that will be transferred to a Darlington Used Fuel Dry Storage Facility for processing and storage. The dry storage container is identical to that currently approved for the storage of used fuel at the Pickering Used Fuel Dry Storage Facility and the WUFDSF. The project includes seeking approval for the storage of Darlington used fuel in dry storage containers.

Under the NSCA, construction and operation of the Darlington Used Fuel Dry Storage Facility requires a licence from the CNSC. As the responsible authority for the regulation of nuclear facilities in Canada, the CNSC is required, in accordance with the CEAA, to conduct an environmental assessment of the project. The environmental assessment must address such items as spatial and temporal boundaries of the assessment; the existing environment; assessment and mitigation of environmental effects; assessment of cumulative effects; significance of the residual effects; stakeholder consultation; and, the identification of a follow-up program. Therefore the elements of **Article 6 (Siting of Proposed Facilities)** are addressed during the environmental assessment and subsequent consideration of the first licensing step for siting authorization. The scope of the environmental assessment for the Darlington Used Fuel Dry Storage Facility is provided in Annex 11.

With the completion and acceptance of the environmental assessment, the Darlington Used Fuel Dry Storage Project will then be subject to the CNSC licensing process for nuclear facilities. As a Class I nuclear facility, the information required pursuant to the *Class I Nuclear Facilities Regulations* and other pertinent regulations, as indicated in subsection 7.11, will be required. In conjunction with the environmental assessment results, the required information must demonstrate that the construction and operation of the Darlington Used Fuel Dry Storage Facility will be conducted in a safe, secure manner ensuring the safety of persons and the environment. By demonstrating their compliance with the regulations, the CNSC considers the proposed dry storage facility will meet the intent of this Joint Convention.

7.17 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) (AECL 1994) 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 federal government 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 (Morrison et al. 1996):

- 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, and 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 (CEAA 1998). 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 waste management organization (NRCAN 1998).

In 2001, following consultation with the public, provincial governments, waste owners and other interested parties, the Canadian federal government tabled Bill C-27, the NFWA. The purpose of the NFWA is to enable the Governor-in-Council to select the preferred approach to the long-term management of nuclear fuel waste, based on a study of approaches prepared by a waste management organization. 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, reflecting a broad range of scientific and technical disciplines; expertise including public affairs, other social sciences as needed, and traditional aboriginal knowledge; and including representatives of local and regional governments and aboriginal organisations 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 approaches must include:
 - a modified AECL concept for deep geological disposal;
 - storage at 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 an economic region for implementation, and a plan for implementation. 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.

The NFWA received Royal Assent in June 2002, and came into force on November 25, 2002 (NRCan 2002). The waste management organization has been 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.

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 federal government selects an option, the NWMO must submit information for a specific project in order to obtain a licence from the CNSC.

SECTION H

8. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

8.1 Scope of the Section

This section addresses **Article 11 (General Safety Requirements)** to **Article 17 (Institutional Measures After Closure)**. This section provides a comprehensive description of radioactive waste management in Canada. At all stages of radioactive waste management, there are effective defences against potential hazards to 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 describes the steps or controls in place to prevent accidents with radiological consequences, and to mitigate their consequences should they occur.

8.2 Radioactive Waste in Canada

Nuclear facilities and users of prescribed substances produce radioactive waste. 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 8.3).

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 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 practised in Canada for the management of radioactive waste are similar to that practised 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 licenced 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, that is to control and limit the release of potentially harmful substances into the environment.

8.3 Characteristics of Radioactive Waste in Canada

8.3.1 Fuel Manufacturing Waste

In the past, wastes from refineries and conversion facilities were managed by means of direct in-ground burial. This practice is currently not in use. 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 clean up of materials for conventional disposal. The residual volume of low-level waste now being produced is drummed and stored in warehouses pending the establishment of an appropriate disposal facility. The seepage and runoff from the waste management facilities where direct in-ground burial was practised 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.

8.3.2 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, 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-, medium- and high-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.

8.3.3 Historic Waste

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 *Atomic Energy Control Act*, but which are now not exempt from licensing under the *Nuclear Safety and Control Act*. Four categories of such sites include:

- waste management areas owned by the Provincial Crown;
- historic contaminated land sites resulting from past practices in the radium and uranium industries;
- landfills; and
- radium-luminescent devices.

Deloro was previously exempted from licensing because it was in the care and control of a provincial government agency and the *Atomic Energy Control Act* was not binding on the Crown. Many historic contaminated land sites were not licensed because the concentration of prescribed substance was less than that requiring a licence. Landfills had been previously exempted because they were under the control of the provincial governments, and they usually did not accept materials with concentrations exceeding AECB requirements. Releases to landfills of prescribed substances were and are controlled by AECB/CNSC licences. The possession of radium-luminescent devices had not been licensed in the past because there was no specific requirement to do so. With the coming into force of the NSCA, anyone possessing more than 10 devices requires a licence; anyone repairing, opening, or disposing of a device also requires a licence.

8.3.4 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 molybdenum-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.

8.3.5 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. Tailings can broadly be defined as those materials that are extracted during processing of the ore but which contain very little or none of the metal or mineral that is being sought. The other main source of waste from these operations is waste rock, which can broadly be defined as material that must be removed from the deposit in order to gain access to the ore. 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. The cut-off grade for benign waste rock is typically 0.03% uranium, with material greater than 0.03% but less than an economic grade defined as "special waste." This semi-mineralized grade of waste rock is segregated and handled separately, receiving a higher level of containment.

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. The grade is a measure of the concentration of the uranium in the ore; this also varies from mine

to mine. At the Elliot Lake uranium mines that operated in northern Ontario up to the 1990s, typically 1 000 kg of ore had to be mined to produce 1 or 2 kg of uranium. The high-grade ore bodies in northern Saskatchewan currently yield up to 20 to 30 kg of uranium per 100 kg of ore. Consequently, for the production of identical amounts of uranium, the mines in Saskatchewan produce much lower volumes of tailings.

Different mines use different chemicals in the milling process due to differences in the minerology of ores. Sometimes, the same chemicals are used in different concentrations. As a result, tailings vary in composition from mine to mine. In addition, specific physical conditions at different mine sites dictate different methods of tailings management. The method used is selected to provide the highest quality environmental protection under the circumstances for each mine.

Mill tailings are produced as a slurry of solids and liquids. The solids are either undissolved components of the ore or chemical precipitates formed during ore processing. When the slurry is discharged into a tailings management area, the solids consolidate and the water drains off. The solid tailings that result are generally similar in composition to the ore that was originally extracted from the ground, but contain many secondary mineralization and some chemical precipitates. The solid tailings contain no more hazardous substance than the original rock, but their chemical form has often been modified. Consequently, the contaminants can be more mobile, and tailings management efforts are directed primarily at ensuring that the solid materials are contained and immobilized. However, it should also be noted that the process of extracting the uranium from ore, under fairly aggressive leaching conditions, also means that the residual minerals are generally not prone to leaching under the less aggressive natural aging conditions encountered on long-term management. In the case of uranium ore tailings, much of the inventory of progeny radionuclides remains in the tailings.

Tailings management facilities have evolved over the years from deposition into natural landforms and lakes, to construction of surface storage facilities complete with seepage collection systems. The current practice is to place mill tailings into mined-out pits, 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. At most mines a portion of this water can be reused in the milling process; however, much of it must be discharged to the environment. Before this can happen, the water is treated by the addition of certain chemicals. For example, barium chloride is added to remove radium by precipitation. The water discharged from uranium mines and mills in Canada is monitored to ensure that it meets limits on chemical concentrations that have been prescribed by the Canadian government. These limits ensure that the impact on the environment is minimal. Recently, legislation has been introduced to require that these discharges are not acutely toxic to fish.

Waste rock characteristics can be highly variable. Some of this waste 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.

8.3.6 Radioactive Waste at Research Reactors

Radioactive waste material at all research reactors is 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 the TRIUMF (TriUniversity Meson Facility) 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) facility, there is also a small amount of contaminated oil produced annually from oil used by 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 9.

8.4 Waste Minimization

The practice of waste minimization in Canada is currently not a regulatory requirement. 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 practises 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.

It should also be noted that one of the key principles of *Managing Radioactive Waste* (CNSC draft Regulatory Policy P-290) 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.

Draft Regulatory Policy P-290 is presented in subsection 2.5.

8.5 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 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.

8.5.1 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*, described in Annex 7.

8.5.2 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.

8.6 Protection of Existing Facilities

The safety of radioactive waste management facilities existing 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.

8.6.1 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 would have on the environment. Progress in this area is proceeding.

8.7 Protection in the Siting of Proposed Facilities

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

- 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 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, with which Canada shares an international border, is part of a Nuclear Cooperation Agreement between Canada and the United States, which 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.

8.8 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 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*.

8.9 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 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. A complete list of the required information is provided in Annex 4 and Annex 6.

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.

8.9.1 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.

8.10 Institutional Measures after Closure

For radioactive waste produced since the 1970s, the main caretaking activity in Canada is storage. Low- and intermediate-level radioactive waste is stored in above or below-ground engineered structures. Canada does not currently have a disposal or long-term management facility in operation.

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.

8.11 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. The monitoring program 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 and groundwater sampling.

SECTION I

9. TRANSBOUNDARY MOVEMENT

9.1 Scope of the Section

This section addresses **Article 27 (Transboundary Movement)** of the Joint Convention, and provides information on Canada's experience with 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.

9.2 Introduction

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

- *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 environmentally-significant substances.

9.3 Controlled Substances

Nuclear substance possession licences issued in Canada 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. These lists and regulations are administered by the Department of Foreign Affairs and International Trade (DFAIT) through the *Export and Import Permits Act* and the CNSC under the NSCA.

The list include the following 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.

9.4 State of Origin

The CNSC and DFAIT 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 9.3. The application is submitted to DFAIT four to six weeks before the scheduled export to allow sufficient time to process, consult intra- and inter-departmentally, and issue both the CNSC licence and the DFAIT export permit.

For exports of substances listed in subsection 9.3, the process that is used in administering the application consists, in very general terms of the following elements:

- Is Canada the State of Origin? If not, has the substance been made subject to a Nuclear Cooperation Agreement at the time of import? Is prior consent from the State of Origin required prior to export? If “yes,” the proper communications must be made and consent obtained.
- Has Canada signed a Nuclear Cooperation Agreement with the State of Destination? Canada’s nuclear export policy requires that a State of Destination has already signed a Nuclear Cooperation Agreement with Canada prior to transferring radioactive source material (uranium, plutonium, or thorium). A Nuclear Cooperation Agreement defines the substances that are allowed to be exported or imported subject to the Nuclear Cooperation Agreement. If “no,” the export might not be authorized.
- Does the transfer require a prior notification to the State of Destination? If “yes,” the proper communications must be made.

Typically, the exporting country is required to produce a prior notification to the State of Destination if and only if the Shipping State wishes to make the material subject to the Nuclear Cooperation Agreement. Often, a notification of shipment is also expected by the State of Destination, allowing it the opportunity to make necessary preparations. These notifications are typically done directly between governmental authorities via established information channels dictated by administrative arrangements negotiated in support of the application Nuclear Cooperation Agreement. Diplomatic channels are normally avoided due to lengthy delays in exchanging information, although this option is exercised in a very limited number of partnerships. The CNSC is responsible for transmitting prior notifications.

9.5 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 further authorizations. For cases of import of substances described in subsection 9.3, 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 Customs and Revenue Agency (CCRA) 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 on import or export of nuclear substance items. If a valid licence is not available, the movement of the material is not allowed.

9.6 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.

SECTION J

10. DISUSED SEALED SOURCES

10.1 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. The Contracting Party must demonstrate that the possession, remanufacturing, or disposal of disused sealed sources takes place in a safe manner.
2. The Contracting Party permits disused sealed sources to re-enter into its territory to a manufacturer qualified to receive and possess the disused sealed sources.

10.2 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.

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 become radioactive waste and must be disposed of. In addition, substantial shielding is often required, which may increase the size of the shipping/storage package.

10.3 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 exemption 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 (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*).

10.4 Sealed Sources Used in Canada

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

Pursuant to the *Nuclear Substances and Radiation Devices Regulations*, every licensee who possesses, uses, or produces either a sealed source containing 50 MBq or more of a nuclear substance, or a nuclear substance as shielding, must conduct a leak test on the sealed source or shielding. The leak test must be conducted using instruments and procedures that enable the licensee to detect a leakage of 200 Bq or less of the nuclear substance

- where the sealed source or shielding is used after being stored for 12 or more consecutive months, immediately before using it;
- where the sealed source or shielding is being stored, every 24 months;
- where an event that may have damaged the sealed source or shielding has occurred, immediately after the event; and
- in all other cases where the sealed source or shielding is located in a radiation device, every 12 months, and where the sealed source or shielding is not located in a radiation device, every 6 months.

It should be noted that leak testing with respect to a sealed source does not apply to sealed sources that are gaseous or contained in a static eliminator that has been retained by the licensee for less than 15 months.

In the course of conducting a leak test on a sealed source or on shielding, when a leakage of 200 Bq or more of a nuclear substance is discovered, the licensee must

- discontinue using the sealed source or shielding;
- discontinue using the radiation device in which the sealed source or shielding is located or may have been located;
- take measures to limit the spread of radioactive contamination from the sealed source or shielding; and
- immediately comply with the regulations and notify the regulatory body that the leakage has been detected.

10.4.1 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 the AECL CRL for management or to their state of origin. On arrival at the CRL waste management facilities, the sources are often removed from their overpack and placed along with other sources in a single container. The container of sources is then placed in a concrete bunker for interim management.

10.4.2 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.

10.4.3 Safety of Sealed Sources

The requirement to license 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 5.6), the CNSC verifies that the disposal of sealed sources is in accordance with the regulations, licence condition, or written instructions it has issued.

10.5 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

11. PLANNED ACTIVITIES TO IMPROVE SAFETY

11.1 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.

11.2 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 safety of humans, society and the environment. These initiatives include:

- the development and implementation of regulatory documentation;
- regulating historic radioactive waste;
- spent fuel disposal options;
- low-level radioactive waste disposal options; and
- research projects.

11.3 Regulatory Documentation

The CNSC is currently in the process of updating several outdated regulatory documents. Of particular interest is *Managing Radioactive Waste* (draft Regulatory Policy P-290). This policy is intended to promote the implementation of measures to safely manage radioactive wastes:

- so as to protect health, safety, security, and the environment;
- to respect Canada's international commitments on the peaceful use of nuclear energy; and
- to promote consistent national and international standards and practices for the management and control of radioactive waste.

11.4 Historic Radioactive Waste

11.4.1 The Port Hope Area Initiative for the Long-Term Management of Historic Low-Level Wastes

On March 29, 2001, the Government of Canada, represented by the Minister of Natural Resources of Canada, and the Municipalities of Port Hope and Clarington signed an agreement for the cleanup of contaminated sites in the area of Port Hope and the construction of two long-term management facilities for historic low-level radioactive waste. The waste consists of about one million cubic metres of low-level radioactive waste and contaminated soil containing radium-226, uranium, and arsenic.

With this agreement, the Government of Canada began a ten-year, \$260 million initiative to evaluate and implement a long-term solution for the management of the wastes from the contaminated Port Hope sites. The initiative will be implemented in three phases. The first phase will involve the environmental assessment (EA) and regulatory review of the two proposed projects. Subsequent phases will involve cleaning contaminated sites and developing new management facilities and emplacing the wastes,

followed by a phase of long-term inspection, monitoring, and maintenance. The EA, which has already started in accordance with the CEAA will be conducted on two separate projects:

- The Port Hope Long-Term Radioactive Waste Management Project, which involves the cleanup and long-term management of historic and certain industrial wastes in the Municipality of Port Hope; and
- The Port Granby Long-Term Radioactive Waste Management Project, which involves the cleanup and long-term management of historic waste relating to the Port Granby facility in the Municipality of Clarington.

The Low-Level Radioactive Waste Management Office (LLRWMO) is the proponent for both projects.

11.4.2 Contaminated Lands

The CLEAN program was implemented to provide a framework for co-operation between proponents and the CNSC for sites that require regulatory control as a result of changes in legislation from the NSCA which superseded the *Atomic Energy Control Act* on May 31, 2000.

Under the CLEAN program, a number of sites previously exempted from regulatory control are being brought under CNSC licences. Five historic, closed waste consolidation sites will be licensed for safe management. Ten other contaminated lands in northern Canada will be characterized to help ensure the most appropriate regulatory approach is applied. They are currently under institutional control. One large contaminated land site in southern Canada is currently undergoing an EA and will be remediated under a CNSC licence. Seven legacy mine tailings sites are being brought under licence. Two of these will require remedial measures, while all will require long-term commitments to monitoring and maintenance. A comprehensive study of the potential impacts of the continuing possession and use of radium-luminescent dials is being completed, and the appropriate regulatory environment to encourage safe use will be explored.

11.5 Spent Fuel Disposal Options

The NFWA requires nuclear utilities to form a waste management organization. Under the NFWA, the mandate of the NWMO is to propose approaches for the long-term management of nuclear fuel waste to the Government of Canada, and to implement the approach that is selected by the government. The NFWA also requires the utilities and AECL, to establish trust funds to finance the implementation of the selected long-term nuclear fuel waste management approach.

The NFWA requires the NWMO to submit a study setting out its proposed approaches for the long-term management of nuclear fuel waste, and its recommendation on which proposed approach should be adopted, to the government by November 15, 2005. The NFWA requires the NWMO to include approaches based on both storage (on-site or centralized) and disposal in the study. In carrying out this study, the NWMO must consult with the general public on each of the proposed approaches. The NWMO must also create an Advisory Council whose role is to examine and provide written comments on the NWMO's program activities. The Advisory Council's membership must reflect technical and social sciences expertise. Once the Government of Canada has selected the general approach, the Advisory Council must include representatives from local and regional governments and aboriginal organizations.

The Government of Canada will select one of the approaches for the long-term management of nuclear fuel waste from among those set out in the study. The NWMO will then be required to implement the selected approach. This implementation will be funded through trust funds that have been set up by the nuclear utilities and AECL in accordance with requirements in the NFWA.

11.6 Low-Level Radioactive Waste Disposal Options

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. Waste disposal plans will be reviewed by the CNSC for assessment and approval according to health, safety, and environmental criteria.

The following initiatives described below are currently underway in Canada to address the disposal of low-level radioactive waste.

11.6.1 Intrusion Resistant Underground Structures

Radioactive waste has been managed at CRL for over 44 years. These are mostly low-level radioactive wastes and are currently in storage in a variety of structures, most of them located in the ground. These structures, although having performed well over the years, are not designed for long-term storage.

The Intrusion Resistant Underground Structures (IRUS) is a below ground vault with reinforced concrete walls and roof and a permeable floor. The structure is intended to endure for at least 500 years. Multiple barriers are employed to minimize water entry into the waste, to retard the release of radionuclides to the environment, and to discourage inadvertent intruders.

The intent of this initiative is to optimize both the safety and cost of disposal.

11.6.2 Power Utility Initiative

OPG has recognized that even though radioactive waste is being safely stored, it will eventually require disposal. Disposal will ensure that it can be kept isolated from the environment in the long term without burdening future generations with the caretaking of the waste.

Several approaches are under review. Public consultation for site selection, site characterization and development, EA, licensing, design, and construction could be expected to require a lengthy lead time.

11.7 Past Practices

Although radioactive waste from past practices, such as direct in-ground burial, are continuously under review by the CNSC, they are safely stored and await a long-term management solution. Environmental Risk Assessments will determine the potential impact of these wastes on the environment. Progress in this area is proceeding.

11.8 Research Projects

The CNSC conducts limited research aimed at helping to develop appropriate criteria to protect people and the environment as well as to develop appropriate regulatory guidance. Research is also conducted to help CNSC staff understand the nature of the safety issues related to waste management and to gain experience with the use of a variety of assessment tools and techniques. Examples of research projects concerning geosciences, geotechnical and regulatory aspects of waste management and decommissioning are provided below.

11.8.1 Comprehensive Review of the Effectiveness of Waste Rock Management and Decommissioning Practices

This project will perform and document a critical review of existing decommissioned waste rock piles in Canada and around the world, focusing on decommissioning criteria and objectives, the decommissioning options considered, the adequacy of monitoring programs, and the analysis of observed versus predicted performance. The project will include:

- a review of the recent developments in the understanding of short- and long-term environmental problems associated with waste rock;
- the contaminant transfer mechanisms;
- the adequacy of existing environmental impact prediction models; and
- the different field characterization and monitoring tools.

11.8.2 Participation in DECOVALEX

DECOVALEX (DEvelopment of COupled models and their VALidation against EXperiments) is an international co-operative project, initiated by the Swedish Nuclear Power Inspectorate. DECOVALEX supports the development of mathematical models of coupled thermal, hydrological, and mechanical processes in rock formations. These models are needed to predict the perturbing effects of excavation, operation, and long-term evolution of nuclear fuel waste repositories.

11.8.3 Performance of the In-Pit Disposal of Uranium Mine Tailings

Although disposal of uranium tailings in mined-out open pits is practised at a number of mines in Canada, no such facilities have been closed and decommissioned to fully demonstrate the technology. This study uses a laboratory-scale physical model of a generic in-pit disposal facility to perform and analyze experiments that will provide empirical evidence of the factors that affect the geotechnical and environmental performance of in-pit disposal systems. This will allow CNSC staff to identify any safety issues related to both the operation and the decommissioning of existing and future facilities.

ANNEXES

ANNEX 1

FEDERAL STRUCTURE

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:

- The production, use, and application of nuclear energy;
- The research, or investigation, with respect to nuclear energy; and
- The production, refining 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;
- off-site emergency preparedness; 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 co-operative arrangements between the federal and provincial departments and agencies having responsibilities or expertise in these areas.

Although these co-operative arrangements have been successful in achieving industry compliance, a need exists to provide them with a firmer legal basis. The 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 CNSC to perform any of the nuclear-related activities otherwise prohibited by the NSCA. In addition, the NSCA provides authority for the CNSC 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:

1.1 The Canadian Nuclear Safety Commission

The Canadian Nuclear Safety Commission (CNSC), created by the Governor-in-Council under the NSCA, 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 will 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 cases.

The CNSC regulates 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. Under the NSCA, the CNSC:

- regulates the development, production and use of nuclear energy in Canada;
- regulates the production, possession, use, and transport of nuclear substances, and the production, possession, and use of prescribed equipment and prescribed information;
- implements measures respecting international control of the development, production, transport, and use of nuclear energy and nuclear substances, including measures respecting the non-proliferation of nuclear weapons and nuclear explosive devices; and
- disseminates scientific, technical, and regulatory information concerning the activities of the CNSC and the effects, on the environment and on the health and safety of persons, of the development, production, possession, transport, and use referred to above.

The CNSC's vision is regulatory excellence based on knowledge, objectivity, and consideration of all viewpoints. In carrying out its mandate, the CNSC values quality, integrity, competence, dedication and respect for others. The CNSC's regulatory philosophy is:

- to establish, and require compliance with, regulatory requirements;
- to make independent, objective decisions;
- to base regulatory action on the level of risk; and
- to serve the public interest.

