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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

Third Report
October 2008

Canada

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

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Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
CANADA

Tel.: (613) 995-5894 or 1-800-668-5284
Facsimile: (613) 995-5086
E-mail: info@cnsc-ccsn.gc.ca
Web site: www.nuclearsafety.gc.ca

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LIST OF ACRONYMS

ACR	Advanced CANDU Reactor
ACS	Advisory Committee on Standards
AECA	*Atomic Energy Control Act*
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AGTMF	Above-Ground Tailings Management Facility
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
APM	Adaptive Phased Management
AREVA	AREVA Resources Canada Inc.
ASDR	L'aire de stockage des déchets radioactifs
ASME	American Society of Mechanical Engineers
BLW	Boiling Light Water
BNPD	Bruce Power Nuclear Power Development
Cameco	Cameco Corporation
CANDU	Canadian Deuterium Uranium
CANSTOR	CANDU Storage
CCP	CNSC Compliance Program
CEA Act	*Canadian Environmental Assessment Act*
CEA Agency	Canadian Environmental Assessment Agency
CEPA	*Canadian Environmental Protection Act*
CLEAN	Contaminated Lands Evaluation and Assessment Network
CNEN	Brazilian Nuclear Energy Commission
CNSC	Canadian Nuclear Safety Commission
CMD	Commission Member Document
CRAG	Cost Recovery Advisory Group
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CURE	Canadian Uranium Regulatory Examination
DELs	Derived Emission Limits
DGR	Deep Geologic Repository
DJX	Dominique-Janine Extension
DNJ	Dominique-Janine North
DO	Designated Officer
DPNGS	Douglas Point Nuclear Generating Station
DPWMF	Douglas Point Waste Management Facility
DRLs	Derived Release Limits
DSM	Dry Storage Modules
EA	Environmental Assessment
EASR	EA Study Report
EC	Environment Canada
EMS	Environmental Management System
EOC	Emergency Operations Centre
EP	Emergency Preparedness
EQC	Environmental Quality Committee
FA	Federal Authority
FA	*Fisheries Act*
FISST	Fissile Solution Storage Tank
FNEP	Federal Nuclear Emergency Plan
FPS	Fuel Packaging and Storage
GNSCR	*General Nuclear Safety and Control Regulations*
G1WMF	Gentilly-1 Waste Management Facility
HADD	Harmful Alteration, Disruption or Destruction
HC	Health Canada

HEPA	High-Efficiency Particulate Air
HEU	Highly Enriched Uranium
HQ	Hydro-Québec
HLW	High-Level Radioactive Waste
HWUP	Heavy Water Upgrade Plant
IAEA	International Atomic Energy Agency
IAEA BSS	International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources
IAS	Independent Assessment Study
ICMS	Informal Conflict Management System
ICP	Institutional Control Program
ICRP	International Commission on Radiological Protection
ICWP	Institutional Control Working Group
ILW	Intermediate-Level Radioactive Waste
ILW-LL	Long-Lived Intermediate-Level Radioactive Waste
ILW-SL	Short-Lived Intermediate-Level Radioactive Waste
INAC	Indian and Northern Affairs Canada
IRRS	