This regulatory philosophy is founded on two principles:

- (i) Persons and organizations that are 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 respect Canada's international commitments on the peaceful use of nuclear energy.
- (ii) The CNSC is responsible to the public for regulating persons and organizations that are subject to the NSCA and regulations in order to assure that they are properly discharging their obligations.

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

1.3 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 market;
- exports;
- international trade; and
- end uses.

It also represents Canada on the Uranium Exports Review Panel.

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 has a policy mandate related to energy sources in Canada, including nuclear energy. For example, with respect to radioactive waste, NRCan funds the clean up of certain historic low-level radioactive waste. Such clean up activities are licensed under the NSCA.

1.4 Canadian Environmental Assessment Agency

The Canadian Environmental Assessment Agency is charged with the administration of the *Canadian Environmental Assessment Act* (see Annex 2, Subsection 2.6). 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 process.

1.5 Nuclear Waste Management Office

The Nuclear Waste Management Office (NWMO) was established by the nuclear power utilities in Canada to comply with the requirements of the *Nuclear Fuel Waste Act* (refer to Annex 2, subsection 2.4).

1.6 Low-Level Radioactive Waste Management Office

The Low-Level Radioactive Waste Management Office (LLRWMO) was established by the Canadian federal government to carry out the federal government's relevant responsibilities for low-level radioactive waste management in Canada. The LLRWMO functions as one line of business within the decommissioning and waste management business of AECL. In addition to resolving historic waste issues that are a federal responsibility, the LLRWMO is responsible for ensuring that a permanent disposal system becomes available in Canada for low-level radioactive wastes generated from ongoing activities of federally regulated generators.

1.7 Department of Foreign Affairs and International Trade

The Department of Foreign Affairs and International Trade (DFAIT) is charged with promoting nuclear co-operation 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 honoured. The Department is also responsible for the implementation of the *Chemical Weapons Convention* and the *Comprehensive Nuclear-Test-Ban Treaty*. Canada signed the *Chemical Weapons Convention* and the *Comprehensive Nuclear-Test-Ban Treaty* in 1993 and 1996 respectively, and ratified them respectively in 1995 and 1998.

1.8 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.

HC accomplishes this through:

- the Federal Nuclear Emergency Plan (see Subsection 6.6.1);
- the National Radioactivity Monitoring Network;
- development of guidelines for exposure to radioactivity in water, food, and air following a nuclear emergency;
- providing advice and assistance to environmental assessment and reviews as required by the CEEA;
- 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; and
- 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*.

The National Dosimetry Services, operated through Health Canada, provides occupational monitoring for ionizing radiation to Canadians everywhere. Services offered are whole body and extremity thermoluminescent dosimetry services (TLD), as well as neutron dosimetry services and dosimetry of uranium miners. The National Dosimetry Services is licensed by the CNSC.

The National Dose Registry is a centralized radiation dose record system, managed by Health Canada. It contains the occupational radiation dose records of all monitored radiation workers in Canada from the 1940s to the present.

ANNEX 2

CANADIAN LEGISLATIVE SYSTEM AND INSTITUTIONAL FRAMEWORK

2.1 Introduction

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

2.2 Nuclear Safety and Control Act (www.nuclearsafety.gc.ca)

The 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 establishes the CNSC, which is comprised of the Commission (the tribunal which makes licensing decisions), and the CNSC staff, which 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.*

2.3 Nuclear Energy Act (laws.justice.gc.ca/en/A-16/index.html)

Concurrent with the NSCA, the NEA came into force in 2000. The NEA 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.

2.4 Nuclear Fuel Waste Act (www.nfwbureau.gc.ca)

The NFWA came into force on November 15, 2002. The NFWA 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 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.

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, make public statements on all of the NWMO’s reports.

2.5 Nuclear Liability Act (laws.justice.gc.ca/en/N-28/index.html)

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 modelled closely after the Vienna and Paris conventions. NRCan is undertaking a comprehensive review of the legislation, which is being influenced by recent revisions to the Vienna Convention. The NLA is administered by the CNSC, while NRCan has responsibility for policy direction.

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 Nuclear Damage Claims 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. The NLA recognizes that Canada may enter into international arrangements that carry nuclear liability, but at present, Canada is not a party to any such arrangement.

2.6 Canadian Environmental Assessment Act (laws.justice.gc.ca/en/C-15.2/index.html)

The *Canadian Environmental Assessment Act* sets out responsibilities and procedures for the environmental assessment of projects involving the federal government. The CEAA applies to projects for which the federal government holds decision-making authority—whether as proponent, land administrator, source of funding, or regulator.

The majority of federal projects requiring an environmental assessment undergo either a screening or a comprehensive study. Both can be considered self-directed environmental assessments in the sense that the Responsible Authority determines the scope of the environmental assessment and the scope of the factors to be considered, directly manages the environmental assessment process, and ensures that the environmental assessment 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.

In practice, the project proponent may be delegated to conduct the environmental assessment, 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 environmental assessment 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 environmental assessment process.

ANNEX 3

CANADIAN NUCLEAR SAFETY COMMISSION AND THE REGULATORY PROCESS

3.1 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 AECB with the implementation of the NSCA on 31 May 2000.

3.2 Nuclear Safety and Control Act

The NSCA was passed by Parliament on 20 March 1997. This was the first major overhaul of Canada's nuclear regime since the creation of AECB and the AECA in 1946. 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.

The NSCA establishes the CNSC, which is comprised of the Commission (the tribunal which makes licensing decisions), and the CNSC staff, which prepares recommendations to the Commission, exercises delegated licensing and authorization powers, and assesses licensee compliance with the Act, Regulations, and licence conditions.

3.3 Canadian Nuclear Safety Commission

The CNSC's regulatory regime covers the entire nuclear substance life cycle, from production, 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;
- Implementation of measures respecting international commitments on the peaceful use of nuclear energy and substances; and
- Dissemination of scientific, technical and regulatory information concerning CNSC activities.

3.4 CNSC in the Government Structure

The CNSC is a departmental corporation, named in Schedule II of the Government of Canada *Financial Administration Act*. The NSCA stipulates that the CNSC reports to the Parliament of Canada through a member of the Privy Council for Canada (Cabinet) designated by the Governor-in-Council as the Minister for purposes of the Act. Currently, this designate is the Minister of Natural Resources.

The NSCA requires the Commission to "comply with any general or special direction given by the Minister with reference to the carrying out of its purposes." However, 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.

The Commission requires the involvement and support of the Minister of Natural Resources for special initiatives, such as the introduction of new legislation. (For example, the NSCA was sponsored by the Minister of Natural Resources.) The CNSC is not part of a government department, nor is it accountable to staff or executives of NRCan other than the Minister.

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, formal consultations are conducted in an open and transparent manner. CNSC staff routinely interact with management and staff of NRCan in areas of mutual interest. NRCan has a general interest in various matters relating to nuclear energy and natural resources. For example, the department funds the cleanup of certain low-level radioactive wastes on behalf of the Government of Canada, and consequently has an interest in related CNSC policies and licensing matters.

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.

3.5 Organizational Structure

3.5.1 Commission Tribunal

The Commission is an independent, quasi-judicial seven member tribunal that provides licensing decisions on nuclear-related activities in a public forum. Meetings are usually held in Ottawa but are sometimes held in municipalities where major facilities are located. Individually appointed by the federal government, Commission members are separate from the rest of CNSC staff. Six are part-time members, and the scope of their roles is limited to the tribunal. The seventh member is the President of the tribunal and the Chief Executive Officer (CEO) of the CNSC staff organization.

The tribunal's responsibilities are to provide decisions on licensing issues through public hearings, establish legally binding regulations, and set regulatory policy direction relating to the health, safety, security, and environmental issues affecting the industry.

3.5.2 Commission Secretariat

This group is responsible for the logistics of hearings and meetings of the tribunal, including public releases of notices, commission decisions, and records of proceedings.

3.5.3 CNSC Staff

The tribunal is supported by about 400 staff members, whose roles include:

- advisors to the tribunal and assistants to the President;
- preparing recommendations on licensing issues;
- presenting recommendations to the tribunal for consideration during public hearings and administering the decisions made by the tribunal;
- exercising certain licensing decision-making powers delegated by the Commission to designated officers; and
- undertaking the compliance activities needed to administer licensing decisions.

The CNSC is structured into the following directorates and branches:

Corporate Services—Administration of CNSC as a government agency

Operations Branch—Day-to-day regulation of nuclear industry

Office of Regulatory Affairs—Corporate-wide policies and intergovernmental activities

Office of International Affairs—Coordination of international activities and commitments

3.6 Regulatory Philosophy and Activities

3.6.1 CNSC Regulatory Philosophy

CNSC's regulatory philosophy is based on two principles:

- 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 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.

Subsequently, to fulfill Canada's international obligations, CNSC participates with various agencies such as its counterparts in other countries and DFAIT, to ensure that nuclear co-operation is conducted consistent with international agreements. This ensures that there is an effective and comprehensive international nuclear non-proliferation regime.

3.7 Regulatory Documents

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 in meeting regulatory requirements, are established in consultation with stakeholders. Licensees are informed of the standards and policies and are expected 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.

3.8 Licensing Process (www.nuclearsafety.gc.ca/eng/licenses/index.html)

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.

There are several types of licences issued. A facility (Class I, II, Uranium Mines or Mills) is licensed during its life cycle. Licences are required for site preparation, construction, operations, decommissioning, and abandonment.

An application for a licence (including renewals or amendments) can trigger other legislation and regulations. For example, compliance with the CEAA and its regulations is a prerequisite to proceeding with a licence application under the NSCA. CEAA may require an environmental assessment 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 based on the severity of the potential environmental impacts.

In addition, CNSC also licenses the import and export of 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.

3.9 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 held (typically 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 regulates them). Supplementary information the applicant or staff wishes to provide to the tribunal are filed 7 days in advance of the hearing.

During the hearing, applicants present the information on their application. CNSC staff present their 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 intervenors become public record and are sent to the applicant and staff for review. Supplementary information must be filed 7 days prior to hearing.

Hearing Day 2—As appropriate, the applicant and CNSC staff present additional information to the tribunal. Any intervenors 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 intervenors 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).

3.10 Licensing Oversight

Administering licensing decisions of the tribunal entails a 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.

3.10.1 CNSC Compliance Program (CCP)

Confirmation of compliance with licences is managed within this formal compliance verification program that includes promotion, verification and enforcement. These elements of the program are described in Section E.

3.11 Communication Activities

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.

To facilitate external communication, a corporate outreach program is also currently under development. This program provides a proactive, systematic, and risk-informed approach in interacting with stakeholders. Outreach activities and events are planned and organized accordingly and as appropriate.

As an agent of the Government of Canada, the CNSC makes all information and services for stakeholders available in both official languages (English and French).

ANNEX 4

GENERAL NUCLEAR SAFETY AND CONTROL REGULATIONS

INTERPRETATION AND APPLICATION

Interpretation

1. The definitions in this section apply in these Regulations.

“Act” means the *Nuclear Safety and Control Act*. (*Loi*)

“brachytherapy machine” means a device that is designed to place, by remote control, a sealed source inside or in contact with a person for therapeutic purposes. (*appareil de curiethérapie*)

“effective dose” has the meaning assigned to that term by subsection 1(1) of the *Radiation Protection Regulations*. (*dose efficace*)

“equivalent dose” has the meaning assigned to that term by subsection 1(1) of the *Radiation Protection Regulations*. (*dose équivalente*)

“hazardous substance” or “hazardous waste” means a substance or waste, other than a nuclear substance, that is used or produced in the course of carrying on a licensed activity and that may pose a risk to the environment or the health and safety of persons. (*substance dangereuse ou déchet dangereux*)

“IAEA” means the International Atomic Energy Agency. (*AIEA*)

“IAEA Agreement” means the *Agreement between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons*, effective on February 21, 1972; INFCIRC/164; UNTS vol. 814, R. No. 11596. (*Accord avec l’AIEA*)

“irradiator” means a device that is designed to contain a nuclear substance and to deliver controlled doses of radiation to any target material except persons. (*irradiateur*)

“licensed activity” means an activity described in any of paragraphs 26(a) to (f) of the Act that a licence authorizes the licensee to carry on. (*activité autorisée*)

“licensee” means a person who is licensed to carry on an activity described in any of paragraphs 26(a) to (f) of the Act. (*titulaire de permis*)

“prescribed equipment” means the equipment prescribed by section 20. (*équipement réglementé*).

“prescribed information” means the information prescribed by section 21. (*renseignements réglementés*)

“radioactive source teletherapy machine” means a teletherapy machine that is designed to deliver doses of radiation produced by a nuclear substance. (*appareil de téléthérapie à source radioactive*)

“safeguards” means a verification system that is established in accordance with a safeguards agreement. (*garanties*)

“safeguards agreement” means

(a) the *IAEA Agreement* and any arrangement between Canada and the IAEA made under that agreement; and

(b) any agreement to which Canada is a party for the establishment in Canada of a verification system in respect of nuclear substances, prescribed equipment or prescribed information, and any arrangements made under such an agreement. (*accord relatif aux garanties*)

“safeguards equipment” means equipment that is used in accordance with a safeguards agreement. (*équipement de garanties*)

“teletherapy machine” means a device that is designed to deliver controlled doses of radiation in a collimated beam for therapeutic purposes. (*appareil de téléthérapie*).

“transit” means the process of being transported through Canada after being imported into and before being exported from Canada, in a situation where the place of initial loading and the final destination are outside Canada. (*transit*)

“worker” means a person who performs work that is referred to in a licence. (*travailleur*)

Application

2. These Regulations apply generally for the purposes of the Act.

LICENCES

General Application Requirements

3. (1) An application for a licence shall contain the following information:
- (a) the applicant's name and business address;
 - (b) the activity to be licensed and its purpose;
 - (c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;
 - (d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;
 - (e) the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*;
 - (f) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations* ;
 - (g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;
 - (h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;
 - (i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;
 - (j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;
 - (k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority;
 - (l) a description of any proposed financial guarantee relating to the activity to be licensed;
 - (m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence; and
 - (n) at the request of the Commission, any other information that is necessary to enable the Commission to determine whether the applicant
 - (i) is qualified to carry on the activity to be licensed, or
 - (ii) 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.
- (2) Subsection (1) does not apply in respect of an application for a licence to import or export for which the information requirements are prescribed by the *Nuclear Non-Proliferation Import and Export Control Regulations*, or in respect of 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*.

Application for Licence to Abandon

4. An application for a licence to abandon a nuclear substance, a nuclear facility, prescribed equipment or prescribed information shall contain the following information in addition to the information required by section 3:
 - (a) the name and location of the land, buildings, structures, components and equipment that are to be abandoned;
 - (b) the proposed time and location of the abandonment;
 - (c) the proposed method of and procedure for abandonment; and
 - (d) the effects on the environment and the health and safety of persons that may result from the abandonment, and the measures that will be taken to prevent or mitigate those effects.

Application for Renewal of Licence

5. An application for the renewal of a licence shall contain:
 - (a) the information required to be contained in an application for that licence by the applicable regulations made under the Act; and
 - (b) a statement identifying the changes in the information that was previously submitted.

Application for Amendment, Revocation or Replacement of Licence

6. An application for the amendment, revocation or replacement of a licence shall contain the following information:
 - (a) a description of the amendment, revocation or replacement and of the measures that will be taken and the methods and procedures that will be used to implement it;
 - (b) a statement identifying the changes in the information contained in the most recent application for the licence;
 - (c) a description of the nuclear substances, land, areas, buildings, structures, components, equipment and systems that will be affected by the amendment, revocation or replacement and of the manner in which they will be affected; and
 - (d) the proposed starting date and the expected completion date of any modification encompassed by the application.

Incorporation of Material in Application

7. An application for a licence or for the renewal, suspension in whole or in part, amendment, revocation or replacement of a licence may incorporate by reference any information that is included in a valid, expired or revoked licence.

Renewal, Suspension, Amendment, Revocation or Replacement of Licence on Commission's Own Motion

8. (1) For the purpose of section 25 of the Act, the Commission may renew a licence on its own motion if failure to renew the licence could pose an unreasonable risk to the environment, the health and safety of persons or national security.
 - (2) For the purpose of section 25 of the Act, the Commission may, on its own motion, suspend in whole or in part, amend, revoke or replace a licence under any of the following conditions:
 - (a) the licensee is not qualified to carry on the licensed activity;
 - (b) the licensed activity poses an unreasonable risk to the environment, the health and safety of persons or the maintenance of security;
 - (c) the licensee has failed to comply with the Act, the regulations made under the Act or the licence;
 - (d) the licensee has been convicted of an offence under the Act;
 - (e) a record referred to in the licence has been modified in a manner not permitted by the licence;
 - (f) the licensee no longer carries on the licensed activity;

- (g) the licensee has not paid the licence fee prescribed by the *Cost Recovery Fees Regulations*; or
- (h) failure to do so could pose an unreasonable risk to the environment, the health and safety of persons or national security.

EXEMPTIONS

Exemptions from Licence Requirement for Inspectors, Designated Officers and Peace Officers

- 9.** (1) An inspector, a designated officer or a peace officer may carry on any of the following activities without a licence to carry on that activity if the activity is carried on by that person to enforce the Act or the regulations made under the Act:
- (a) possess, transfer, transport or store a nuclear substance; and
 - (b) possess or transfer prescribed equipment or prescribed information.
- (2) An inspector or a designated officer may service prescribed equipment without a licence to carry on that activity if the servicing is carried on by that person to enforce the Act or the regulations made under the Act.
- (3) For greater certainty, the exemptions established in subsections (1) and (2) relate only to the activities specified in those subsections and do not derogate from the licence requirement imposed by section 26 of the Act in relation to other activities.
- (4) Every person who carries on an activity without a licence in accordance with subsection (1) or (2) shall immediately notify the Commission of that fact.

Exemption of Naturally Occurring Nuclear Substances

- 10.** Naturally occurring nuclear substances, 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 Act and the regulations made under the Act except the following:
- (a) the provisions that govern the transport of nuclear substances; and
 - (b) in the case of a nuclear substance listed in the schedule to the *Nuclear Nonproliferation Import and Export Control Regulations*, the provisions that govern the import and export of nuclear substances.

Exemption by the Commission

- 11.** For the purpose of section 7 of the Act, the Commission may grant an exemption if doing so will not
- (a) pose an unreasonable risk to the environment or the health and safety of persons;
 - (b) pose an unreasonable risk to national security; or
 - (c) result in a failure to achieve conformity with measures of control and international obligations to which Canada has agreed.

OBLIGATIONS

Obligations of Licensees

- 12.** (1) Every licensee shall.
- (a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;
 - (b) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;
 - (c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security;
 - (d) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;

- (e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence;
 - (f) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity;
 - (g) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;
 - (h) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;
 - (i) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;
 - (j) instruct the workers on the physical security program at the site of the licensed activity and on their obligations under that program; and
 - (k) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.
- (2) Every licensee who receives a request from the Commission or a person who is authorized by the Commission for the purpose of this subsection, to conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment, to modify procedures or to install a new system or new equipment shall file, within the time specified in the request, a report with the Commission that contains the following information:
- (a) confirmation that the request will or will not be carried out or will be carried out in part;
 - (b) any action that the licensee has taken to carry out the request or any part of it;
 - (c) any reasons why the request or any part of it will not be carried out;
 - (d) any proposed alternative means to achieve the objectives of the request; and
 - (e) any proposed alternative period within which the licensee proposes to carry out the request.

Transfers

- 13.** No licensee shall transfer a nuclear substance, prescribed equipment or prescribed information to a person who does not hold the licence, if any, that is required to possess the nuclear substance, prescribed equipment or prescribed information by the Act and the regulations made under the Act.

Notice of Licence

- 14.** (1) Every licensee other than a licensee who is conducting field operations shall post, at the location specified in the licence or, if no location is specified in the licence, in a conspicuous place at the site of the licensed activity,
- (a) a copy of the licence, with or without the licence number, and a notice indicating the place where any record referred to in the licence may be consulted; or
 - (b) a notice containing
 - (i) the name of the licensee,
 - (ii) a description of the licensed activity,
 - (iii) a description of the nuclear substance, nuclear facility or prescribed equipment encompassed by the licence, and
 - (iv) a statement of the location of the licence and any record referred to in it.
- (2) Every licensee who is conducting field operations shall keep a copy of the licence at the place where the field operations are being conducted.
- (3) Subsections (1) and (2) do not apply to a licensee in respect of
- (a) a licence to import or export a nuclear substance, prescribed equipment or prescribed information;
 - (b) a licence to transport a nuclear substance; or
 - (c) a licence to abandon a nuclear substance, a nuclear facility, prescribed equipment or prescribed information.

Representatives of Applicants and Licensees

- 15.** Every applicant for a licence and every licensee shall notify the Commission of
- (a) the persons who have authority to act for them in their dealings with the Commission;
 - (b) the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed equipment or prescribed information encompassed by the licence; and
 - (c) any change in the information referred to in paragraphs (a) and (b), within 15 days after the change occurs.

Publication of Health and Safety Information

- 16.** (1) Every licensee shall make available to all workers the health and safety information with respect to their workplace that has been collected by the licensee in accordance with the Act, the regulations made under the Act and the licence.
- (2) Subsection (1) does not apply in respect of personal dose records and prescribed information.

Obligations of Workers

- 17.** Every worker shall
- (a) use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible and reasonable manner and in accordance with the Act, the regulations made under the Act and the licence;
 - (b) comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment;
 - (c) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be
 - (i) a significant increase in the risk to the environment or the health and safety of persons,
 - (ii) a threat to the maintenance of security or an incident with respect to security,
 - (iii) a failure to comply with the Act, the regulations made under the Act or the licence,
 - (iv) an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information, or
 - (v) a release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee;
 - (d) observe and obey all notices and warning signs posted by the licensee in accordance with the *Radiation Protection Regulations*; and
 - (e) take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of security.

Presentation of Licence to Customs Officer

- 18.** On importing or exporting a nuclear substance, prescribed equipment or prescribed information, the licensee shall present the required import or export licence to a customs officer.

PRESCRIBED NUCLEAR FACILITIES

- 19.** The following facilities are prescribed as nuclear facilities for the purpose of paragraph (i) of the definition "nuclear facility" in section 2 of the Act:

- (a) a facility for the management, storage or disposal of waste containing radioactive nuclear substances at which the resident inventory of radioactive nuclear substances contained in the waste is 1015 Bq or more;
- (b) a plant for the production of deuterium or deuterium compounds using hydrogen sulphide; and
- (c) a facility that consists of
 - (i) an irradiator that uses more than 1015 Bq of a nuclear substance,
 - (ii) an irradiator that requires shielding which is not part of the irradiator and that can deliver radiation at a dose rate exceeding 1 centigray per minute at 1 m,
 - (iii) a radioactive source teletherapy machine, or
 - (iv) a brachytherapy machine.

PRESCRIBED EQUIPMENT

20. Each of the following items is prescribed equipment for the purposes of the Act:

- (a) a package and special form radioactive material, as defined in subsection 1(1) of the *Packaging and Transport of Nuclear Substances Regulations*;
- (b) a radiation device and a sealed source, as defined in section 1 of the *Nuclear Substances and Radiation Devices Regulations*;
- (c) Class II prescribed equipment, as defined in section 1 of the *Class II Nuclear Facilities and Prescribed Equipment Regulations*; and
- (d) equipment that is capable of being used in the design, production, operation or maintenance of a nuclear weapon or nuclear explosive device.

PRESCRIBED INFORMATION

Prescription

21. (1) Information that concerns any of the following, including a record of that information, is prescribed information for the purposes of the Act:

- (a) a nuclear substance that is required for the design, production, operation or maintenance of a nuclear weapon or nuclear explosive device, including the properties of the nuclear substance;
 - (b) the design, production, use, operation or maintenance of a nuclear weapon or nuclear explosive device;
 - (c) the security arrangements, security equipment, security systems and security procedures established by a licensee in accordance with the Act, the regulations made under the Act or the licence, and any incident relating to security; and
 - (d) the route or schedule for the transport of Category I, II or III nuclear material, as defined in section 1 of the *Nuclear Security Regulations*.
- (2) Information that is made public in accordance with the Act, the regulations made under the Act or a licence is not prescribed information for the purposes of the Act.

Exemptions from Licence Requirement

22. (1) The following persons may possess, transfer, import, export or use prescribed information without a licence to carry on that activity:

- (a) a minister, employee or other person acting on behalf of or under the direction of the Government of Canada, the government of a province or any of their agencies, for the purpose of assisting themselves in exercising a power or performing a duty or function lawfully conferred or imposed on them; and
 - (b) an official of a foreign government or an international agency, for the purpose of meeting obligations imposed by an arrangement made between the Government of Canada and the foreign government or international agency.
- (2) The following persons may possess, transfer or use prescribed information without a licence to carry on that activity:

- (a) a worker, for the purpose of enabling the worker to perform duties assigned by the licensee; and
- (b) a person who is legally required or legally authorized to obtain or receive the information.
- (3) For greater certainty, the exemptions established in subsections (1) and (2) relate only to the activities specified in those subsections and do not derogate from the licence requirement imposed by section 26 of the Act in relation to other activities.

Transfer and Disclosure

- 23.** (1) No person shall transfer or disclose prescribed information unless the person
- (a) is legally required to do so; or
 - (b) transfers or discloses it to
 - (i) a minister, employee or other person acting on behalf or under the direction of the Government of Canada, the government of a province or any of their agencies, for the purpose of assisting themselves in exercising a power or performing a duty or function lawfully conferred or imposed on them,
 - (ii) an official of a foreign government or an international agency, for the purpose of meeting obligations imposed by an arrangement made between the Government of Canada and the foreign government or international agency,
 - (iii) a worker, for the purpose of enabling the worker to perform duties assigned by the licensee, or
 - (iv) a person who is legally required or legally authorized to obtain or receive the information.
- (2) A person who possesses or has knowledge of prescribed information shall take all necessary precautions to prevent any transfer or disclosure of the prescribed information that is not authorized by the Act and the regulations made under the Act.

CONTAMINATION

Prescribed Limits

- 24.** For the purposes of paragraph 45(a) and subsection 46(1) of the Act, the prescribed limit of contamination for a place or vehicle where no licensed activity is being carried on is any quantity of a radioactive nuclear substance that may, based on the circumstances, increase a person's effective dose by 1 mSv or more per year in excess of the background radiation for the place or vehicle.

Prescribed Public Offices

- 25.** For the purpose of subsection 46(2) of the Act, a municipal office, a public library and a public community centre are prescribed public offices.

Prescribed Measures

- 26.** For the purpose of subsection 46(3) of the Act, the prescribed measures to reduce the level of contamination are any measures to control access to or clean the place, or to cover or remove the contamination, that are appropriate for the substance and location and that will reduce the level of contamination to below the limit prescribed by section 24.

RECORDS AND REPORTS

Record of Licence Information

- 27.** Every licensee shall keep a record of all information relating to the licence that is submitted by the licensee to the Commission

Retention and Disposal of Records

28. (1) Every person who is required to keep a record by the Act, the regulations made under the Act or a licence shall retain the record for the period specified in the applicable regulations made under the Act or, if no period is specified in the regulations, for the period ending one year after the expiry of the licence that authorizes the activity in respect of which the records are kept.
- (2) No person shall dispose of a record referred to in the Act, the regulations made under the Act or a licence unless the person
- (a) is no longer required to keep the record by the Act, the regulations made under the Act or the licence; and
- (b) has notified the Commission of the date of disposal and of the nature of the record at least 90 days before the date of disposal.
- (3) A person who notifies the Commission in accordance with subsection (2) shall file the record, or a copy of the record, with the Commission at its request.

General Reports

29. (1) Every licensee who becomes aware of any of the following situations shall immediately make a preliminary report to the Commission of the location and circumstances of the situation and of any action that the licensee has taken or proposes to take with respect to it:
- (a) a situation referred to in paragraph 27(b) of the Act;
- (b) the occurrence of an event that is likely to result in the exposure of persons to radiation in excess of the applicable radiation dose limits prescribed by the *Radiation Protection Regulations*;
- (c) a release, not authorized by the licence, of a quantity of radioactive nuclear substance into the environment;
- (d) a situation or event that requires the implementation of a contingency plan in accordance with the licence;
- (e) an attempted or actual breach of security or an attempted or actual act of sabotage at the site of the licensed activity;
- (f) information that reveals the incipient failure, abnormal degradation or weakening of any component or system at the site of the licensed activity, the failure of which could have a serious adverse effect on the environment or constitutes or is likely to constitute or contribute to a serious risk to the health and safety of persons or the maintenance of security;
- (g) an actual, threatened or planned work disruption by workers;
- (h) a serious illness or injury incurred or possibly incurred as a result of the licensed activity;
- (i) the death of any person at a nuclear facility; or
- (j) the occurrence of any of the following events:
- (i) the making of an assignment by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
- (ii) the making of a proposal by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
- (iii) the filing of a notice of intention by the licensee under the *Bankruptcy and Insolvency Act*,
- (iv) the filing of a petition for a receiving order against the licensee under the *Bankruptcy and Insolvency Act*,
- (v) the enforcement by a secured creditor of a security on all or substantially all of the inventory, accounts receivable or other property of the licensee that was acquired for, or used in relation to, a business carried on by the licensee,
- (vi) the filing in court by the licensee of an application to propose a compromise or an arrangement with its unsecured creditors or any class of them under section 4 of the *Companies' Creditors Arrangement Act*,

- (vii) the filing in court by the licensee of an application to propose a compromise or an arrangement with its secured creditors or any class of them under section 5 of the *Companies' Creditors Arrangement Act*,
 - (viii) the making of an application for a winding-up order by or in respect of the licensee under the *Winding-up and Restructuring Act*,
 - (ix) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of the licensee under provincial or foreign legislation, or
 - (x) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of a body corporate that controls the licensee under provincial or foreign legislation.
- (2) Every licensee who becomes aware of a situation referred to in subsection (1) shall file a full report of the situation with the Commission within 21 days after becoming aware of it, unless some other period is specified in the licence, and the report shall contain the following information:
- (a) the date, time and location of becoming aware of the situation;
 - (b) a description of the situation and the circumstances;
 - (c) the probable cause of the situation;
 - (d) the effects on the environment, the health and safety of persons and the maintenance of security that have resulted or may result from the situation;
 - (e) the effective dose and equivalent dose of radiation received by any person as a result of the situation; and
 - (f) the actions that the licensee has taken or proposes to take with respect to the situation.
- (3) Subsections (1) and (2) do not require a licensee to report a situation referred to in paragraphs (1)(a) to (j) if the licence contains a term or condition requiring the licensee to report that situation, or any situation of that nature, to the Commission.

Safeguards Reports

- 30.** (1) Every licensee who becomes aware of any of the following situations shall immediately make a preliminary report to the Commission of the situation and of any action that the licensee has taken or proposes to take with respect to it:
- (a) interference with or an interruption in the operation of safeguards equipment or the alteration, defacement or breakage of a safeguards seal, other than in accordance with the safeguards agreement, the Act, the regulations made under the Act or the licence; and
 - (b) the theft, loss or sabotage of safeguards equipment or samples collected for the purpose of a safeguards inspection, damage to such equipment or samples, or the illegal use, possession, operation or removal of such equipment or samples.
- (2) Every licensee who becomes aware of a situation referred to in subsection (1) shall file a full report of the situation with the Commission within 21 days after becoming aware of it, unless some other period is specified in the licence, and the report shall contain the following information:
- (a) the date, time and location of becoming aware of the situation;
 - (b) a description of the situation and the circumstances;
 - (c) the probable cause of the situation;
 - (d) the adverse effects on the environment, the health and safety of persons and the maintenance of national and international security that have resulted or may result from the situation;
 - (e) the effective dose and equivalent dose of radiation received by any person as a result of the situation; and
 - (f) the actions that the licensee has taken or proposes to take with respect to the situation.

Report of Deficiency in Record

- 31.** (1) Every licensee who becomes aware of an inaccuracy or incompleteness in a record that the licensee is required to keep by the Act, the regulations made under the Act or the licence shall file a

report of the inaccuracy or incompleteness with the Commission within 21 days after becoming aware of it, and the report shall contain the following information:

- (a) the details of the inaccuracy or incompleteness; and
- (b) any action that the licensee has taken or proposes to take with respect to the inaccuracy or incompleteness.
- (2) Subsection (1) does not apply to a licensee if
 - (a) the licence contains a term or condition that requires the licensee to report inaccuracies or incompleteness in a record to the Commission; or
 - (b) the inaccuracy or incompleteness in the record could not reasonably be expected to lead to a situation in which the environment, the health and safety of persons or national security is adversely affected.

Filing of Reports

- 32. (1) Every report shall include the name and address of its sender and the date on which it was completed.
- (2) The date of filing of a report is the date on which it is received by the Commission.

INSPECTORS AND DESIGNATED OFFICERS

Certificate of Inspector

- 33. An inspector's certificate issued under section 29 of the Act shall be in the form set out in the schedule and shall include, in addition to the information required by subsection 29(2) of the Act,
 - (a) the name and signature of the inspector;
 - (b) a photograph showing the face of the inspector;
 - (c) the name of the employer of the inspector;
 - (d) a statement of designation;
 - (e) the name, position and signature of the person who issued the certificate; and
 - (f) the expiry date of the certificate.

Certificate of Designated Officer

- 34. A designated officer's certificate issued under section 37 of the Act shall include, in addition to the information required by subsection 37(1) of the Act,
 - (a) the name and position or title of the designated officer;
 - (b) the name of the employer of the designated officer;
 - (c) a statement of designation;
 - (d) the name, position and signature of the person who issued the certificate; and
 - (e) the expiry date of the certificate.

Notification and Surrender of Certificate

- 35. (1) An inspector and a designated officer shall notify the Commission of any of the following situations:
 - (a) the loss or theft of their certificate;
 - (b) any change in their employment that results in their no longer exercising a function that relates to the purpose of the certificate; and
 - (c) the suspension or termination of their employment with the employer named in the certificate.
- (2) An inspector and a designated officer shall surrender their certificate to the Commission
 - (a) if the information contained in the certificate is not accurate;
 - (b) when the certificate expires; or

(c) on termination by the Commission of their designation as an inspector or a designated officer, as the case may be.

REPEAL

36. The *Atomic Energy Control Regulations*¹ are repealed.

37. The *Transport Packaging of Radioactive Materials Regulations*² are repealed.

38. The *Uranium and Thorium Mining Regulations*³ are repealed.

39. The *Physical Security Regulations*⁴ are repealed.

COMING INTO FORCE

40. These Regulations come into force on the day on which they are approved by the Governor-in-Council.

SCHEDULE (Section 33)

CERTIFICATE OF INSPECTOR

	<p>This is to certify that Le présent certificat atteste que</p> <p>employed by employé de</p> <p>is designated as an inspector for the Canadian Nuclear Safety Commission pursuant to section 29 of the <i>Nuclear Safety and Control Act</i>.</p> <p>est un inspecteur désigné par la Commission canadienne de sûreté nucléaire conformément à l'article 29 de la <i>Loi sur la sûreté et la réglementation nucléaires</i>.</p> <p>This is to certificate expires on Ce certificat expire le</p>	<p>The person identified on this certificate may exercise the powers granted to an inspector under the <i>Nuclear Safety and Control Act</i> in respect of the following places or vehicles:</p> <p>La personne identifiée sur ce certificat peut exercer les pouvoirs d'un inspecteur prévue à la <i>Loi sur la sûreté et la réglementation nucléaires</i> dans les lieux ou véhicules suivants:</p>
<p>Inspector / Inspecteur _____ Secretary CNSC / Secrétaire, CCSN _____</p>		<p>This certificate is not transferable and is to be surrendered on the termination of this designation.</p> <p>Le certificat est incessible et doit être remis lorsque la désignation prend fin.</p>
 <p>Canadian Nuclear Safety Commission Commission canadienne de sûreté nucléaire</p>		

ANNEX 5

RADIATION PROTECTION REGULATIONS

INTERPRETATION AND APPLICATION

Interpretation

1. (1) The definitions in this subsection apply in these Regulations.

“absorbed dose” means the quotient, in gray, obtained by dividing the energy absorbed through exposure to radiation by the mass of the body or part of the body that absorbs the radiation. (*dose absorbée*)

“Act” means the *Nuclear Safety and Control Act*. (*Loi*)

“balance of the pregnancy” means the period from the moment a licensee is informed, in writing, of the pregnancy to the end of the pregnancy. (*reste de la grossesse*)

“committed” means, in respect of a dose of radiation, received by an organ or tissue from a nuclear substance during the 50 years after the substance is taken into the body of a person 18 years old or older or during the period beginning at intake and ending at age 70, after it is taken into the body of a person less than 18 years old. (*engagée*).

“dosimeter” means a device for measuring a dose of radiation that is worn or carried by an individual. (*dosimètre*)

“effective dose” means the sum of the products, in sievert, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue set out in column 1 of an item of Schedule 1 by the weighting factor set out in column 2 of that item. (*dose efficace*)

“equivalent dose” means the product, in sievert, obtained by multiplying the absorbed dose of radiation of the type set out in column 1 of an item of Schedule 2 by the weighting factor set out in column 2 of that item. (*dose équivalente*)

“exemption quantity” has the same meaning as in section 1 of the *Nuclear Substances and Radiation Devices Regulations*. (*quantité d'exemption*)

“five-year dosimetry period” means the period of five calendar years beginning on January 1 of the year following the year in which these Regulations come into force, and every period of five calendar years after that period. (*période de dosimétrie de cinq ans*)

“licensed activity” means an activity described in any of paragraphs 26(a) to (f) of the Act that a licence authorizes the licensee to carry on. (*activité autorisée*)

“licensee” means a person who is licensed to carry on an activity described in any of paragraphs 26(a) to (f) of the Act. (*titulaire de permis*).

“one-year dosimetry period” means the period of one calendar year beginning on January 1 of the year following the year in which these Regulations come into force, and every period of one calendar year after that period. (*période de dosimétrie d'un an*)

“radon progeny” means the following radioactive decay products of radon 222: bismuth 214, lead 214, polonium 214 and polonium 218. (*produit de filiation du radon*)

“skin” means the layer of cells within the skin that are 7 mg/cm² below the surface. (*peau*)

“worker” means a person who performs work that is referred to in a licence. (*travailleur*)

“working level” means the concentration of radon progeny in 1 m³ of air that has a potential alpha energy of 2.08 x 10⁻⁵ J. (*unité alpha*)

“working level month” means the exposure that results from the inhalation of air containing one working level for 170 hours. (*unité alpha-mois*)

(2) For the purpose of the definition “dosimetry service” in section 2 of the Act, a facility for the measurement and monitoring of doses of radiation received by or committed to nuclear energy workers who have a reasonable probability of receiving an effective dose greater than 5 mSv in a one-year dosimetry period is prescribed as a dosimetry service.

(3) For the purpose of the definition “nuclear energy worker” in section 2 of the Act, the prescribed limit for the general public is 1 mSv per calendar year.

Application

2. (1) Subject to subsection (2), these Regulations apply generally for the purposes of the Act.
- (2) Only section 3 of these Regulations applies to a licensee in respect of a dose of radiation received by or committed to a person
 - (a) in the course of the person’s examination, diagnosis or treatment, as directed by a medical practitioner who is qualified to examine, diagnose or treat the person under the applicable provincial legislation;
 - (b) while the person is acting as a caregiver, outside a medical facility and not as an occupation, for a patient to whom a nuclear substance has been administered for therapeutic purposes as directed by a medical practitioner who is qualified to give such direction under the applicable provincial legislation; or
 - (c) as a result of the person’s voluntary participation in a biomedical research study supervised by a medical practitioner who is qualified to provide such supervision under the applicable provincial legislation.

OBLIGATIONS OF LICENSEES AND NUCLEAR ENERGY WORKERS

Administration of Nuclear Substance for Medical Purposes

3. When a nuclear substance is administered to a person for therapeutic purposes, the licensee shall, before the person leaves the place where the substance is administered, inform the person of methods for reducing the exposure of others to radiation from that person.

Radiation Protection Program

4. Every licensee shall implement a radiation protection program and shall, as part of that program,
 - (a) keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons as low as is reasonably achievable, social and economic factors being taken into account, through the implementation of
 - (i) management control over work practices,
 - (ii) personnel qualification and training,
 - (iii) control of occupational and public exposure to radiation, and
 - (iv) planning for unusual situations; and
 - (b) ascertain the quantity and concentration of any nuclear substance released as a result of the licensed activity
 - (i) by direct measurement as a result of monitoring, or
 - (ii) if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the quantity and concentration using that method, by estimating them.

Ascertainment and Recording of Doses

5. (1) For the purpose of keeping a record of doses of radiation in accordance with section 27 of the Act, every licensee shall ascertain and record the magnitude of exposure to radon progeny of each person referred to in that section, as well as the effective dose and equivalent dose received by and committed to that person.
- (2) A licensee shall ascertain the magnitude of exposure to radon progeny and the effective dose and equivalent dose
 - (a) by direct measurement as a result of monitoring; or

- (b) if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the amount of exposure and doses using that method, by estimating them.

Action Levels

6. (1) In this section, “action level” means a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee’s radiation protection program and triggers a requirement for specific action to be taken.
- (2) When a licensee becomes aware that an action level referred to in the licence for the purpose of this subsection has been reached, the licensee shall
- (a) conduct an investigation to establish the cause for reaching the action level;
 - (b) identify and take action to restore the effectiveness of the radiation protection program implemented in accordance with section 4; and
 - (c) notify the Commission within the period specified in the licence.

Provision of Information

7. (1) Every licensee shall inform each nuclear energy worker, in writing,
- (a) that he or she is a nuclear energy worker;
 - (b) of the risks associated with radiation to which the worker may be exposed in the course of his or her work, including the risks associated with the exposure of embryos and fetuses to radiation;
 - (c) of the applicable effective dose limits and equivalent dose limits prescribed by sections 13, 14 and 15; and
 - (d) of the worker’s radiation dose levels.
- (2) Every licensee shall inform each female nuclear energy worker, in writing, of the rights and obligations of a pregnant nuclear energy worker under section 11 and of the applicable effective dose limits prescribed by section 13.
- (3) Every licensee shall obtain from each nuclear energy worker who is informed of the matters referred to in paragraphs (1)(a) and (b) and subsection (2) a written acknowledgement that the worker has received the information.

Requirement to Use Licensed Dosimetry Service

8. Every licensee shall use a licensed dosimetry service to measure and monitor the doses of radiation received by and committed to nuclear energy workers who have a reasonable probability of receiving an effective dose greater than 5 mSv in a one-year dosimetry period.

Collection of Personal Information

9. When, for purposes related to the administration of the Act and these Regulations, a licensee collects personal information, as defined in section 3 of the Privacy Act, that may be required to be disclosed to the Commission, another government institution or a dosimetry service, the licensee shall inform the person to whom the information relates of the purpose for which it is being collected.

Nuclear Energy Workers

10. Every nuclear energy worker shall, on request by a licensee, inform the licensee of the worker’s
- (a) given names, surname and any previous surname;
 - (b) Social Insurance Number;
 - (c) sex;
 - (d) date, province and country of birth; and
 - (e) dose record for the current one-year and five-year dosimetry periods.

Pregnant Nuclear Energy Workers

11. (1) Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee in writing.
- (2) On being informed by a nuclear energy worker that she is pregnant, the licensee shall, in order to comply with section 13, make any accommodation that will not occasion costs or business inconvenience constituting undue hardship to the licensee.

RADIATION DOSE LIMITS

Interpretation

12. (1) The definitions in this subsection apply in section 13.
 - “ALI” or “annual limit on intake” means the activity, in becquerel, of a radionuclide that will deliver an effective dose of 20 mSv during the 50-year period after the radio nuclide is taken into the body of a person 18 years old or older or during the period beginning at intake and ending at age 70 after it is taken into the body of a person less than 18 years old. (LAI ou limite annuelle d’incorporation).
 - “E” means the portion of the effective dose, in millisievert
 - (a) received by a person from sources outside the body; and
 - (b) received by and committed to the person from sources inside the body, measured directly or from excreta. (E)
 - “I” means the activity, in becquerel, of any radionuclide that is taken into the body, excluding the radon progeny and the activity of other radionuclides accounted for in the determination of E. (I)
 - “Rn” means the average annual concentration in the air, in Bq per m³, of radon 222 that is attributable to a licensed activity. (Rn)
 - “RnP” means the exposure to radon progeny in working level months. (RnP)
 - “E I/ALI” means the sum of the ratios of I to the corresponding ALI. (E I/LAI)
- (2) For the purposes of sections 13 and 14, doses of radiation include those received from X-rays or other man-made sources of radiation.

Effective Dose Limits

13. (1) Every licensee shall ensure that the effective dose received by and committed to a person described in column 1 of an item of the table to this subsection, during the period set out in column 2 of that item, does not exceed the effective dose set out in column 3 of that item.

TABLE

	Column 1	Column 2	Column 3
Item	Person	Period	Effective Dose (mSv)
1.	Nuclear energy worker, including a pregnant nuclear energy worker	(a) One-year dosimetry period (b) Five-year dosimetry period	50 100
2.	Pregnant nuclear energy worker	Balance of pregnancy	4
3.	A Person who is not a nuclear energy worker	One calendar year	1

- (2) For the purpose of item 1 of the table to subsection (1), the effective dose shall be calculated using the following formula and expressed in millisievert:

$$E + 5RnP + 20 \sum \frac{I}{ALI}$$

- (3) For the purpose of item 2 of the table to subsection (1), the effective dose shall be calculated using the following formula and expressed in millisievert:

$$E + 20 \sum \frac{I}{ALI}$$

- (4) For the purpose of item 3 of the table to subsection (1), the effective dose shall be calculated using either of the following formulas and expressed in millisievert:

$$E + \frac{Rn}{60} + 20 \sum \frac{I}{ALI}$$

$$E + 4RnP + 20 \sum \frac{I}{ALI}$$

- (5) For the purpose of subsection (1), where the end of a dosimeter-wearing period or a bioassay-sampling period does not coincide with the end of a dosimetry period set out in column 2 of the table to that subsection, the licensee may extend or reduce the dosimetry period to a maximum of two weeks so that the end of the dosimetry period coincides with the end of the dosimeter-wearing period or bioassay-sampling period, as the case may be.

Equivalent Dose Limits

14. (1) Every licensee shall ensure that the equivalent dose received by and committed to an organ or tissue set out in column 1 of an item of the table to this subsection, of a person described in column 2 of that item, during the period set out in column 3 of that item, does not exceed the equivalent dose set out in column 4 of that item.

TABLE

Item	Column 1 Organ or Tissue	Column 2 Person	Column 3 Period	Column 4 Equivalent Dose (mSv)
1.	Lens of an eye	(a) Nuclear energy worker	One-year dosimetry period	150
		(b) Any other person	One calendar year	15
2.	Skin	(a) Nuclear energy worker	One-year dosimetry period	500
		(b) Any other person	One calendar year	50
3.	Hands and feet	(a) Nuclear energy worker	One-year dosimetry period	500
		(b) Any other person	One calendar year	50

- (2) For the purpose of subsection (1), where a dosimeter-wearing period or a bioassay-sampling period extends beyond the end of a dosimetry period set out in column 3 of the table to that subsection, the period is extended to the end of the dosimeter-wearing or bioassay-sampling period or by two weeks, whichever extension is shorter.

- (3) When skin is unevenly irradiated, the equivalent dose received by the skin is the average equivalent dose over the 1 cm² area that received the highest equivalent dose.

Emergencies

15. (1) During the control of an emergency and the consequent immediate and urgent remedial work, the effective dose and the equivalent dose may exceed the applicable dose limits prescribed by sections 13 and 14, but the effective dose shall not exceed 500 mSv and the equivalent dose received by the skin shall not exceed 5 000 mSv.
- (2) Subsection (1) does not apply in respect of pregnant nuclear energy workers who have informed the licensee in accordance with subsection 11(1).
- (3) The dose limits prescribed by sections 13 and 14 and subsection (1) may be exceeded by a person who acts voluntarily to save or protect human life.

When Dose Limit Exceeded

16. When a licensee becomes aware that a dose of radiation received by and committed to a person or an organ or tissue may have exceeded an applicable dose limit prescribed by section 13, 14 or 15, the licensee shall
- (a) immediately notify the person and the Commission of the dose;
- (b) require the person to leave any work that is likely to add to the dose;
- (c) conduct an investigation to determine the magnitude of the dose and to establish the causes of the exposure;
- (d) identify and take any action required to prevent the occurrence of a similar incident; and
- (e) within 21 days after becoming aware that the dose limit has been exceeded, report to the Commission the results of the investigation or on the progress that has been made in conducting the investigation.

Authorization of Return to Work

17. (1) When the Commission or a designated officer authorized under paragraph 37(2)(h) of the Act authorizes the return to work of a person referred to in section 16, the authorization may specify conditions and prorated dose limits.
- (2) For the purpose of this section, a prorated effective dose limit is the product obtained by multiplying the applicable dose limit prescribed by section 13 or 15 by the ratio of the number of months remaining in the dosimetry period to the total number of months in the dosimetry period.
- (3) If an equivalent dose that exceeds the applicable equivalent dose limit prescribed by section 14 or 15 is received by or committed to a person and the Commission or a designated officer authorized under paragraph 37(2)(h) of the Act authorizes the return to work of that person, the equivalent dose limit for the dosimetry period is the sum of the equivalent dose limit that was exceeded and the equivalent dose that was received by and committed to the person up to the time that the person was required to leave work in accordance with paragraph 16(b).

DOSIMETRY SERVICES

Application for Licence to Operate

18. An application for a licence to operate a dosimetry service shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations* :
- (a) a description of the proposed operation of the dosimetry service;
- (b) the proposed quality assurance program;

- (c) the types of dosimetry services proposed to be provided, including the types of radiation that will be monitored and their respective energy ranges;
- (d) the precision, accuracy and reliability of the dosimetry services to be provided; and
- (e) the proposed qualification requirements and training program for workers.

Obligations of Licensees

- 19.** Every licensee who operates a dosimetry service shall file with the National Dose Registry of the Department of Health, at a frequency specified in the licence and in a form compatible with the Registry, the following information with respect to each nuclear energy worker for whom it has measured and monitored a dose of radiation:
- (a) the worker's given names, surname and any previous surname;
 - (b) the worker's Social Insurance Number;
 - (c) the worker's sex;
 - (d) the worker's job category;
 - (e) the date, province and country of birth of the worker;
 - (f) the amount of exposure of the worker to radon progeny; and
 - (g) the effective dose and equivalent dose received by and committed to the worker.

LABELLING AND SIGNS

Labelling of Containers and Devices

- 20.** (1) No person shall possess a container or device that contains a radioactive nuclear substance unless the container or device is labelled with
- (a) the radiation warning symbol set out in Schedule 3 and the words "RAYONNEMENT — DANGER — RADIATION"; and
 - (b) the name, quantity, date of measurement and form of the nuclear substance in the container or device.
- (2) Subsection (1) does not apply in respect of a container or device
- (a) that is an essential component for the operation of the nuclear facility at which it is located;
 - (b) that is used to hold radioactive nuclear substances for current or immediate use and is under the continuous direct observation of the licensee;
 - (c) in which the quantity of radioactive nuclear substances is less than or equal to the exemption quantity; or
 - (d) that is used exclusively for transporting radioactive nuclear substances and labelled in accordance with the Packaging and Transport of Nuclear Substances Regulations.

Posting of Signs at Boundaries and Points of Access

- 21.** (1) Every licensee shall post and keep posted, at the boundary of and at every point of access to an area, room, enclosure or vehicle, a durable and legible sign that bears the radiation warning symbol set out in Schedule 3 and the words "RAYONNEMENT — DANGER — RADIATION", if
- (a) there is a radioactive nuclear substance in a quantity greater than 100 times its exemption quantity in the area, room, enclosure or vehicle; or
 - (b) there is a reasonable probability that a person in the area, room, enclosure or vehicle will be exposed to an effective dose rate greater than 25 $\mu\text{Sv/h}$.
- (2) Subsection (1) does not apply in respect of a vehicle that is placarded in accordance with the Packaging and Transport of Nuclear Substances Regulations.

Use of Radiation Warning Symbol

- 22.** Whenever the radiation warning symbol set out in Schedule 3 is used,
- (a) it shall be
 - (i) prominently displayed,
 - (ii) of a size appropriate for the size of the container or device to which it is affixed or attached, or of the area, room, enclosure or vehicle in respect of which it is posted,
 - (iii) in the proportions depicted in Schedule 3, and
 - (iv) oriented with one blade pointed downward and centred on the vertical axis; and
 - (b) no wording shall be superimposed on it.

Frivolous Posting of Signs

- 23.** No person shall post or keep posted a sign that indicates the presence of radiation, a nuclear substance or prescribed equipment at a place where the radiation, nuclear substance or prescribed equipment indicated on the sign is not present.

RECORDS TO BE KEPT BY LICENSEES

- 24.** Every licensee shall keep a record of the name and job category of each nuclear energy worker.

TRANSITIONAL PROVISION

- 25.** During the period before the beginning of the first one-year dosimetry period
- (a) “one-year dosimetry period” means the period beginning on the day these Regulations come into force and ending on December 31, 2000; and
 - (b) each effective dose limit set out in these Regulations for a one-year dosimetry period is equal to the product obtained by multiplying the applicable dose limit by the ratio of the number of days in the one-year dosimetry period to 365.

COMING INTO FORCE

- 26.** These Regulations come into force on the day on which they are approved by the Governor in Council.

SCHEDULE 1
(Subsection 1(1))

ORGAN OR TISSUE WEIGHTING FACTORS

TABLE

	Column 1	Column 2
Item	Organ or Tissue	Weighting Factor
1.	Gonads (testes or ovaries)	0.20
2.	Red bone marrow	0.12
3.	Colon	0.12
4.	Lung	0.12
5.	Stomach	0.12
6.	Bladder	0.05
7.	Breast	0.05
8.	Liver	0.05
9.	Oesophagus	0.05
10.	Thyroid gland	0.05
11.	Skin ¹	0.01
12.	Bone surfaces	0.01
13.	All organs and tissues not listed in items 1 to 12 (remainder organs and tissues) collectively including the adrenal glands, brain, extra-thoracic airway, small intestine, kidney, muscles, pancreas, spleen, thymus and uterus ^{2,3}	0.05
14.	Whole Body	1.00

¹ The weighting factor for skin applies only when the skin of the whole body is exposed.

² When the equivalent dose received by and committed to one of these remainder organs and tissues exceeds the equivalent dose received by and committed to any one of the organs and tissues listed in items 1 to 12, a weighting factor of 0.025 shall be applied to that remainder organ or tissue and a weighting factor of 0.025 shall be applied to the average equivalent dose received by and committed to the rest of the remainder organs and tissues.

³ Hands, feet and the lens of an eye have no weighting factor.

SCHEDULE 2
(Subsection 1(1))

RADIATION WEIGHTING FACTORS

TABLE

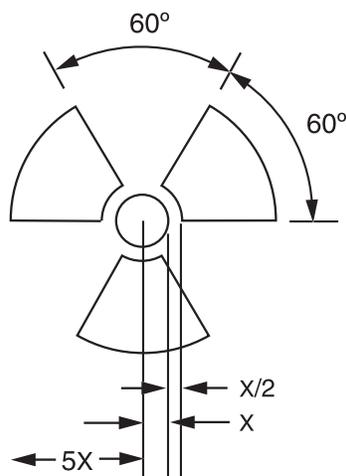
Item	Column 1 Type of Radiation and Energy Range	Column 2 Weighting Factor
1.	Protons all energies	1
2.	Electrons and muons, all energies	1
3.	Neutrons ² of energy < 10 KeV	5
4.	Neutrons ² of energy 10 KeV to 100 KeV	10
5.	Neutrons ² of energy > 100 KeV to 2 MeV	20
6.	Neutrons ² of energy > 2 MeV to 20 MeV	10
7.	Neutrons ² of energy > 20 MeV	5
8.	Protons other than recoil protons, of energy > 2 MeV	5
9.	Alpha particles, fission fragments and heavy nuclei	20

¹ Excluding Auger electrons emitted from nuclei bound to DNA.

² Radiation weighting factors for these neutrons may also be obtained by referring to the continuous curve shown in Figure 1 on page 7 of the 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, published in 1991.

SCHEDULE 3
(Sections 20, 21 and 22)

RADIATION WARNING SYMBOL



NOTE: The three blades and the central disk of the symbol shall be

- a) magenta or black; and
- b) located on a yellow background.

ANNEX 6

CLASS I NUCLEAR FACILITIES REGULATIONS

INTERPRETATION AND APPLICATION

Interpretation

1. The definitions in this section apply in these Regulations.

“Act” means the Nuclear Safety and Control Act. (*Loi*)

“certificate” means a document issued by the Commission or by a designated officer authorized under paragraph 37(2)(b) of the Act, indicating that a person is certified. (*attestation*)

“certified” means certified by the Commission under paragraph 21(1)(i) of the Act or by a designated officer authorized under paragraph 37(2)(b) of the Act. (*version anglaise seulement*)

“Class I nuclear facility” means a Class IA nuclear facility and a Class IB nuclear facility. (*installation nucléaire de catégorie I*)

“Class IA nuclear facility” means any of the following nuclear facilities:

- (a) a nuclear fission or fusion reactor or subcritical nuclear assembly; and
- (b) a vehicle that is equipped with a nuclear reactor. (*installation nucléaire de catégorie IA*)

“Class IB nuclear facility” means any of the following nuclear facilities:

- (a) a particle accelerator with a beam energy equal to or greater than 50 MeV;
- (b) a plant for the processing, reprocessing or separation of an isotope of uranium, thorium or plutonium;
- (c) a plant for the manufacture of a product from uranium, thorium or plutonium;
- (d) a plant, other than a Class II nuclear facility as defined in section 1 of the Class II Nuclear Facilities and Prescribed Equipment Regulations, for the processing or use, in a quantity greater than 1015 Bq per calendar year, of nuclear substances other than uranium, thorium or plutonium;
- (e) a facility for the disposal of a nuclear substance generated at another nuclear facility; and
- (f) a facility prescribed by paragraph 19(a) or (b) of the General Nuclear Safety and Control Regulations. (*installation nucléaire de catégorie IB*)

“effective dose” has the same meaning as in subsection 1(1) of the Radiation Protection Regulations. (*dose efficace*)

“equivalent dose” has the same meaning as in subsection 1(1) of the Radiation Protection Regulations. (*dose équivalente*)

“exclusion zone” means a parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control. (*zone d'exclusion*)

“hazardous substance” or “hazardous waste” means a substance or waste, other than a nuclear substance, that is used or produced in the course of carrying on a licensed activity and that may pose a risk to the environment or the health and safety of persons. (*substance dangereuse ou déchet dangereux*)

“IAEA” means the International Atomic Energy Agency. (*AIEA*)

“IAEA Agreement” means the *Agreement between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons*, effective on February 21, 1972; INFCIRC/164; UNTS vol. 814, R. No. 11596. (*Accord avec l'AIEA*).

“licensed activity” means an activity described in paragraph 26(e) of the Act that a licence authorizes the licensee to carry on in relation to a Class I nuclear facility. (*activité autorisée*)

“licensee” means a person who is licensed to carry on an activity described in paragraph 26(e) of the Act in relation to a Class I nuclear facility. (*titulaire de permis*)

“prescribed equipment” means the equipment prescribed by section 20 of the *General Nuclear Safety and Control Regulations*. (*équipement réglementé*)

“prescribed information” means the information prescribed by section 21 of the *General Nuclear Safety and Control Regulations*. (*renseignements réglementés*)

“safeguards” means a verification system that is established in accordance with a safeguards agreement. (*garanties*)

“safeguards agreement” means

- (a) the *IAEA Agreement* and any arrangement between Canada and the IAEA made under that agreement; and
- (b) any agreement to which Canada is a party for the establishment in Canada of a verification system in respect of nuclear substances, prescribed equipment or prescribed information, and any arrangements made under such an agreement. (*accord relatif aux garanties*).

“sealed source” 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. (*source scellée*)

“worker” means a person who performs work that is referred to in a licence. (*travailleur*)

Application

2. These Regulations apply in respect of Class I nuclear facilities.

LICENCE APPLICATIONS

General Requirements

3. An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*:
 - (a) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;
 - (b) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;
 - (c) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;
 - (d) the proposed quality assurance program for the activity to be licensed;
 - (e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;
 - (f) the proposed worker health and safety policies and procedures;
 - (g) the proposed environmental protection policies and procedures;
 - (h) the proposed effluent and environmental monitoring programs;
 - (i) if the application is in respect of a nuclear facility referred to in paragraph 2(b) of the *Nuclear Security Regulations*, the information required by section 3 of those Regulations;
 - (j) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and
 - (k) the proposed plan for the decommissioning of the nuclear facility or of the site.

Licence to Prepare Site

4. An application for a licence to prepare a site for a Class I nuclear facility shall contain the following information in addition to the information required by section 3:
 - (a) a description of the site evaluation process and of the investigations and preparatory work that have been and will be done on the site and in the surrounding area;

- (b) a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods;
- (c) the proposed program to determine the environmental baseline characteristics of the site and the surrounding area;
- (d) the proposed quality assurance program for the design of the nuclear facility; and
- (e) the effects on the environment and the health and safety of persons that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects.

Licence to Construct

- 5.** An application for a licence to construct a Class I nuclear facility shall contain the following information in addition to the information required by section 3:
- (a) a description of the proposed design of the nuclear facility, including the manner in which the physical and environmental characteristics of the site are taken into account in the design;
 - (b) a description of the environmental baseline characteristics of the site and the surrounding area;
 - (c) the proposed construction program, including its schedule;
 - (d) a description of the structures proposed to be built as part of the nuclear facility, including their design and their design characteristics;
 - (e) a description of the systems and equipment proposed to be installed at the nuclear facility, including their design and their design operating conditions;
 - (f) a preliminary safety analysis report demonstrating the adequacy of the design of the nuclear facility;
 - (g) the proposed quality assurance program for the design of the nuclear facility;
 - (h) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;
 - (i) the effects on the environment and the health and safety of persons that may result from the construction, operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;
 - (j) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;
 - (k) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;
 - (l) the proposed program and schedule for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility; and
 - (m) a description of any proposed full-scope training simulator for the nuclear facility.

Licence to Operate

- 6.** An application for a licence to operate a Class I nuclear facility shall contain the following information in addition to the information required by section 3:
- (a) a description of the structures at the nuclear facility, including their design and their design operating conditions;
 - (b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions;
 - (c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;
 - (d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility;
 - (e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances;
 - (f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;

- (g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility;
- (h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;
- (i) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;
- (j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;
- (k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of security, including measures to
 - (i) assist off-site authorities in planning and preparing to limit the effects of an accidental release,
 - (ii) notify off-site authorities of an accidental release or the imminence of an accidental release,
 - (iii) report information to off-site authorities during and after an accidental release,
 - (iv) assist off-site authorities in dealing with the effects of an accidental release, and
 - (v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;
- (l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts;
- (m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and
- (n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility.

Licence to Decommission

7. An application for a licence to decommission a Class I nuclear facility shall contain the following information in addition to the information required by section 3:
- (a) a description of and the proposed schedule for the decommissioning, including the proposed starting date and the expected completion date of the decommissioning and the rationale for the schedule;
 - (b) the nuclear substances, hazardous substances, land, buildings, structures, systems and equipment that will be affected by the decommissioning;
 - (c) the proposed measures, methods and procedures for carrying on the decommissioning;
 - (d) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;
 - (e) the nature and extent of any radioactive contamination at the nuclear facility;
 - (f) the effects on the environment and the health and safety of persons that may result from the decommissioning, and the measures that will be taken to prevent or mitigate those effects;
 - (g) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;
 - (h) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;
 - (i) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of security, including an emergency response plan;
 - (j) the proposed qualification requirements and training program for workers; and
 - (k) a description of the planned state of the site on completion of the decommissioning.

Licence to Abandon

- 8.** An application for a licence to abandon a Class I nuclear facility shall contain the following information in addition to the information required by sections 3 and 4 of the *General Nuclear Safety and Control Regulations*:
- (a) the results of the decommissioning; and
 - (b) the results of the environmental monitoring programs

CERTIFICATION OF PERSONS

Application for Certification

- 9.** (1) This section and sections 10 to 13 do not apply in respect of Class IB nuclear facilities.
- (2) The Commission or a designated officer authorized under paragraph 37(2)(b) of the Act may certify a person referred to in paragraph 44(1)(k) of the Act for a position referred to in a licence after receiving from the licensee an application stating that the person
- (a) meets the applicable qualification requirements referred to in the licence;
 - (b) has successfully completed the applicable training program and examination referred to in the licence; and
 - (c) is capable, in the opinion of the licensee, of performing the duties of the position.
- (3) The Commission or a designated officer authorized under paragraph 37(2)(b) of the Act may renew a certification after receiving from a licensee an application stating that the certified person
- (a) has safely and competently performed the duties of the position for which the person was certified;
 - (b) continues to receive the applicable training referred to in the licence;
 - (c) has successfully completed the applicable requalification tests referred to in the licence for renewing the certification; and
 - (d) is capable, in the opinion of the licensee, of performing the duties of the position.
- (4) A certification expires five years after the date of its issuance or renewal.

Application for Examination

- 10.** (1) If a licence requires a person to successfully complete an examination administered by the Commission in order to be certified, the person may take the examination after the Commission receives from the licensee an application that includes
- (a) the name of the person;
 - (b) the name of the applicable examination; and
 - (c) a statement that the person has successfully completed the applicable training program referred to in the licence.
- (2) The Commission shall notify the licensee and the person of the examination results.
- (3) The notice of examination results shall include a description of the licensee's and the person's right to be provided with an opportunity to be heard in accordance with the procedure referred to in section 13.

Refusal to Certify

- 11.** (1) The Commission or a designated officer authorized under paragraph 37(2)(b) of the Act shall notify a licensee who has applied for the certification of a person and the person in respect of whom certification is being sought of a proposed decision not to certify the person, as well as the basis for the proposed decision, at least 30 days before refusing to certify the person.
- (2) The notice shall include a description of the licensee's and the person's right to be provided with an opportunity to be heard in accordance with the procedure referred to in section 13.

Decertification

12. (1) The Commission or a designated officer authorized under paragraph 37(2)(b) of the Act shall notify a person in respect of whom a certificate has been issued and the licensee concerned of a proposed decision to decertify the person, as well as the basis for the proposed decision, at least 30 days before decertifying the person.
- (2) The notice shall include a description of the licensee's and the person's right to be provided with an opportunity to be heard in accordance with the procedure referred to in section 13.

Opportunity to Be Heard

13. (1) If a licensee or a person referred to in section 10, 11 or 12 has received a notice and has requested, within 30 days after the date of receipt of the notice, an opportunity to be heard either orally or in writing, the licensee or the person shall be provided with such an opportunity in accordance with the request.
- (2) On completion of a hearing held in accordance with subsection (1), the licensee and the person shall be notified of the decision and the reasons for it.

RECORDS TO BE KEPT AND RETAINED

14. (1) Every licensee shall keep a record of the results of the effluent and environmental monitoring programs referred to in the licence.
- (2) Every licensee who operates a Class I nuclear facility shall keep a record of
 - (a) operating and maintenance procedures;
 - (b) the results of the commissioning program referred to in the licence;
 - (c) the results of the inspection and maintenance programs referred to in the licence;
 - (d) the nature and amount of radiation, nuclear substances and hazardous substances within the nuclear facility; and
 - (e) the status of each worker's qualifications, requalification and training, including the results of all tests and examinations completed in accordance with the licence.
- (3) Every licensee who decommissions a Class I nuclear facility shall keep a record of
 - (a) the progress achieved in meeting the schedule for the decommissioning;
 - (b) the implementation and results of the decommissioning;
 - (c) the manner in which and the location at which any nuclear or hazardous waste is managed, stored, disposed of or transferred;
 - (d) the name and quantity of any radioactive nuclear substances, hazardous substances and radiation that remain at the nuclear facility after completion of the decommissioning; and
 - (e) the status of each worker's qualifications, requalification and training, including the results of all tests and examinations completed in accordance with the licence.
- (4) Every person who is required by this section to keep a record referred to in paragraph (2)(a) to (d) or (3)(a) to (d) shall retain the record for 10 years after the expiry date of the licence to abandon issued in respect of the Class I nuclear facility.
- (5) Every person who is required by this section to keep a record referred to in paragraph (2)(e) or (3)(e) shall retain the record for the period that the worker is employed by the licensee and for five years after the worker ceases to be so employed.

COMING INTO FORCE

15. These Regulations come into force on the day on which they are approved by the Governor in Council.

ANNEX 7

URANIUM MINES AND MILLS REGULATIONS

INTERPRETATION AND APPLICATION

Interpretation

1. The definitions in this section apply in these Regulations.

“Act” means the *Nuclear Safety and Control Act*. (*Loi*)

“concentrate” means an extracted product that contains uranium and that results from the physical or chemical separation of uranium from ore. (*concentré*)

“effective dose” has the meaning assigned to that term by subsection 1(1) of the *Radiation Protection Regulations*. (*dose effective*)

“equivalent dose” has the meaning assigned to that term by subsection 1(1) of the *Radiation Protection Regulations*. (*dose équivalente*)

“excavation site” means a place at which uranium is moved by means of underground activities for the purpose of evaluating a potential orebody. (*site d’excavation*).

“hazardous substance” means a substance, other than a nuclear substance, that is used or produced in the course of carrying on a licensed activity and that may pose a risk to the environment or the health and safety of persons. (*substance dangereuse*)

“licensed activity” means an activity described in paragraph 26(e) of the Act that a licence authorizes the licensee to carry on in relation to a uranium mine or mill. (*activité autorisée*)

“licensee” means a person who is licensed to carry on an activity described in paragraph 26(e) of the Act in relation to a uranium mine or mill. (*titulaire de permis*) “mill” means a facility at which ore processed and treated for the recovery of uranium concentrate, including any tailings- handling and water treatment system associated with the facility. (*usine de concentration*)

“mine” includes an excavation site and a removal site. (*mine*)

“ore” means a mineral or chemical aggregate containing uranium in a quantity and of a quality that makes mining and extracting the uranium economically viable. (*minerai*)

“removal site” means a place at which uranium is removed from its place of natural deposit by means of surface activities for the purpose of evaluating a potential orebody. (*site d’extraction*).

“waste management system” means a system for collecting, transporting, receiving, treating, processing, storing or disposing of the wastes that are produced as a result of the licensed activity at a uranium mine or mill. (*système de gestion des déchets*)

“worker” means a person who performs work that is referred to in a licence. (*travailleur*)

“workers’ representative” means

(a) a person who is a member of the workers’ safety and health committee;

(b) the workers’ safety and health representative;

(c) where there is no person referred to in paragraph (a) or (b), the workers’ collective bargaining agent; or

(d) where there is no person referred to in paragraph (a), (b) or (c), a worker.

(*représentant des travailleurs*)

“work place” means any area within a uranium mine or mill where a worker could reasonably be expected to be in the course of performing work. (*lieu de travail*).

Application

2. (1) These Regulations apply in respect of uranium mines and mills.

(2) These Regulations do not apply in respect of uranium prospecting or surface exploration activities.

LICENCE APPLICATIONS

General Requirements

3. An application for a licence in respect of a uranium mine or mill, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the General Nuclear Safety and Control Regulations :
- (a) in relation to the plan and description of the mine or mill,
 - (i) a description of the site evaluation process and of the investigations and preparatory work to be done at the site and in the surrounding area,
 - (ii) a surface plan indicating the boundaries of the mine or mill and the area where the activity to be licensed is proposed to be carried on,
 - (iii) a plan showing the existing and planned structures, excavations and underground development,
 - (iv) a description of the mine or mill, including the installations, their purpose and capacity, and any excavations and underground development,
 - (v) a description of the site geology and mineralogy,
 - (vi) a description of any activity that may have an impact on the development of the mine or mill, including any mining-related activity that was carried on at the site before the date of submission of the application to the Commission,
 - (vii) a description of the design of and the maintenance program for every eating area,
 - (viii) the proposed plan for the decommissioning of the mine or mill, and
 - (ix) a description of the proposed emergency power systems and their capacities;
 - (b) in relation to the activity to be licensed,
 - (i) a description of and the schedule for the planned activity,
 - (ii) a description of the proposed methods for carrying on the activity,
 - (iii) a list of the categories of material proposed to be mined and a description of the criteria used to determine those categories,
 - (iv) the anticipated duration of the activity, and
 - (v) the proposed quality assurance program for the activity;
 - (c) in relation to the environment and waste management,
 - (i) the program to inform persons living in the vicinity of the mine or mill of the general nature and characteristics of the anticipated effects of the activity to be licensed on the environment and the health and safety of persons,
 - (ii) the program to determine the environmental baseline characteristics of the site and the surrounding area,
 - (iii) the effects on the environment that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects,
 - (iv) the proposed positions for and qualifications and responsibilities of environmental protection workers,
 - (v) the proposed environmental protection policies and programs,
 - (vi) the proposed effluent and environmental monitoring programs,
 - (vii) the proposed location, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics,
 - (viii) the proposed measures to control releases of nuclear substances and hazardous substances into the environment,
 - (ix) a description of the anticipated liquid and solid waste streams within the mine or mill, including the ingress of fresh water and any diversion or control of the flow of uncontaminated surface and ground water,

- (x) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of security, including measures to.
 - (A) assist off-site authorities in planning and preparing to limit the adverse effects of an accidental release,
 - (B) notify off-site authorities of an accidental release or the imminence of an accidental release,
 - (C) report information to off-site authorities during and after an accidental release,
 - (D) assist off-site authorities in dealing with the adverse effects of an accidental release, and
 - (E) test the implementation of the measures to control the adverse effects of an accidental release,
- (xi) the anticipated quantities, composition and characteristics of backfill, and
- (xii) a description of the proposed waste management system;
- (d) in relation to health and safety,
 - (i) the effects on the health and safety of persons that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects,
 - (ii) the proposed program for selecting, using and maintaining personal protective equipment,
 - (iii) the proposed worker health and safety policies and programs,
 - (iv) the proposed positions for and qualifications and responsibilities of radiation protection workers,
 - (v) the proposed training program for workers,
 - (vi) the proposed measures to control the spread of any radioactive contamination,
 - (vii) the proposed ventilation and dust control methods and equipment for controlling air quality, and
 - (viii) the proposed level of effectiveness of and inspection schedule for the ventilation and dust control systems; and
- (e) in relation to security, the proposed measures to alert the licensee to acts of sabotage or attempted sabotage at the mine or mill.

Requirement for Code of Practice

4. (1) In this section, “action level” means a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee’s radiation protection program or environmental protection program, and triggers a requirement for specific action to be taken.
- (2) An application for a licence in respect of a uranium mine or mill, other than a licence to abandon, shall contain a proposed code of practice that includes
 - (a) any action level that the applicant considers appropriate for the purpose of this subsection;
 - (b) a description of any action that the applicant will take if an action level is reached; and
 - (c) the reporting procedures that will be followed if an action level is reached.

Licence to Prepare Site and Construct

5. (1) An application for a licence to prepare a site for and construct a uranium mine shall contain the following information in addition to the information required by section 3 and subsection 4(2):
 - (a) a description of the proposed design of the mine;
 - (b) the proposed construction program, including its schedule;
 - (c) a description of the components, systems and equipment proposed to be installed at the mine, including their design operating conditions;
 - (d) the proposed quality assurance program for the design of the mine;
 - (e) the results of a process-hazard analysis and a description of how those results have been taken into account;
 - (f) a description of the proposed design, construction and operation of the waste management system,

- including the measures to monitor its construction and operation, the construction schedule, the contingency plans for construction and the measures to control the movement of water in existing waterways;
- (g) a description of the proposed disposition of the ore;
 - (h) the anticipated quantities and grade of ore and waste rock that will be removed, their proposed storage location, and the proposed method, program and schedule, for their removal and disposal;
 - (i) the proposed mining methods and programs; and
 - (j) the proposed commissioning plan for the components, systems and equipment to be installed at the mine.
- (2) An application for a licence to prepare a site for and construct a uranium mill shall contain the following information in addition to the information required by section 3 and subsection 4(2):
- (a) a description of the proposed design of the mill;
 - (b) the proposed construction program, including its schedule;
 - (c) a description of the components, systems and equipment proposed to be installed at the mill, including their design operating conditions;
 - (d) the proposed quality assurance program for the design of the mill;
 - (e) the results of a process-hazard analysis and a description of how those results have been taken into account;
 - (f) a description of the proposed design, construction and operation of the waste management system, including the measures to monitor its construction and operation, the construction schedule, the contingency plans for construction and the measures to control the movement of water in existing waterways;
 - (g) the proposed milling methods and programs;
 - (h) a description of all proposed laboratory facilities and programs; and
 - (i) the proposed commissioning plan for the components, systems and equipment to be installed at the mill.

Licence to Operate

6. (1) An application for a licence to operate a uranium mine shall contain the following information in addition to the information required by section 3 and subsection 4(2):
- (a) the results of any commissioning work;
 - (b) a description of the structures, components, systems and equipment at the mine, including any changes to their design and their design operating conditions as a result of the commissioning;
 - (c) the proposed policies, methods and programs for operating and maintaining the mine; and
 - (d) the proposed methods for handling, storing, loading and transporting nuclear substances and hazardous substances.
- (2) An application for a licence to operate a uranium mill shall contain the following information in addition to the information required by section 3 and subsection 4(2):
- (a) the results of any commissioning work;
 - (b) a description of the structures, components, systems and equipment at the mill, including any changes to their design and their design operating conditions as a result of the commissioning;
 - (c) the proposed policies, methods and programs for operating and maintaining the mill;
 - (d) the proposed methods for handling, storing and loading concentrates and uraniumbearing material, both solid and liquid;
 - (e) the proposed operating schedule;
 - (f) the daily and annual design capacity of the mill, and the expected recovery and composition of mill feed, concentrates and tailings; and
 - (g) a description of the proposed operation of the waste management system.

Licence to Decommission

7. An application for a licence to decommission a uranium mine or mill shall contain the following information in addition to the information required by section 3 and subsection 4(2):
- (a) a description of and the proposed schedule for the decommissioning work, including the proposed starting date and the expected completion date of the decommissioning work and the rationale for the schedule;
 - (b) the land, buildings, structures, components, systems, equipment, nuclear substances and hazardous substances that will be affected by the decommissioning;
 - (c) the proposed measures, methods and programs for carrying on the decommissioning; and
 - (d) a description of the planned state of the site upon completion of the decommissioning work.

Licence to Abandon

8. An application for a licence to abandon a uranium mine or mill shall contain the following information in addition to the information required by sections 3 and 4 of the *General Nuclear Safety and Control Regulations*:
- (a) the program to inform persons living in the vicinity of the site of the mine or mill of the general nature and characteristics of the anticipated effects of the abandonment on the environment and the health and safety of person;
 - (b) the results of the decommissioning work; and
 - (c) the results of the environmental monitoring programs.

OBLIGATIONS OF LICENSEES

Posting of Code of Practice

9. Every licensee shall post a copy of the code of practice referred to in the licence at a location within the uranium mine or mill that is accessible to all workers and where it is most likely to come to their attention.

Operating Procedures

10. Every licensee shall
- (a) establish, implement and maintain written operating procedures for the licensed activity;
 - (b) train its workers to perform their work in accordance with the operating procedures; and
 - (c) audit its workers for the purpose of verifying compliance with the operating procedures.

Ventilation Systems

11. Every licensee shall, with respect to the ventilation systems established in accordance with the licence,
- (a) ensure that each main fan is equipped with a device that provides a warning signal when the main fan is not functioning properly;
 - (b) ensure that a person is designated to receive and respond to a warning signal provided by a device referred to in paragraph (a); and
 - (c) implement measures to prevent any person or activity from interfering with the proper operation of the ventilation systems.

Malfunction of Ventilation System

- 12.** (1) Where a ventilation system in a work place is not functioning in accordance with a licence, the licensee shall
- (a) implement alternative measures to protect the health and safety of its workers; and
 - (b) ensure that only the work necessary to restore that system is performed in the work place.
- (2) Before a worker performs any work that is necessary to restore a ventilation system, the licensee shall inform the worker of the protective measures that have been taken and are to be taken in connection with the work.

Use of Respirators

- 13.** No licensee shall rely on the use of a respirator to comply with the *Radiation Protection Regulations* unless the use of the respirator
- (a) is for a temporary or unforeseen situation; and
 - (b) is permitted by the code of practice referred to in the licence.

Gamma Radiation

- 14.** Every licensee shall
- (a) post signs at all entrances to each area where the dose rate of gamma radiation exceeds 25 $\mu\text{Sv/h}$, designating the area as a radiation area and indicating the dose rate of gamma radiation in that area; and
 - (b) provide every worker who is to enter an area where the dose rate of gamma radiation exceeds 100 $\mu\text{Sv/h}$ with a direct-reading dosimeter.

Training Program

- 15.** (1) Where a worker successfully completes the training program in basic radiation health and safety referred to in a licence, the licensee shall issue to the worker a certificate indicating that the worker has completed a training program in basic radiation health and safety that is acceptable to the Commission.
- (2) Every licensee shall provide a copy of the training program referred to in the licence to a workers' representative.

RECORDS TO BE KEPT AND MADE AVAILABLE

- 16.** (1) Every licensee shall keep a record of
- (a) its operating and maintenance procedures;
 - (b) its mine plans showing the actual and planned mine workings;
 - (c) the schedules for all of its planned mining operations;
 - (d) the plans of every tailings-containment structure and area and every diversion structure and system associated with the waste management system;
 - (e) the design of the uranium mine or mill and of the components and systems installed at the mine or mill;
 - (f) the method and relevant data used to ascertain the doses of radiation received by the workers at the uranium mine or mill and the intake of radioactive nuclear substances by those workers;
 - (g) any measurement made in accordance with the licence or the regulations made under the Act; (h) the inspections and maintenance carried out in accordance with the licence or the regulations made under the Act;
 - (i) the quantity of air delivered by each main fan;
 - (j) the performance of each dust control system; and

- (k) the training received by each worker.
- (2) Every licensee shall make the records referred to in subsection (1) available at the uranium mine or mill to the workers and a workers' representative.
- (3) Every licensee shall retain a record of the training referred to in paragraph (1)(k) for the period that the worker is employed at the uranium mine or mill.
- (4) Every licensee shall post, at a location within the uranium mine or mill that is accessible to all workers and where it is most likely to come to their attention, a record of the measurements made in respect of every work place in accordance with the licence and these Regulations.

COMING INTO FORCE

- 17. These Regulations come into force on the day on which they are approved by the Governor in Council.

ANNEX 8

SPENT FUEL MANAGEMENT FACILITIES

8.1 Storage Technologies in Canada

8.2 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 provides good heat transfer to control fuel temperatures. The water also provides 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 2 metres thick. Inner walls and floors are lined with a watertight liner consisting of stainless steel or a fibreglass-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.

8.2.1 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.

8.2.2 Storage Containers

Storage containers are used to hold spent fuel. A number of designs are used. 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.

8.2.3 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.

8.3 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)
- Ontario Power Generation Dry Storage Container

8.3.1 AECL Concrete Canisters

The AECL Concrete Canister Fuel Storage Program was developed at WL in the early 1970s to demonstrate that dry storage for irradiated reactor fuel was a feasible alternative to waterpool 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 at Douglas Point 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.



Dry storage in AECL concrete canister
Douglas Point Spent Fuel Dry Storage Facility

Photo courtesy of Atomic Energy of Canada Limited.

The shielded workstation is a shielded enclosure with facilities 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 sub-assemblies used for lifting, washing, drying, seal welding, and inspection of 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 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 of epoxy-coated carbon steel. To provide additional shielding, a two-piece loading plug is used until the canister is filled. Provision is made for International Atomic Energy Agency (IAEA) safeguard seals to go over the top of the canister plug such that the plug cannot be removed without breaking the seals. Two small-diameter pipes allow the monitoring of the air between the liner and the fuel baskets in order to confirm the integrity of the confinement barriers. The concrete canisters are supported on reinforced concrete foundations above the water table. A canister holds 6, 8, 9, or 10 baskets, depending on the specific needs of the station. The fuel baskets used at the Point Lepreau facility contain 60 spent fuel bundles that have been stored for a minimum of seven years in the water-filled storage bays at the nuclear generating station for a total of 540 spent fuel bundles per concrete canister. 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.

8.3.2 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. Five modules have been constructed since 1995.



AECL MACSTOR System
Hydro-Québec Spent Fuel Dry
Storage Facility

Photo courtesy of Hydro - Québec.

A typical MACSTOR module is 8.2 metres wide, 20.4 metres long and 6.4 metres high. It stores 20 canisters in two rows of 10 vertical cylindrical cavities, each holding 10 baskets of 60 spent fuel bundles, for a total of 12,000 spent fuel bundles per module. Each canister is secured to the floor and top slab of the module.

The heat of the spent fuel is dissipated primarily by natural convection through ventilation ports (air inlets and outlets) extending through the concrete walls. The ventilation is provided by 10 large inlets near the base of the module (five in each longitudinal wall), and by 12 large air outlets located slightly below the top 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 that of the concrete canister. Each use the fuel basket, shielded work station, and transfer flask concept. The only essential difference is the storage structure itself.

8.3.3 Ontario Power Generation Dry Storage Container

OPG currently operates two spent fuel dry storage facilities for the storage of dry storage containers (Pickering Used Fuel Dry Storage Facility and the Western Used Fuel Dry Storage Facility).

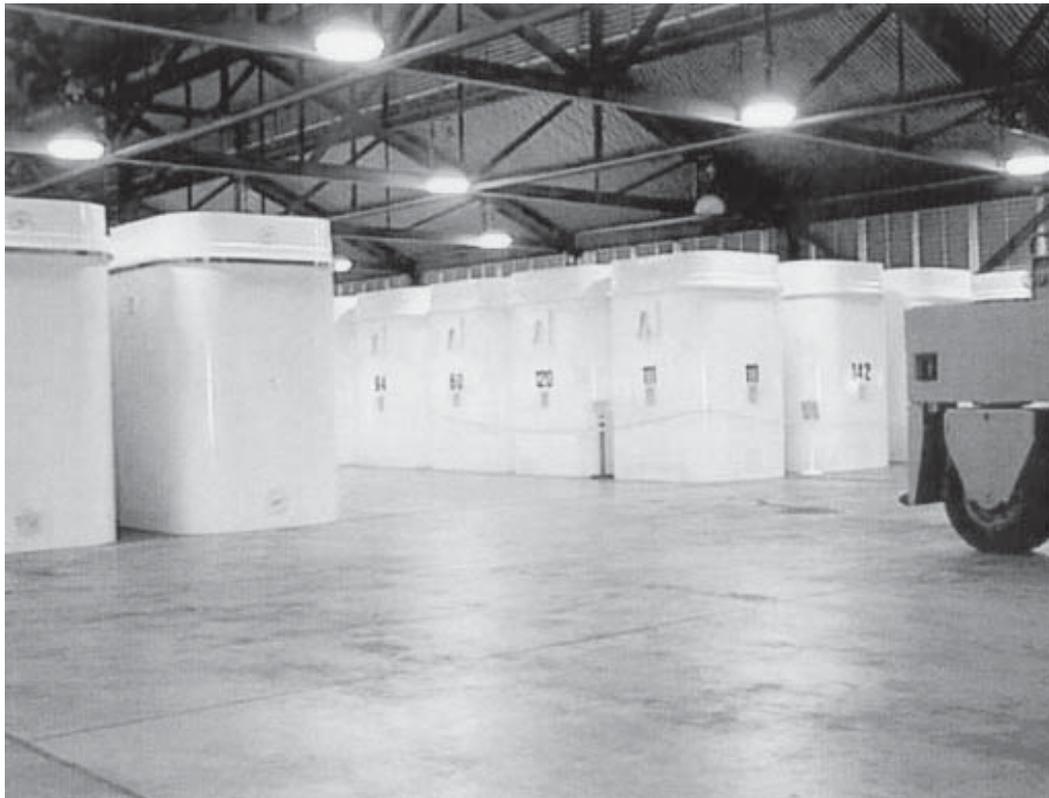


Photo courtesy of Ontario Power Generation.

Ontario Power Generation Dry Storage containers
Pickering Used Fuel Dry Storage Facility

OPG has submitted a construction licence application to the CNSC for a spent fuel dry storage facility at the Darlington NGS. An environmental assessment pursuant to the CEAA is presently being conducted. Completion of the environmental assessment and consideration of the licensing application is expected to be completed in 2004.

The OPG dry storage facilities employ standard dual-purpose dry storage containers. The dry storage containers are massive, transportable containers, constructed primarily of reinforced concrete with an inner cavity for fuel containment. Each dry storage container is designed to hold 384 fuel bundles, and weighs approximately 53 tonnes when empty and 63 tonnes when loaded. The dry storage containers are of rectangular design, with walls of concrete sandwiched between interior and exterior layers made of carbon steel. The inner liner constitutes the containment boundary while the outer liner is intended to enhance structural integrity and to 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 exterior facilities. In either case, there are no anticipated radiological releases from the dry storage containers under normal operating conditions.

8.4 Experiences with Wet Storage

The early operating experience gained at the AECL research reactor spent fuel bays (which have been in operation since 1947) and at the NPD and Douglas Point reactors, has 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, and the level of 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 Pickering Nuclear Generating Station-A (Pickering NGS-A) Primary Bay (where the first epoxy liner was used). Location and repair 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 the underwater repair of defects, 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.

8.5 Experiences with Dry Storage

Research programs have been carried out to assess 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.

In addition to these research experiments, prototype programs indicated that shielding can be maintained, there is no enhanced release from spent fuel, and fuel and structure temperatures are at the levels predicted by analysis or lower. 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 Pickering Used Fuel Dry Storage Facility (PUFDSF) 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 exposures by 30% or more. Emissions from the processing area have remained below regulatory limits. The PUFDSF 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 PUFDSF 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, 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.

8.6 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.

8.6.1 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 environmental assessment 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 PUFDSF.

8.6.2 Pickering Used Fuel Dry Storage Facility

The OPG PUFDSF is located within the perimeter of the NGS. In operation since 1996, the intended purpose of the PUFDSF is to store used fuel from the reactors of the Pickering NGSs only. It is expected that the PUFDSF will be in operation until at least 10 years after the shutdown of the last Pickering

reactor unit. The Pickering Used Fuel Dry Storage system is designed to transfer used fuel from wet storage in the Pickering NGSs irradiated fuel bays into a dual-purpose (storage and transport) concrete dry storage container designed by OPG. Prior to transfer to the PUFDSF the loaded dry storage containers are drained and monitored for loose contamination; and if necessary, they are decontaminated.

At the PUFDSF workshop, the dry storage container 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 vent port is also welded and a weld dye penetrate inspection is performed. The lid weld is subsequently inspected for defects using X-ray radiography. The dry storage container undergoes final vacuum drying and helium backfilling. The drain port is then welded; the weld is inspected, and helium leak testing performed. The dry storage container is monitored to ensure that no loose contamination is present, and decontaminated if necessary. Finally, touch-up paint is applied to welded areas and scuffs or scrapes on the container exterior. Prior to being introduced into the storage building, IAEA seals are reapplied to each container. The PUFDSF currently processes approximately two dry storage containers (or 768 spent fuel bundles) per week.

The PUFDSF currently has authorization to store an estimated 270,000 fuel bundles in dry storage. An application to expand the facility is currently under review.

8.6.3 Bruce Nuclear Generating Stations A and B

Tiverton, Ontario hosts two NGSs (Bruce NGS-A and NGS-B). Bruce NGS-A consists of four CANDU Pressurized Heavy Water reactors. The station commenced operation in 1976. It is currently in an approved shutdown state. An application to restart units 3 and 4 is currently under review by the CNSC. An environmental assessment has been completed. The application is currently being considered in accordance with the CNSC licensing process.

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. The nuclear fuel waste produced is currently stored in their irradiated fuel bays. The current proposal being considered is that after a minimum storage of 10 years in the fuel bays, the used fuel will be transferred to OPG for storage at the WUFDSF, which is currently undergoing commissioning.

8.6.4 Western Used Fuel Dry Storage Facility

The OPG WUFDSF located adjacent to the Western Waste Management Facility, which began operations in February 2003, was designed to provide safe storage for the Bruce NGS-A or NGS-B used fuel until all the used fuel is transported to an alternative long-term used fuel storage or disposal facility. The WUFDSF is designed to provide additional storage capacity for about 705,000 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 that currently in use at the PUFDSF. The processing of dry storage containers is identical to the PUFDSF.

Once in full operation, the WUFDSF will process four to five dry storage containers per week. OPG is authorized to store 750,000 spent fuel bundles into dry storage.

8.6.5 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 waterfilled storage bays.

8.6.6 Darlington Used Fuel Dry Storage Facility

The proposed Darlington Used Fuel Dry Storage Facility (DUFDSF) will be located within the Darlington NGS site. The proposed DUFDSF will provide safe storage for the Darlington NGS used fuel until all the used fuel is transported to an alternative long-term used fuel storage or disposal facility. The used fuel dry storage proposal is currently under regulatory review and is undergoing an environmental assessment in accordance with the CEAA. The in-service date for the DUFDSF is forecasted for 2007.

8.6.7 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.

8.6.8 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 (see Annex 8, Subsection 8.3.2). 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 50,000 spent fuel bundles are transferred to dry storage each year depending on the status of the Gentilly-2 nuclear reactor.

8.6.9 Point Lepreau Nuclear Generating Station

The Point Lepreau NGS, operated by New Brunswick Power, 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.

8.6.10 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 (see Annex 8, Subsection 8.3.1). The Point Lepreau Used Fuel Dry Storage Facility is authorized to construct 300 canisters for a total of 180,000 spent fuel bundles. Approximately 50,000 spent fuel bundles are transferred to dry storage each year depending on the status of the Point Lepreau nuclear reactor.

8.6.11 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.

8.6.12 Gently-1 Used Fuel Dry Storage Facility

The AECL Gently-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 decommissioning program, a total of 3,213 spent fuel bundles were transferred to concrete canisters located internally in a section of the Gently-1 Turbine Building. The concrete canisters are currently in a storage-with-surveillance mode.

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

NPD was a demonstration reactor operated by Ontario Hydro (now Ontario Power Generation) 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 Chalk River Laboratories Used Fuel Dry Storage Area. AECL has stored at this site 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.

8.6.14 Whiteshell Used Fuel Storage Facility

The WL were 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 is 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 Concrete Canister Storage Facility is composed of two storage areas:

- The main canister site adjacent to the Waste Management Area (WMA); and
- The demonstration canister site within the site laboratory area.

With the closure of the reactor, the nuclear fuel waste was transferred to the Whiteshell Used Fuel Storage Facility (also referred to as the Concrete Canister Storage Facility). This facility provides storage for 360 irradiated fuel bundles. Some fuel waste from operations prior to 1975 are buried in standpipes in the WMA. The Used Fuel Storage Facility and WMA are undergoing decommissioning. Further details on the decommissioning program can be found in Annex 9.

ANNEX 9

RADIOACTIVE WASTE MANAGEMENT FACILITIES

9.1 Radioactive Waste Management Methods

Currently, there is no disposal facility for radioactive waste in Canada. All radioactive wastes produced in Canada are placed into storage with surveillance, pending the establishment of a disposal facility. 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.

9.1.1 In-ground Burial

As a result of improvements to waste handling and storage at the CRL in 2002, the use of the in-ground burial technique has been limited to biodegradable material. These wastes are placed into an unlined continuous sand trench. Waste material is covered with local sand so as to provide a cover for the waste layers and to act as a fire retardant. One metre of clean sand is placed on top of the waste material as the final layer. Prior to 2002, the radioactive waste material placed in trenches consisted primarily of contaminated paper, packing material, broken glassware, protective clothing, and cleaning material.

9.1.2 Low-Level Storage Buildings

Ontario Power Generation uses low-level storage buildings at the Western Low and Intermediate Level Waste Management Facility. Low-level storage buildings provide storage capacity for approximately 7,660 cubic metres of solid radioactive waste. The structural design of the building utilizes prefabricated pre-stressed concrete. The concrete panels are joined in an overlapping configuration to prevent radiation streaming between the panels. The buildings are provided with services such as fire protection, ventilation, lighting, and drainage.

9.1.3 Modular Above-Ground Storage Buildings

Modular above-ground storage buildings provide storage capacity for compacted radioactive waste in an above-ground storage facility, rather than in-ground burial. Each building provides a storage capacity of 2,000 cubic metres. A typical storage building consists of a prefabricated metal building situated on a reinforced concrete floor. The buildings are fitted with floor drain systems connected to an outside sump to collect any liquids released in the buildings, such as condensed moisture from the air, precipitation, or possibly liquids tracked in by heavy equipment.

9.1.4 Quonset Huts

At the AECL WL, Quonset huts are used for the storage of solid radioactive waste that does not require shielding or may require retrieval at a later date.

9.1.5 Tile Holes

Tile holes are used primarily at the AECL CRL. They were in the past used at the OPG Western Low and Intermediate Level Waste Management Facility.

Tile holes at the CRL Waste Management Areas (WMA) are used to store radioactive material that requires more shielding than can be obtained by concrete bunkers and that may require consideration of heat dissipation. Approximately 3,500 tile holes of differing sizes and construction are in-service at the CRL site. The material stored in tile holes includes irradiated fuel, cell waste, experimental fuel bundles, unusable radioisotopes, spent resin columns, active exhaust system filters, and cemented fission-product waste from the molybdenum-99 production process.

The OPG Western Low and Intermediate Level Waste Management Facility currently has 80 tile holes in use. The tile holes were an early design (i.e., 1970s) for the storage of solid radioactive waste which required shielding. Shielding is provided by the surrounding backfill. The tile holes currently contain radioactive waste and are in a storage-with-surveillance mode.

9.1.6 In-ground Containers

In-ground containers are exclusively used at the OPG Western Low and Intermediate Level Waste Management Facility. In-ground containers provide safe storage for solid radioactive waste produced at the Darlington, Pickering, and Bruce nuclear generating stations. The following is the current inventory of in-ground containers:

- twenty two-cubic-metre in-ground containers (IC-2);
- twenty twelve-cubic-metre in-ground containers (IC-12);
- approximately two hundred eighteen-cubic-metre in-ground containers (IC-18); and
- forty in-ground heat exchanger (IC-HX) containers.

The IC-2 and IC-12 in-ground containers are currently in a storage-with-surveillance mode. The IC-18 in-ground container is currently being used for the storage of solid radioactive waste, such as waste resin and other waste requiring shielding. The IC-18 has a similar design to the IC-12 with the exception that it is deeper. The design of the IC-18 utilizes the natural shielding provided by the surrounding material. The liner is constructed from steel pipe with a welded steel bottom. There is an inner-space between the waste-packaging containers and the IC-18 structure. An in-structure water detection and removal capability is provided by the use of an external sample pipe.

The IC-HX containers provide storage for heat exchanger tube bundles from moderator, PHT and auxiliary systems from the Pickering, Darlington, and Bruce NGSs. The radiation fields from the buried IC-HXs are shielded by the crushed limestone backfill and surrounding till.

9.1.7 Concrete Bunkers

Concrete bunkers of varying design are used at all reactor site waste management facilities and at AECL's CRL and WL. The concrete bunkers vary in size and type (i.e., cylindrical, trench, rectangular, etc.), and are located in-ground, partially above-ground, or completely above-ground. The concrete bunkers are constructed of reinforced concrete. The waste stored in these engineered structures consists of radioactive waste requiring less shielding.

9.2 Pickering Waste Management Facility

The Pickering Waste Management Facility consists of the used fuel dry storage area and the retube components storage area (see Annex 8, Subsection 8.6.2). The Retube Components Storage Area (RCSA) is located at the Pickering NGSs, and provides storage for reactor components removed during the retubing of the Pickering NGS-A reactors, that had become radioactive due to neutron activation and deposited contamination. The RCSA is a closed area, meaning that no new waste is to be added without the prior written approval of the CNSC.

The RCSA is designed to accommodate 38 dry storage modules (DSMs). The DSMs 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 ALARA. At present the RCSA consists of 16 DSMs from retubing units 1 and 2 of the Pickering NGS-A and 18 DSMs from units 3 and 4.

The RCSA is paved and provides a non-water-ponding and maintenance-free surface. A drainage system is provided to direct the runoff water from the storage area to the Pickering NGS-B outfall, with catch basins permitting periodic sampling of the water.

9.3 Western Low and Intermediate Level Waste Storage Facility

The Western Low and Intermediate Level Waste Storage Facility (WLILWSF), owned and operated by OPG, is located at Bruce Nuclear Power Development in Tiverton, Ontario. The WLILWSF consists of two distinct areas:

- Low and Intermediate Level Radioactive Waste Storage Area; and
- Western Used Fuel Dry Storage Area.

The Low and Intermediate Level Radioactive WMA provides safe handling, treatment, and storage of radioactive materials produced at NGSs and other facilities currently or previously operated by OPG, or its predecessor Ontario Hydro. The Low and Intermediate Level Radioactive WMA consists of various structures such as the Waste Volume Reduction Building, low-level storage buildings, quadricells, in-ground containers, trenches, and tile holes.

The Waste Volume Reduction Building provides for the management of low-level radioactive wastes such as waste receiving and handling, compaction, and incineration prior to storage. The Waste Volume Reduction Building consists of the following main areas:

- **Radioactive Waste Incinerator Area** — This area contains the radioactive waste incinerator and associated equipment, active drainage sump, a shredder, and a box compactor. OPG has developed Derived Release Limits (DRLs) for the radioactive effluents from the radioactive incinerator. The non-radioactive effluents must conform to the provincial air effluent discharge limits. Currently radioactive and non-radioactive effluents are below all regulatory requirements.
- **Non-radioactive Waste Incinerator Area** — This area contains a nonradioactive waste incinerator and associated equipment, sewage sump, and storage of the breathing air module.
- **Service Area** — This area provides an inside truck unloading area along with a separate temporary storage area for radioactive waste in bulk handling containers. This area also includes an electrical equipment room and a control room for both radioactive and non-radioactive waste incinerators.

- **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.

The safe handling, processing, and storage of radioactive waste at the WLILWSF require:

- a combination of design features, procedures, policies, and monitoring programs, some of which are generic design considerations;
- radiation protection;
- occupational health and safety;
- environmental protection policy; and
- monitoring programs for the individual area and also for the overall facility.

The WLILWSF receives approximately 600 cubic metres of radioactive waste per month.

9.4 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 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.

Concrete bunker Type A is used for the storage of high activity level radioactive waste such as filters. Concrete bunker Type B is used for the storage of medium activity level radioactive waste, while concrete bunker Type C is used for the storage of low activity level radioactive waste. The Hydro-Québec Low-Level Radioactive WMA also contains filter storage bunkers for medium to low activity level material.

The Hydro-Québec Low-Level Radioactive WMA receives approximately 3 cubic metres of radioactive waste per month.

9.5 Point Lepreau Waste Management Facility

The Point Lepreau Solid Radioactive Waste Management Facility (SRWMF) provides safe storage of radioactive materials produced at the Point Lepreau NGS. The SRWMF 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 cubic metres of storage in the four vault structures. Each vault has four equal compartments.
- **Quadricell**—The quadricell structures are designed to contain high activity level waste, such as spent ion exchange resins and filters from reactor systems. An example of this is activated system components. There are approximately 144 cubic metres of quadricell storage for high activity level waste 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 SRWMF receives approximately three to five cubic metres of radioactive waste per month.

9.6 Nuclear Research and Test Establishment Facilities

There are currently two operating research facilities in Canada—at the AECL CRL in Ontario and at the AECL WL in Pinawa, Manitoba. Operational wastes produced at these two sites are stored in waste management facilities at each site. In addition to two operating reactors, the NRU reactor, and the zero power ZED-2 reactor, research and development activities at AECL CRL include the application of nuclear science, reactor development, environmental science, and Low-Level Radioactive Waste management.

Research work at the WL is primarily related to disposal of nuclear fuel waste, environmental sciences, and reactor development. Operations at the WL have been significantly reduced in recent years. The WR-1 reactor has been partially decommissioned and the Slowpoke Demonstration Reactor has been fully decommissioned.

The CRL WMAs have been in operation since the early 1940s. They are the oldest and largest of Canada's waste storage facilities. The CRL WMAs manages wastes produced from CRL operations and also operates 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.

Wastes such as scintillation cocktails, radiological contaminated lubricating oils, and polychlorinated biphenyl (PCB)-contaminated waste and isotope production wastes from off-site waste generators, are also stored at the CRL WMAs. Approximately 1,500 cubic metres is added to the WMAs per year. In addition to the WMAs, the Waste Treatment Centre (WTC) is located at the CRL.

The WMAs described below are currently located at the CRL.

9.6.1 Waste Management Area A

WMA A started operation in 1946 and was the only waste management facility at CRL until 1953. Between 1946 and 1952, solid waste from the CRL site, as well as some offsite waste, was buried directly in the ground in a series of sand trenches. Few details on the facilities and wastes emplaced in WMA A are available. The records for this area were destroyed in a fire in 1956. The inspection of other information was used to provide an indication of the inventory in this area.

The soil trenches were the first disposal facility in WMA A and were in use until similar facilities were constructed in WMA B in 1953. The sand trenches are expected to have a wide variety of wastes because they were initially the only waste facility at the time. The site operations over the period in which the sand trenches were in use included the operation of the NRX reactor, fuel reprocessing, clean-up of the NRX accident, and reactor and fuel processing research and development.

WMA A received both solid and liquid radioactive wastes. There are some estimates of the radionuclide inputs from some liquid disposals (the 1952 incident and the two slug releases of fuel reprocessing solutions), but there are no comprehensive inventories of other liquid releases and of solids buried in the area.

WMA A is currently in a storage-with-surveillance mode and the monitoring consists of surveillance monitoring, operational control monitoring (groundwater), and surface water monitoring.

9.6.2 Waste Management Area B

WMA B started operation in 1953 with the burial of radioactive solid waste into unlined sand trenches. In 1955, waste was segregated between sand trenches for lower radiation field waste and asphalt trenches for higher radiation field waste. The use of sand trenches continued until 1963 when this type of burial was transferred to WMA C. Storage of waste in engineered facilities began in 1955 with the construction of asphalt lined trenches and development continued to the cylindrical concrete bunkers and tile holes currently in use.

The storage facilities currently in use at WMA B are

- cylindrical concrete bunkers;
- tile holes; and
- contaminated polychlorinated biphenyl waste storage structures.

The cylindrical concrete bunkers are used to store solid radioactive waste such as bags, bales, small boxes, wooden crates, and 5-gallon pails, which requires less shielding. Tile holes are used to store radioactive material that requires more shielding than can be obtained in concrete bunkers and may require consideration of heat dissipation. This material includes irradiated fuel, cell waste, experimental fuel bundles, unusable radioisotopes, spent resin columns, active exhaust system filters, and cemented fission-product waste from the Molybdenum-99 production.

WMA B is also used for the storage of PCB-contaminated mixed wastes. The PCB waste consists mainly of electrical devices such as light ballasts, capacitors, and transformers and also includes some contaminated soils and building materials. WMA B also houses the Waste Handling Building that is used to super compact the compactable waste into steel storage containers. These containers are then transferred for storage in the Modular Above-Ground Storage facilities located in WMA H. A program is in progress to evaluate the older tile holes where water has occurred or is suspected. This program aims to limit the hazards of contamination spread and unstable chemical reactions.

9.6.3 Waste Management Area C

WMA C began operation in 1953, and its operation continues today. However the current use of WMA C was restricted in 2002 to animal carcasses and sewage sludge. The main facilities in WMA C are sand trenches. The trenches were filled with solid waste and when the trench was full; it was covered with sand and compacted. Some wastes are in temporary storage on the surface and include: sections of NRX research reactor stack, wrapped in tarpaulins, sitting on the grassed-in area, a mound of soil, liquid waste in barrels, and solidified waste oils in barrels.

9.6.4 Waste Management Area D

WMA D is not used for subsurface waste storage. In addition to marine containers and buildings, this area is also used as a temporary lay-down area for equipment that may be suitable for future use and is known or suspected to be contaminated with low levels of contamination. No secondary containment is provided because the equipment either has no loose contamination or is properly packaged to contain any loose contamination.

WMA D also provides temporary storage for waste oils, organic, and aqueous liquids in drums. The drums of liquid waste are stored inside marine containers with spill dams. There are periodic campaigns to ship these liquids off-site for disposal (e.g., a recent program to dispose of 92,000 litres of mixed waste from this area).

Two single-story pre-engineered steel buildings were constructed between 1984 and 1990 for the storage of slightly contaminated material from non-AECL sites. Also in 1996, seven luggers containing primarily soil contaminated with low levels of radium-226 and its decay products were transferred to this area for temporary storage.

9.6.5 Waste Management Area E

WMA E is an area that received suspected contaminated soils and building materials and other bulk soils and building debris from approximately 1977 to 1984. The suspected material was deposited directly on the ground.

9.6.6 Waste Management Area F

WMA F was developed for the storage of contaminated soil from sites in Port Hope, Mono Mills, and Ottawa, Ontario. Between 1976 and 1979, this area received soil contaminated predominantly with radium-226. The contaminated soil from Port Hope also contains stable arsenic, a residue of the uranium refining process. There is approximately 13 Mg of arsenic in this area. The contaminated soil is stored aboveground and covered into a mound.

9.6.7 Waste Management Area G

WMA G is used for the storage of spent fuel (see Section 7.7.1).

9.6.8 Waste Management Area H

WMA H began operation in 2002. The intended purpose of this area was to replace the sand trench operation at WMA C, which was approaching capacity.

WMA H consists of Modular Above-Ground Storage (MAGS) facilities. The MAGS facilities were designed, constructed, and put into operation to respond to requirements for alternative management of

low-level radioactive waste. It should be noted that the MAGS facilities cannot be used for all of the current types of low-level radioactive waste that are placed in WMA C. These excluded wastes include such things as contaminated animal carcasses and sewage sludge.

9.6.9 Liquid Dispersal Area

Between 1953 and 1998, AECL operated three types of seepage pits (Reactor Pits, Chemical Pits, and Laundry/Decontamination Pits).

The reactor pits were used for the dispersal of large volumes of contaminated process water associated with reactor operations at CRL. Since 1998, no liquids have been diverted to the reactor pits.

The chemical pits were used for the dispersal of the liquid waste from the chemical laboratories located at the CRL. The chemical pits are currently primarily in a standby state because almost all of the chemical laboratories waste has been treated by the WTC.

The laundry/decontamination pit was used for waste water from the Active Area laundry, but was only employed for that purpose in the first year after its construction in 1956. It was used only intermittently thereafter and was eventually taken out of service in 1958.

9.6.10 Emergency Storage Basin

The Emergency Storage Basin was built in the summer of 1960. The pit was constructed as a temporary holding facility for any contaminated water generated in a major accident at a reactor site. To date, the Emergency Storage Basin has not been used, and, therefore, there is no inventory or hazard associated with this facility.

9.6.11 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 concentrated tenfold by evaporation. 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.

9.6.12 Acid, Chemical, and Solvent Pits

In 1982, a separate area to the north of WMA C was fenced off, and a series of three pits—one each for the dispersal of inactive chemicals, acids, and solvents—were dug in the area. The acid, chemical, and solvent pits were used up to 1987.

9.6.13 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*.

9.6.14 Thorium Nitrate Pit

In 1955, about 20 cubic metres 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 1.85×10^{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.

9.6.15 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), based on nepheline syenite, 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.

9.6.16 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) or practices that are currently being phased out. The contaminant releases are either dispersed off-site, into the atmosphere, or into a major water body or retained on-site in soils, sediment, water systems, or biota. 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 in order that the situation will be investigated promptly.

9.7 CRL Waste Treatment Centre (WTC)

The WTC is located within the Controlled Area at the CRL. The WTC was built for the development and implementation of an integrated waste processing system capable of converting both liquid and solid wastes to a stable, compact form. The WTC is capable of processing more than 23,000 cubic metres of low-level radioactive liquid waste per year.

The processes applied include

- filtration;
- oil/water separation;
- evaporation;
- vapour entrainment;
- dry vapour compression; and
- condensate solidification in bitumen.

The low-level radioactive solids are currently volume reduced by compaction. Once the segregated solid waste has been compacted into bales, with a typical volume reduction of seven to one, the bales are transported to WMA B and stored in the cylindrical bunkers.

In 1998, AECL proposed to upgrade the WTC in two phases, in order to increase the treatment capacity and efficiency of the facility. The completed upgrades would permit the reliable treatment of the low-

level liquid wastes generated at CRL, including the wastes currently discharged to the on-site Liquid Dispersal Area, the water contained in the NRX spent fuel storage bays, and the liquid wastes currently stored in various tanks at the CRL. The completed upgrades to the WTC would result in an approximate sevenfold increase in treatment capacity.

The upgraded facility is to consist of a liquid waste evaporator system followed by an emulsified bitumen solidification system, with a micro-filtration and reverse osmosis system to back up the evaporator and provide effluent polishing on an as-needed basis. Phase 1 consists of installing and commissioning the liquid waste evaporator. Phase 2 consists of replacing the existing micro-filtration and reverse osmosis system, and upgrading the existing emulsified bitumen solidification system. AECL has completed Phase 1. Phase 2 is planned to begin at a later date.

9.8 AECL Whiteshell Laboratories (WL)

WL has provided research facilities for the Canadian nuclear industry since the early 1960s. In 1997, AECL decided to discontinue research programs and operations at WL. In 1998, the Canadian federal government concurred with the decision to decommission the WL. In 1999, AECL began to prepare plans for the safe and effective decommissioning of the WL.

Before the responsible federal authorities could permit the WL Decommissioning Project to proceed, the results of an environmental assessment prepared pursuant to the CEAA was required to be approved by the Minister of the Environment. Following the issuance of this approval in 2002, a six-year Decommissioning Licence for the first stage of site decommissioning was granted. This process is currently undergoing.

The following is a list of the facilities that will be decommissioned:

- Nuclear Facilities
 - o Shielded Facilities
 - o Van de Graaff Accelerator
 - o Neutron Generator
 - o Active Liquid WTC
 - o Whiteshell Reactor-1
 - o Concrete Canister Storage Facility
 - o WMAs
- Radioisotope Facilities
 - o Research and Development Laboratories
 - o Decontamination Centre
 - o Biomedical Research Laboratories
- General Infrastructure
 - o Non-nuclear Buildings
 - o Landfill
 - o Sewage Lagoon
 - o Buried Services
 - o Contaminated lands

The proposed WL Decommissioning Project will be implemented through a phased approach preceded by operational shut down work. 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 will be 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 fulfil 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.

9.9 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 cubic metres of radioactive waste per month.

ANNEX 10

URANIUM MINE AND MILL FACILITIES

10.1 Background

The first uranium mine in Canada began operation 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 development of a uranium mine in the Beaverlodge area of northern Saskatchewan, 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. 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 centres 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 in a standby mode and Cigar Lake currently under development. Uranium mills and tailings exist at Cluff Lake and McClean Lake, as well as at Rabbit Lake and 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 at the Key Lake mill.

10.2 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.

10.3 Operational Tailings Management

10.3.1 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 concluded at the end of 2002; and
- sites of planned future production at Cigar Lake and Midwest.

The new sites include the highest grade uranium ore bodies in the world (at McArthur River and Cigar Lake) with grades ranging up to 30 per cent uranium. In addition, some of the Athabasca Basin ores may be high in nickel and arsenic content (up to 5 and 1 per cent, respectively), which introduces additional considerations into the management of tailings and waste rock resulting from these ores.

Mills with 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 Cigar Lake or Midwest, since the ores will be transported to McClean Lake for processing, with some processing activities for Cigar Lake ore also planned for Rabbit Lake. With the end of production resulting from the depletion of the ore bodies at Cluff Lake, milling and tailings management activities will be continued at 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 from 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 after that time.

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 for the future.

10.3.2 Key Lake Tailings Management

The purpose of tailings management at Key Lake is to isolate and store the waste residue from the milling process, so that people 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 a surface TMF covering an area 600 metres by 600 metres, and 15 metres deep.

The tailings facility 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.

The mined-out Deilmann open pit is now used as a tailings facility. It was commissioned in January 1996 to store the remainder of the Key Lake tailings as well as ongoing McArthur River tailings.

This tailings facility has a bottom drainage layer, and was constructed in the basement rock of the mined-out pit. Tailings are deposited on top of this drainage blanket, which is pumped out to promote solid consolidation of tailings above it.

The subaqueous deposition process consists of flooding the TMF with water. Through the use of a tremie pipe system, tailings are deposited below the tailings surface under the water cover.

In this system, tailings are placed in a highly permeable envelope of crushed rock and sand in the mined-out pit. 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 and tailings are collected for treatment. The consolidated tailings become a low-permeability mass contained in a permeable envelope. After decommissioning, groundwater will take the path of least resistance (i.e., around the tailings, rather than through them). This minimizes environmental impacts.

10.3.2.1 Decommissioning

The operator has committed to continually monitor and sample the site to ensure that the environment is effectively protected prior to regulatory release. Areas no longer in use are landscaped and revegetated to return them as closely as possible to their predevelopment state.

Open Pits—When the Gaertner and Deilmann pits were developed, the lakes overlying the ore bodies were dewatered, lowering the groundwater levels by up to 50 metres at Gaertner and 80 metres at Deilmann. Now that the Gaertner ore body is depleted, the water level is being restored in the pit, a process which will continue until 2005. Segregated nickel-rich waste rock generated during the mining of the Deilmann pit was relocated into the Gaertner pit prior to flooding. The objective is to minimize waste rock oxidation, which could lead to excessive nickel leaching.

Deilmann Open Pit Tailings Facility—When it is ready to be decommissioned, the tailings surface will be covered with clean material and groundwater will be allowed to rise to its natural levels. Surrounding waste rock piles will be contoured and covered as necessary to manage seepage quality and quantity.

Key Lake Tailings Management Facility—An engineered cover will be placed over the original tailings facility and vegetated. The cover will ensure long-term integrity and effective drainage of surface run off.

10.3.3 Rabbit Lake Tailings Management

The Rabbit Lake mine site has had three distinct eras. Originally a fairly large deposit was mined from Rabbit Lake. This was followed by extraction of uranium from three smaller open pit mines that were located along the shoreline of the much larger Collins Bay of Wolloston Lake. Finally, an underground mine (Eagle Point) was developed underneath Collins Bay.

The tailings from the mill are currently deposited in the mined-out original Rabbit Lake pit using the pervious surround method of tailings management previously described for Key Lake.

The pit floor and wall is lined with crushed rock and sand. Once the tailings are placed in the pit, water from the tailings is pumped out and returned to the mill for use in the process. Self-weight and ongoing dewatering below the tailings ensures that the tailings become compacted.

When the pit is filled, the tailings will be covered with a layer of sand and crushed rock, and the lake's water level will be restored. The compacted tailings will thus remain safely in the pit, below the bottom of the lake.

Groundwater will follow the path of least resistance and flow through the crushed rock and sand but not through the compacted tailings. As a result, the groundwater will not be contaminated because it flows around the tailings. The results of environmental monitoring, after more than a decade of operation, show this disposal system is performing well, as predicted.

Prior to conversion of the original Rabbit Lake open pit to a TMF, tailings were placed in a conventional surface impoundment. This involved construction of two dams at either end of the small valley used to contain the tailings solids.

10.3.3.1 Decommissioning

The conceptual decommissioning scenarios listed below are not final. They may change as detailed engineering is completed and regulatory approvals are granted.

Rabbit Lake Open Pit Tailings Facility—The open pit tailings facility will be capped with clean material once the tailings are fully consolidated. Water will then be allowed to return to natural pre-mining lake levels (the ore body being below the natural lake level).

Original Rabbit Lake Tailings Management Facility—Approximately 600,000 cubic metres of soil fill have been deposited on top of the tailings. A contoured cap will be placed over the facility once the tailings are consolidated and the surface will be vegetated. The cap will ensure long-term integrity and effective drainage of surface runoff. The tailings dams have already been subjected to remedial measures to ensure long-term stability.

Collins Bay Zones—Special waste was placed in the bottom of the mined-out open pits and covered with clean till. The pits were then re-flooded. The remaining waste stockpiles will be contoured and revegetated. The dams isolating the flooded pits from Collins Bay will be opened to allow the free exchange of water.

Eagle Point—All special waste and as much waste rock as is feasible, will be returned underground at Eagle Point as fill. Surface areas will be contoured and vegetated.

Waste Rock—Inventories of waste rock are situated in the vicinity of the original Rabbit Lake pit, and near one of the Collins Bay flooded open pits. The waste rock near the Rabbit Lake pit is relatively free of

mobile secondary contaminant leachate, whereas the Collins Bay rock pile leachate contains the signature arsenic and nickel found in many of Saskatchewan's Athabaska Basin uranium deposits. In both cases, the combination of recontouring soil cover and revegetation will be used to generate a low flux of contaminant seepage from the rock piles.

10.3.4 McClean Lake Tailings Management

McClean Lake is the first new uranium mill constructed in North America in 15 years, and the mill and TMF represent the state-of-the-art in worker and environmental protection for processing high grade uranium ore. The mill had an initial design capacity of 6 million pounds U_3O_8 annually, which has been updated to 8 million pounds, based on its initial performance. The mill will be further expanded to process ores from the Cigar Lake and Midwest projects in the future.



Photo courtesy of Cogema.

McLean (JEB) mill with one stockpile to the left, JEB TMF in the foreground and the camp to the right.



Photo courtesy of Cogema.

JEB TMF with the walkway tailings placement barge. The JEB mill is at the top of the photo.

Open pit mining of the initial ore body (JEB ore body) began in 1995. Once 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 of the environment both during operation and in the long-term. Key features include the following:

- 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 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 containment for the JEB pit hydrogeological conditions.
- 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 shielding from the water cover.
- 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 water from the TMF to the mill.
- Complete backfilling of the pit, upon decommissioning, with clean waste rock and a till cap.

10.3.4.1 Decommissioning

The objective is to return the site to as close to its original state as possible, in a manner that both protects the environment and allows traditional uses such as fishing, trapping, or hunting to be safely carried out. In addition to dismantling and disposing of the mill and other industrial facilities, and landscaping and revegetating disturbed areas, the TMF and waste rock disposal sites will be closed out and reclaimed.

10.3.4.2 Tailings Management Facility

The maximum depth of tailings will be at, or below, the interface between the sandstone and the overlying soil overburden. That is, the tailings will remain surrounded by the sandstone formation. Pumping from the perimeter and raise wells, as well as treatment of contaminated water, will continue until the tailings are fully consolidated. The wells will then be shut down and a cover placed on the tailings. Final decommissioning will consist of backfilling the pit completely with waste rock (approximately 10 metres in depth), followed by a layer of overburden that will consolidate the tailings further and provide shielding to establish conditions comparable to those that existed prior to development. The surface will then be revegetated. Over time, the natural groundwater flow system in the sandstone formation will be re-established.

10.3.4.3 Waste Rock

Waste rock disposal takes place in two ways. Most of the waste rock is sandstone containing no mineralization, having no potential to cause leachates that are acidic or elevated in heavy metal concentrations (or both), and posing no risk or hazard for future use. Two large surface stockpiles of this type of rock, from the JEB and Sue C open pit mines, will be decommissioned by resloping the piles for long-term stability, and then revegetating.

Special waste rock, which contains some mineralization, but which contains uranium at less than the ore grade cut-off, is segregated from the clean waste rock during mining and stored for future disposal. Exposure of this rock to atmospheric oxygen in the presence of moisture may, over time, result in chemical reactions that produce leachates that are acidic or elevated in heavy metal concentrations (or both). Disposal under water (subaqueous disposal) effectively stops the formation of the leachates by excluding oxygen from the reaction process. Special waste rock mined from the JEB and Sue C pits has been backhauled into the Sue C pit, and the pit is now partially re-flooded. The water level will be drawn down and additional waste rock added, on a campaign basis, in the future. Upon completion of waste rock disposal in Sue C pit, a layer of till will be added to isolate the waste rock. The pit will gradually re-flood to the natural water level, leaving a small lake meeting all surface water quality criteria.

10.3.5 Cluff Lake Tailings Management

Uranium production started at Cluff Lake in 1981, and was completed at the end of 2002, with more than 62 million pounds of U_3O_8 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 is now carrying out cleanup work while regulatory approvals for decommissioning are acquired. The environmental assessment of the proposed decommissioning plan, a prerequisite under the CEAA prior to issuance of a decommissioning licence by the CNSC, is expected to be concluded by mid-2003.



Cluff Lake mill with the TMA in the background.

Photo courtesy of Cogema.

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. Liquids collect in the decant area, where further solids are allowed to settle out. Liquids from the decant area, and raffinate from the tailings thickener in the mill or pumped water from the pits and mines, is fed to the first stage water treatment plant. BaCl_2 and $\text{Fe}_2(\text{SO}_4)_3$ 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. The final discharge water quality is generally in the range of 0.01-0.05 Bq/L of radium-226, well below the surface water quality objective of 0.11 Bq/L established by the regulatory agencies.

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.

10.3.5.1 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. In addition to dismantling and disposing of the mill and other industrial facilities, and landscaping and revegetating disturbed areas, the TMA and mining area will be closed and reclaimed.

10.3.5.2 Tailings Management Area (TMA)

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 recontouring and vegetated cover will promote runoff of rainfall and snowmelt, as well as evapotranspiration 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.

10.3.5.3 Mining Area

Mining involved four open pits and two underground mines. One open pit (“D” pit) and its associated waste rock pile were reclaimed over 10 years ago. Water quality data from the flooded pit show no further work is required, and native species of vegetation have re-established on the waste rock pile. Two of the other open pits have been used for waste rock disposal during mining. 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 vegetating the areas.
- Re-contouring and covering the waste rock with till in another open pit (DJN pit) and then allowing this pit and a contiguous DJN 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 resloping for long-term stability, compacting the waste rock surface, and placing a till cover and vegetating.
- Re-contouring and revegetating disturbed areas with native species.

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 longterm performance.

10.4 Historical Idle/Decommissioned Tailings Facilities

10.4.1 Saskatchewan

There are three inactive uranium sites in Saskatchewan. The Beaverlodge operation was shut down in 1982 and decommissioned in 1985. Cameco Corporation is currently conducting post-decommissioning monitoring and site evaluation of the Beaverlodge facilities under CNSC licence.

The Lorado and Gunnar sites have been closed since 1960 and 1964 respectively, and have not been adequately decommissioned. Some decommissioning activities were conducted at the Gunnar site in the early 1990s. These sites have not yet been brought under CNSC licence.

10.4.2 Northwest Territories

There are two inactive uranium sites in the Northwest Territories. Mining at the Port Radium site occurred from 1933 to 1940, from 1942 to 1960, and finally from 1964 to 1982 to recover silver. The site was partially decommissioned in 1984. In 2000, the federal government signed a partnership agreement with the local community to discuss measures to be taken at the site.

Uranium mining and milling occurred at the Rayrock site from 1957 until 1959, at which time it was abandoned. Indian and Northern Affairs Canada began decommissioning and rehabilitating the Rayrock site, including capping the tailings, in 1996. Performance monitoring of the Rayrock site began in 1996.

10.4.3 Ontario

10.4.3.1 Elliot Lake Area

There are 12 inactive uranium mines and 10 inactive uranium tailings sites in and around Elliot Lake, Ontario (some of the mines utilized other mills or tailings disposal areas). The tailings disposal areas are referred to as waste management areas (WMAs) by Rio Algom Ltd., and TMAs by Denison Mines Ltd.

Rio Algom Ltd. is responsible for the Quirke, Panel, Spanish American, Stanleigh, Lacnor, Nordic, Buckles, Pronto and Milliken mines, whereas Denison Mines Ltd. is responsible for the Denison and Stanrock/Can-Met mines.

Decommissioning of the Stanleigh, Quirke and Panel and the Stanrock/Can-Met and Denison uranium mining facilities was essentially completed by the end of 1999. Site decommissioning is governed by the *Uranium Mine and Mills Regulations* under the NSCA. All five sites have CNSC Mine Facility Decommissioning Licences. Most, if not all, of the major site decommissioning and reclamation has been completed at all of these sites. The WMAs/TMAs have been stabilized and contained, and most have been flooded. Tailings at the Stanrock TMA have been saturated to reduce acid generation but have a dry cover. These areas will continue under interim monitoring and active management until effluent meets discharge criteria without treatment. Long-term monitoring with care and maintenance will follow.

Rio Algom Ltd.'s six other Elliot Lake mine facilities (Spanish American, Lacnor, Nordic, Bucles, Pronto and Milliken) were reclaimed about 30 years ago, prior to the establishment of the current legal framework for mine closure and decommissioning. Since nuclear substances are present at these sites, they are licensed as a waste management facility.

Between 1992 and 1997, Rio Algom Ltd. upgraded these facilities to meet current requirements. Upgrading was completed at all sites except Pronto, where revegetation of the WMA continues. The Spanish American WMAs has been flooded, whereas tailings at Nordic and Pronto are contained in dry, vegetated WMAs and Lacnor tailings have been partially flooded.

All of the Elliot Lake tailings sites have effluent water treatment plants that generally employ barium chloride and lime to remove radium and neutralize pH. Discharges to the environment are monitored on a continuous basis and meet water quality objectives.

The Agnew Lake Mine near Espanola, Ontario, ceased operation in 1983. The site was decommissioned and monitored by Kerr Addison Mines from 1983 until 1988. The site was turned over to the Province of Ontario in the early 1990s.

10.4.3.2 Bancroft Area

Inactive uranium tailings sites also exist in the Bancroft, Ontario area at the Madawaska/Faraday, 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. EnCana Ltd. has completed decommissioning activities at the Madawaska and Dyno mine sites. Lac Properties Inc. has completed decommissioning activities at the Bicroft Mine. The Madawaska site has a decommissioning licence from the CNSC. The site has been decommissioned and is managed and monitored by EnCana Ltd. The Dyno and Bicroft sites are being brought under CNSC licence. Effluent discharges from the tailings areas at the three Bicroft sites meet water quality objectives and there is no active water treatment.

10.5 Historic Contaminated Land Sites

10.5.1 Overview

Over 200 small contaminated sites resulting from past practices in the historic radium and uranium industries exist in three general locations across Canada. The majority of these are in Port Hope, Ontario. Five exist in Toronto while six exist along the Northern Transportation Route (NTR) in the Northwest Territories.

All of these sites are considered historic waste sites. Historic waste is defined as low-level radioactive waste that was managed in the past in a manner no longer considered acceptable but for which the original producer cannot reasonably be held responsible, and for which the federal government has accepted responsibility.

10.5.2 Port Hope Contaminated Sites

Numerous mildly contaminated sites have been identified in the Town of Port Hope. These sites include consolidation mounds resulting from road construction, sediments in the Port Hope harbour, small isolated pockets of mildly contaminated soil on private properties, and other small areas of mildly contaminated soil on town properties. The LLRWMO has been taking possession of any radiologically contaminated material generated by ongoing construction and renovation activities in Port Hope. This material has been moved to a licensed storage facility.

10.5.3 Toronto Area Contaminated Sites

Toronto area contaminated sites include

- radium contaminated soils on lands owned by the Province of Ontario;
- Toronto Region Conservation Authority and private landowners; and
- radium contamination fixed to structural elements in privately owned buildings.

The contaminated soils are generally covered and occur in areas of low use (primarily open space).

10.5.4 Fort McMurray Waterways Site

The Fort McMurray Waterways Site was the southernmost terminus of the NTR from the mines at Port Radium. It was at this site that uranium ore was off-loaded and transferred to trains for transport to Port Hope for processing. The site is currently fenced open land, and is monitored.

ANNEX 11

ENVIRONMENTAL ASSESSMENT FOR THE DARLINGTON USED FUEL DRY STORAGE FACILITY

1.0 PURPOSE

The purpose of this document is to provide guidance on the scope of the environmental assessment (EA) that will be conducted on the proposed construction and operation of the Darlington Used Fuel Dry Storage facility at the Darlington Nuclear Generating Station (DNGS) site. A federal environmental assessment is required under the provisions of the *Canadian Environmental Assessment Act* (CEAA). Under the CEAA, the scope of the project and the scope of the factors included in the assessment are determined by the Responsible Authority (RA), in this case, the Canadian Nuclear Safety Commission (CNSC).

The EA Guidelines describe the basis for the conduct of the EA and focus the assessment on relevant issues and concerns. This document also provides specific direction to the proponent, Ontario Power Generation (OPG), on how to document the technical environmental assessment study which will be delegated to OPG by Canadian Nuclear Safety Commission staff pursuant to subsection 17(1) of the CEAA. Finally, the EA Guidelines provide a means of communicating the environmental assessment process to stakeholders.

2.0 BACKGROUND

Ontario Power Generation has submitted notice of intent to the Canadian Nuclear Safety Commission of their intention to apply for authorization to construct and operate a used fuel dry storage facility at the DNGS site. A project description document for the proposal has been submitted to the Canadian Nuclear Safety Commission by OPG.

The Darlington Used Fuel Dry Storage (DUFDS) facility, if approved, would be licenced by the Canadian Nuclear Safety Commission as a Class I B Nuclear Facility under the *Nuclear Safety and Control Act* (NSCA). The siting and construction of the DUFDS would be authorized by the Canadian Nuclear Safety Commission through the issuance of a licence to construct, under subsection 24(2) of the NSCA. Subsequent operation of the facility would also require authorization by the Canadian Nuclear Safety Commission, through the issuance of a licence to operate under subsection 24(2) of the NSCA.

The environmental assessment will provide part of the information that the Canadian Nuclear Safety Commission will use in considering Ontario Power Generation's application to construct the DUFDS facility. The application will also be subjected to a thorough evaluation under the provisions of the NSCA and its regulations. That includes a detailed safety review as part of the Canadian Nuclear Safety Commission licensing process which provides the public with opportunities to input to the Commission prior to any licensing decision on the DUFDS facility being made.

3.0 APPLICATION OF THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT

Canadian Nuclear Safety Commission staff have determined, pursuant to paragraph 5(1)(d) of the CEAA, that a federal environmental assessment is required before it can provide Ontario Power Generation with an authorization to construct and operate the Darlington Used Fuel Dry Storage facility. The Canadian

Nuclear Safety Commission is a responsible authority under CEAA for the purposes of the assessment. With the promulgation of the NSCA, amendments to the regulations under the CEAA are needed to replace references to the *Atomic Energy Control Act* and its regulations by appropriate reference to the provisions of the NSCA. Pending completion of the amendment process by the Canadian Environmental Assessment Agency (Agency), section 44 of the *Interpretation Act* deems references to the former legislation to be references to the analogous provisions of the NSCA.

In this case, the former provision authorizing the construction of waste facilities for a nuclear facility was section 10 of the *Atomic Energy Control Regulations*, which is listed as a “trigger” for an assessment under the *Law List Regulations* of the CEAA. Reading the NSCA in analogous fashion, the proposal to construct the DUFDS is a “trigger” for the CEAA under the *Law List Regulations*, given that section 10 is cited in those regulations and appears in analogous provisions of the NSCA.

There are no other CEAA “triggers”, such as funding, being a proponent or disposing of an interest in land to support the proposed project, that involve the Canadian Nuclear Safety Commission.

The proposed licensing action would involve authorization of activities relating to a physical work, namely the construction of the Darlington Used Fuel Dry Storage (DUFDS) facility, and thus there is a “project” for the purposes of the CEAA. There are no identified exclusions from environmental assessment for the project pursuant to section 7 of the CEAA and Schedule I of the *Exclusion List Regulations* of the CEAA. Accordingly, Canadian Nuclear Safety Commission authorization of the proposal to construct and operate the DUFDS facility will require that a federal environmental assessment be conducted pursuant to the CEAA.

The project is not of a type identified in the *Comprehensive Study List Regulations* of the CEAA. The facility is proposed to be located entirely within the licenced area of the DNGS. At this time, Canadian Nuclear Safety Commission staff is not aware of any potential significant adverse environmental effects or public concerns associated with this project which would warrant a need to have it referred to a mediator or review panel pursuant to section 25 of the CEAA. Thus, pursuant to subsection 18(1) of CEAA, the Canadian Nuclear Safety Commission is required to ensure the conduct of a screening environmental assessment of the project and the preparation of a screening report before the proposed licensing decision can be made pursuant to the NSCA.

4.0 IDENTIFICATION OF OTHER FEDERAL AND PROVINCIAL EXPERT DEPARTMENTS

The Canadian Nuclear Safety Commission is currently the only responsible authority under the CEAA that has been identified for this environmental assessment.

Pursuant to the *Federal Coordination Regulations of CEAA*, Health Canada, Environment Canada, Natural Resources Canada, and the Department of Fisheries and Oceans have been identified as expert Federal Authorities (FA) for the purpose of providing expert assistance during the environmental assessment. Indian and Northern Affairs Canada has indicated that they do not have a role in the assessment, but that they would like to have Aboriginal groups including the Métis Nation of Ontario, Alderville, Chippewas of Georgian Island, Hiwatha, Curve Lake, Mississaugas of Scugog Island and Mississaugas of New Credit consulted during the process.

Canadian Nuclear Safety Commission staff has confirmed with the Ontario Ministry of the Environment (OMOE) that there are no provincial environmental assessment requirements under the Ontario *Environmental Assessment Act* that are applicable to the proposal. Canadian Nuclear Safety Commission staff will continue to consult with the OMOE and the Ontario Ministry of Natural Resources throughout the environmental assessment.

5.0 DELEGATION OF ASSESSMENT STUDIES TO ONTARIO POWER GENERATION

Canadian Nuclear Safety Commission staff, pursuant to subsection 17(1) of the CEEA, will be delegating to Ontario Power Generation the conduct of technical support studies for the environmental assessment, as well as a public consultation program and the preparation of an EA study report.

The technical EA study report will be reviewed by Canadian Nuclear Safety Commission staff and the expert federal and provincial authorities. Once accepted, it will be used by Canadian Nuclear Safety Commission staff as the basis for the preparation of the screening report under the CEEA for this project.

6.0 PUBLIC REGISTRY

Canadian Nuclear Safety Commission staff have established a public registry for the assessment as required by section 55 of the CEEA. This includes identification of the assessment in the *Federal Environmental Assessment Index* (FEAI), which can be accessed on the Web site of the Agency (www.ceaa.gc.ca). The FEAI number for this project is 29276.

As part of the registry, Canadian Nuclear Safety Commission staff must also maintain a list of documents pertaining to the environmental assessment. Interested parties may obtain copies of specific documents on the list by contacting the Canadian Nuclear Safety Commission (see Section 11.0 - Contacts for the Assessment).

7.0 SCOPE OF THE PROJECT

In establishing the scope of a project for an assessment under the CEEA, the physical works (e.g., facilities) that are involved in the proposal and the specific undertaking that will be carried out in relation to those physical works must be determined. The physical works involved in this project are the processing and storage buildings for the dry storage containers and all facilities, systems and activities required for the construction and operation of the DUFDS facility. A preliminary decommissioning plan for the DUFDS facility will be included in the assessment.

Associated operations and activities that are within the scope of the project include:

- transfer of used fuel bundles from the DNGS water-filled irradiated fuel bays (IFBs) into dry storage containers (DSCs);
- in-station modifications, consisting of necessary modifications to the irradiated fuel bays and systems for loading used fuel into dry storage containers at the DNGS;
- preparation of the site and construction of the DUFDS facility, consisting of DSCs processing systems and storage buildings and services;
- receipt of new (empty) dry storage containers from the manufacturer;
- transfer of empty and loaded DSCs between the DNGS and the new DUFDS facility, entirely within the licenced area of the DNGS;
- operation of the DUFDS facility;
- facilities and systems for maintaining security of the site with the exception of prescribed information.

The purpose of the proposed project, as described in the Project Description (reference 1), is to provide the capacity for interim storage of DNGS used fuel until a long-term management facility becomes available. The long-term management of radioactive waste, including irradiated nuclear fuel, is being developed through separate federal legislation. No final options or sites have been defined or approved as

yet. Consequently, it is premature to examine long-term waste management alternatives as part of the scope of this project. Provision of national long-term waste disposal facilities is not within the scope of the DUFDS facility environmental assessment.

8.0 FACTORS TO BE CONSIDERED IN THE SCREENING

The scope of the screening assessment under the CEAA must include all the factors identified in paragraphs 16(1)(a) to (d) of the CEAA and, as provided for under paragraph 16(1)(e), any other matter that the Canadian Nuclear Safety Commission requires to be considered. Paragraphs 16(1)(a) to (d) require that the following factors be included in the screening:

- the environmental effects (see Section 14.0 – Glossary of Terms) of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- the significance of the effects identified above;
- comments from the public that are received in accordance with the CEAA and its regulations; and
- measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project.

In accordance with subsection 16(1)(e) of the CEAA, the Canadian Nuclear Safety Commission requires that the following additional factors be included in the environmental assessment:

- the purpose of the project;
- the need for, and requirements of, a follow-up program in respect of the project; and
- the capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future.

Additional or more specific factors and issues to address in the EA may be identified following consultation with the expert federal authorities and other stakeholders during the conduct of the EA.

9.0 ASSESSMENT METHODOLOGY

9.1 Structure of the Screening Report

A recommended structure for the screening report that is to be prepared for this project is provided below as a framework for explaining how the assessment factors are to be systematically considered in the screening study. Information about the project and the existing environment is necessary to permit that consideration, and the results of that consideration will be documented in the screening report to be prepared by Canadian Nuclear Safety Commission staff.

The parts of the assessment that will be delegated to Ontario Power Generation, pursuant to subsection 17(1) of the CEAA, are to be documented in the form of a technical EA study report in a manner consistent with this structure. That technical EA study report will be attached to the screening report as a support document.

Section Headings for the Screening Report:

- ii. 1) Introduction
- iii. 2) Application of the CEAA
- iv. 3) Scope of the Project
- v. 4) Scope of the Assessment

- vi. 5) Purpose of the Project
- vii. 6) Project Description
- viii. 7) Spatial and Temporal Boundaries of the Assessment
- ix. 8) Description of the Existing Environment
- x. 9) Assessment and Mitigation of Environmental Effects
 - description of assessment methodology
 - effects of construction
 - effects of normal operations, malfunctions and accidents, and external natural hazards
- xi. 10) Cumulative Environmental Effects
- xii. 11) Significance of Residual Effects
- xiii. 12) Stakeholder Consultation
- xiv. 13) Follow-up Program
- xv. 14) Conclusions and Recommendations for Decision
- xvi. 15) References

9.2 Specific Information Requirements

9.2.1 Purpose of the Project

The screening report will include a clear statement of the purpose of the DUFDS project. In this case, the purpose of the DUFDS project is to store used fuel bundles from the Darlington Nuclear Generating Station for an interim period, pending availability of a long-term management facility. The purpose of the screening is to determine if the proposed construction and operation of the DUFDS facility is likely to cause significant environmental effects.

9.2.2 Project Description

An adequate description of the project is necessary to permit a reasonable consideration in the screening of the environmental effects of the project. The main objective of the project description is to identify and characterize those specific project components and activities that have the potential to interact with, and thus result in a likely change or disruption to the surrounding environment, during construction and normal operations and during malfunctions and accidents.

The description of the project will refer to, and elaborate upon, the items identified in the project scope, supported with appropriate maps and diagrams. The description of the project will include a proposed schedule for the construction and operation of the DUFDS facility.

The following information will be provided in summary form; where applicable, reference may be made to more detailed information:

General Information, Design Characteristics and Normal Operations:

- the location of the project;
- the design and manufacturing of the dry storage containers;
- the basic layout and design and operation of the storage facility;
- the size of the used fuel dry storage facility based on projection of used fuel volumes which are expected to arise from the operation of DNGS;
- necessary modifications to the irradiated fuel bays and systems to load fuel into the dry storage containers at the DNGS;
- a description of the transporter used to transfer the loaded containers to the DUFDS facility;
- any necessary site road upgrades;
- site preparation and construction activities;

- the key components of the facility and its physical security systems (excluding prescribed information) that are relevant to the management of malfunctions and accidents that may occur during operation;
- the key components associated to operational contingencies;
- the inventories of nuclear substances to be stored at the facility, including locations and storage methods;
- the sources, types and quantities of any radiological and non-radiological waste predicted to be generated by the project;
- the on-site processes for the collection, handling and disposing of any radioactive and non-radioactive wastes to be generated by the project;
- the sources, quantities and points of release from the project of routine radiological and non-radiological emissions and effluents, including water and stormwater;
- the sources and characteristics of any noise, odour, dust and other likely nuisance effects from the project;
- the sources and characteristics of any potential risks to workers, the public or the environment from the project;
- a description of the relevant organizational and management structure, and staff qualification requirements, with emphasis on safety and environmental management programs;
- key operating procedures relevant to protection of workers, the public and the environment relating to the project;
- the source and characteristics of any fire hazards; and
- predicted dose to workers involved with the associated operations and activities that are within the scope of this project.

Malfunctions and Accidents

Information on project malfunctions and accidents is also necessary to permit consideration of relevant potential environmental effects in the screening. The information on malfunctions and accidents will include:

- a description of specific, important malfunction and accident events that have a reasonable probability of occurring during the life of the DUF DS project, including an explanation of how those events were identified for the purpose of this environmental assessment;
- a description of the source, quantity, mechanism, rate, form and characteristics of contaminants and other materials (physical, chemical and radiological) likely to be released to the surrounding environment during the postulated malfunction and accident events; and
- a description of any contingency, clean-up or restoration work in the surrounding environment that would be required during, or immediately following, the postulated malfunction and accident events.

Assessment of Siting Alternative

The environmental assessment will be based on a preferred site, identified in the Project Description (reference 1) as Site “B”. Following the assessment of the preferred site, the differential effects of locating the project on alternative sites, identified in the Project Description (reference 1) as Sites “A”, “C” and “D”, will be assessed. The environmental assessment will therefore take into account the potential environmental effects associated with all four siting options. The assessment of the differential effects may involve a qualitative, as well as a quantitative analysis.

Preliminary Decommissioning Plan

A preliminary decommissioning plan of the facility will be included in the assessment. The plan will document, as appropriate, the preferred decommissioning strategy and end-state objectives; the major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; and an overview of the principal hazards and protection strategies envisioned for decommissioning. However, as indicated in section 7.0, long term waste management options will not be included. The long-term management of radioactive waste, including irradiated nuclear fuel, is being developed through separate federal legislation.

9.2.3 Spatial and Temporal Boundaries of the Assessment

The consideration of the environmental effects in the screening needs to be conceptually bounded in both time and space. This is more commonly known as defining the assessment *study areas* and *time frames*, or spatial and temporal boundaries of the screening.

The geographic study areas for this screening must encompass the areas of the environment that can be reasonably expected to be affected by the project or which may be relevant to the assessment of cumulative environmental effects. Study areas will encompass all relevant components of the environment including the people, land, water, air and other aspects of the natural and human environment. Study boundaries will be defined taking into account ecological, technical and social/political considerations.

The following geographic study areas will be considered for general planning purposes:

- *Site Study Area*: the property on which the facility is located and under the control of Ontario Power Generation. See Figure 1.
- *Local Study Area*: the Local Study Area is defined as that area existing outside the site boundary, where there is a reasonable potential for immediate impacts due to either ongoing normal activities or to accidents or malfunctions. The Local Study Area is tentatively defined as the area within the municipality of Clarington as outlined on the attached map (see Figure 2) and the area of Lake Ontario that may be impacted due to the facility. The boundaries may change following a preliminary assessment of potential impacts.
- *Regional Study Area*: the Regional Study Area is defined as the area wherein there is at least the potential for cumulative environmental effects, and is bounded by the Durham County line in the west, Highway 28 in the east, and Highways 47 and 7A in the north, together with the immediate area of Peterborough and near shore areas and those areas of Lake Ontario where there is a potential for cumulative impacts. This area is clarified on the attached map (see Figure 3).

The temporal boundaries for this assessment must establish over what period of time the project-specific and cumulative effects are to be considered. The initial time frame for the assessment will be the duration of the project; that is, the construction and planned operational life of the DUFDS facility. A time frame appropriate for describing the extent of the longer-term residual effects must be defined where the effects of the project are anticipated to continue beyond the operation of the facility (for example, as a result of environmental contamination from the project).

Both the study areas and time frames will remain flexible during the assessment to allow the full extent of a likely environmental effect to be considered in the screening.

9.2.4 Description of the Existing Environment

A description of the existing environment is needed to determine the likely interactions between the project and the surrounding environment; and likewise between the environment and the project. Both the biophysical environment and the socio-economic (human, cultural) environment are to be considered. An initial screening of likely project-environment interactions will be considered in identifying the relevant components of the environment that need to be described.

The general components of the environment that should be described in the various study areas include, but should not necessarily be limited to:

- meteorology and climate;
- air quality;
- noise;
- physiography and topography;
- soil quality;
- geology;
- seismic activity;
- hydrogeology;
- groundwater quality (physical and chemical);
- surface hydrology;
- surface water quality (physical and chemical);
- aquatic ecology; and
- terrestrial ecology.

The description of the human components of the above environment should include, but should not necessarily be limited to:

- population (including relevant demographic characteristics);
- economic base;
- community infrastructure and services;
- renewable and non-renewable resource use;
- existing and planned land use;
- health
- heritage, cultural or archaeological sites;
- recreation areas; and
- use of lands and resources for traditional purposes by aboriginal persons.

Valued Ecosystem Components (VECs) in the existing environment will be identified and used as specific environmental assessment end-points. VECs are environmental attributes or components identified as having a scientific, cultural, economic, human health or aesthetic value. The VECs proposed in the EA methodology for this project will be reviewed and accepted by Canadian Nuclear Safety Commission staff in the early phases of the EA study.

The required level of detail in the description of the existing environment will be less where the potential interactions between the project and various components of the environment are weak or remote in time and space.

Relevant existing information may be used to describe the environment. Where that information is significantly lacking, additional research and field studies may be required to complete the assessment. Any work being done by OPG to fill identified gaps in information will be reviewed by Canadian Nuclear Safety Commission staff as progress is being made.

9.2.5 Assessment and Mitigation of Environmental Effects

The consideration of environmental effects in the screening will be done in a systematic and traceable manner. The assessment methodology will be summarized. The results of the assessment process should be clearly documented using summary matrices and tabular summaries where appropriate.

Assessment of Effects Caused by the Project

The assessment will be conducted in a manner consistent with the following general method:

- 1) *Identify the potential interactions between the project activities and the existing environment during construction and normal operations, and during identified relevant malfunctions and accidents.*

Specific attention will be given to interactions with the identified VECs.

In this step, the standard design and operational aspects from the project description that prevent or significantly reduce the likelihood of interactions occurring with the environment should be reviewed. Opportunities for additional impact mitigation measures are addressed in step 3 below.

- 2) *Describe the resulting changes that likely would occur to the components of the environment and VECs as a result of the identified interactions with the project.*

Each environmental change must be described in terms of whether it is direct, indirect, positive or adverse.

Identified changes in socio-economic conditions and various aspects of culture, health, heritage, archaeology and traditional land and resource use may be limited to those that are likely to result from the predicted changes that the project is likely to cause to the environment. The consideration of public views, including any perceived changes attributed to the project should be recognized in the assessment methodology.

For each identified effect, the predicted magnitude, duration, frequency, timing, probability of occurrence, ecological and social context, geographic extent, and the degree of reversibility, should be considered in determining if it is a likely adverse effect.

Quantitative as well as qualitative methods may be used to identify and describe the likely adverse environmental effects. Professional expertise and judgement may be used in interpreting the results of the analyses. The basis of predictions and interpretation of results, as well as the importance of remaining uncertainties, will be clearly documented in the EA study report.

- 3) *Identify and describe mitigation measures that may be applied to each likely adverse effect (or sequence of effects), and that are technically and economically feasible.*

Mitigation strategies should reflect precautionary and preventive principles. That is, emphasis should be placed on tempering or preventing the cause or source of an effect, or sequence of effects, before addressing how to reverse or compensate for an effect once it occurs.

Where the prevention of effects cannot be assured, or the effectiveness of preventive mitigation measures is uncertain, further mitigation measures in the form of contingency responses, including emergency response plans, will be described.

Where cost/benefit analyses are used to determine economic feasibility of mitigation measures, the details of those analyses will be included or referenced.

- 4) *Describe the significance of the environmental effects that likely will occur as a result of the project, having taken into account the implementation of the proposed mitigation measures.*

The criteria for judging and describing the significance of the residual (post-mitigation) effects will include: magnitude, duration, frequency, timing, probability of occurrence, ecological and social context, geographic extent, and degree of reversibility. Specific assessment criteria proposed in the EA methodology for this project will be reviewed and accepted by Canadian Nuclear Safety Commission staff in the early phases of the EA study.

Existing regulatory and industry standards and guidelines are relevant as points of reference for judging significance. However, professional expertise and judgement should also be applied in judging the significance of any effect. All applicable federal and provincial laws must be respected.

The analysis must be documented in a manner that readily enables conclusions on the significance of the environmental effects to be drawn. The Canadian Nuclear Safety Commission, as the responsible authority for the EA project, must document in the screening report a conclusion, taking into account the mitigation measures, as to whether the project is likely to cause significant adverse environmental effects.

Assessment of Effects of the Environment on the Project

The assessment must also take into account how the environment could adversely affect the project; for example, from severe weather or seismic events.

This part of the assessment will be conducted in a step-wise fashion, similar to that described for the foregoing assessment of the project effects. The possible important interactions between the environment and the project will be first identified, followed by an assessment of the effects of those interactions, the available additional mitigation measures, and the significance of any remaining likely adverse environmental effects.

Assessment of Effects of the Project on the Capacity of Renewable and Non-Renewable Resources

The assessment must also take into account whether the likely project-related environmental effects will impact on the capacity of renewable and non-renewable resources to meet the needs of the present and those of the future.

The potential interactions between the project and the environment will be identified and assessed in order to determine the likelihood of interactions between the project and resource sustainability.

9.2.6 Assessment of Cumulative Effects

The effects of the project must be considered together with those of other projects and activities that have been, or will be carried out, and for which the effects are expected to *overlap* with those of the project (i.e., overlap in same geographic area and time). These are referred to as *cumulative environmental effects*.

An identification of the specific projects and activities considered in the cumulative effects will be included in the screening report. In general, the cumulative effects assessment will consider the combined effects of the project with the neighbouring or regional industries and other developments.

The information available to assess the environmental effects from other projects can be expected to be more conceptual and less detailed as those effects become more remote in distance and time to the project, or where information about another project or activity is not available. The consideration of cumulative environmental effects may therefore be at a more general level of detail than that considered in the assessment of the direct project-environment interactions.

Where potentially significant adverse cumulative effects are identified, the consideration of additional mitigation measures may be necessary.

9.2.7 Significance of the Residual Effects

The preceding steps in the screening will consider the significance of the environmental effects of the project on the environment, the natural hazards on the project, project malfunctions and accidents, and other projects and activities that could cause cumulative effects.

The screening will consider all of these effects in coming to a final conclusion as to whether the project, taking into account the mitigation measures, will likely cause significant adverse environmental effects. The Canadian Nuclear Safety Commission, as the responsible authority, will document this conclusion in the screening report.

9.2.8 Stakeholder Consultation

The assessment will include notification of, and consultation with, the potentially affected stakeholders, including the local public. Various media will be used to inform and engage individuals, interest groups, local governments and other stakeholders in the assessment. The stakeholder consultation program of Ontario Power Generation will be continuously monitored by Canadian Nuclear Safety Commission staff throughout the environmental assessment process.

Various stakeholders will be consulted throughout the environmental assessment process, including interested parties from:

- federal government
- provincial government
- local government
- First Nations and aboriginal communities
- established committees
- Ontario Power Generation employees
- general public
- neighbouring residents
- local businesses
- non-government organizations and interest groups

The screening report will contain a summary review of the comments received during this environmental assessment process. The screening report will indicate how issues identified have been considered in the completion of the assessment, or where relevant, how they may be addressed in any subsequent regulatory licensing and compliance process.

The Canadian Nuclear Safety Commission will also establish a public consultation process in the review and decision-making process for the screening report. This will include opportunities for the public to review and comment to Canadian Nuclear Safety Commission staff on the draft screening report, as well as to comment and present interventions before the Commission on the final screening report.

9.2.9 Follow-up Program

A preliminary design and implementation plan for a follow-up program will be included in the screening report.

The purpose of the follow-up program is to assist in determining if the environmental and cumulative effects of the project are as predicted in the screening report. It is also to confirm whether the impact mitigation measures are effective and to determine if new mitigation strategies are required. The design of the program will be appropriate to the scale of the project and the issues addressed in the EA. The Canadian Nuclear Safety Commission licensing and compliance program will be used as the mechanism for ensuring the final design and implementation of the follow-up program and the reporting of the program results. The program will be based on regulatory principles of compliance, adaptive management, reporting and analysis.

10.0 ENVIRONMENTAL ASSESSMENT PROCESS

The following steps outline the key steps that have been followed by Canadian Nuclear Safety Commission staff during the environmental assessment to date, and those that will be implemented following adoption of the EA Guidelines:

- Determination of the application of CEAA to the project (complete)
- Establishment of Public Registry (complete)
- Stakeholder notification (complete)
- Preparation of working draft of EA Guidelines (complete)
- Distribution of draft EA Guidelines to proponent and federal and provincial authorities (complete)
- Receive comments from federal and provincial authorities and prepare draft for public comment (complete)
- Distribute draft EA Guidelines for public comment (in progress)
- Canadian Nuclear Safety Commission staff review and disposition of comments received
- Revision of Draft EA Guidelines for submission to the Commission of Canadian Nuclear Safety Commission of the Canadian Nuclear Safety Commission approval of EA Guidelines
- Canadian Nuclear Safety Commission staff delegation of consultative and technical studies to the proponent
- Distribution of draft EA study report to review team (Canadian Nuclear Safety Commission staff, federal and provincial authorities)
- Revision, as appropriate, of EA study report
- Canadian Nuclear Safety Commission staff preparation of draft screening report
- Public review and comment on draft screening report
- Canadian Nuclear Safety Commission staff review and dispositioning of public comments
- Canadian Nuclear Safety Commission completion of screening report
- Canadian Nuclear Safety Commission staff preparation of screening report CMD for Commission consideration
- Public notification of Commission Hearing
- CMD presentation of screening report to Commission Hearing (Day 1)
- Commission Hearing (Day 2)
- Commission Hearing Record of Decision

11.0 CONCLUSIONS AND RECOMMENDATIONS FOR DECISION

The screening report will present a conclusion by Canadian Nuclear Safety Commission staff as to whether the project is likely to cause significant adverse environmental effects, taking into account the appropriate mitigation measures. Recommendations to the Commission on making decisions on the environmental assessment and project-related public concerns, consistent with section 20 of the CEAA, will be provided. These decisions by the Commission will be made through the Commission Hearing procedures.

12.0 CONTACT FOR THE ASSESSMENT

Anyone wishing to obtain additional information or provide comments on any aspect of the environmental assessment being conducted on the proposed construction and operation of the DUFDS facility, can do so through the following Canadian Nuclear Safety Commission staff contact:

Mr. Guy Riverin
EA Project Manager
Processing Facilities and Technical Support Division
Canadian Nuclear Safety Commission
280 Slater Street
PO Box 1046
Ottawa, Ontario K1P 5S9
Phone: 1-800-668-5284
Fax: (613) 995-5086
Internet: ceaainfo@Canadian Nuclear Safety Commission-ccsn.gc.ca

13.0 REFERENCES

3. Letter, K.E. Nash (OPG) to D. Howard (Canadian Nuclear Safety Commission), “*Darlington Used Fuel Dry Storage Project Description for Environmental Assessment Scoping*” (August 17, 2001).
2. Memo, L. Chamney (Canadian Nuclear Safety Commission) to D. Howard (Canadian Nuclear Safety Commission), “Canadian Nuclear Safety Commission Staff Determination of Application of the CEAA to the Darlington Used Fuel Dry Storage Project”, (September 18, 2001).

14.0 GLOSSARY OF TERMS

1. “environmental effect” means, in respect of a project,
 - (a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, and
 - (b) any change to the project that may be caused by the environment, whether any such change occurs within or outside Canada.

The following figures referred to in this document are not available electronically but are attached to the paper copy in Records Office:

Figure 1 – Site study area
Figure 2 – Local study area
Figure 3 – Regional study area

REFERENCES

Atomic Energy of Canada Limited (AECL). 1994. Environmental impact statement on the concept for disposal of Canada's nuclear fuel waste. Atomic Energy of Canada Limited Report, AECL-10711, COG-93-1. Chalk River, Ontario.

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Frost, C.R. 1994. Current Interim Used Fuel Storage Practice in Canada. Ontario Hydro Report No. N-03710-94-0052.

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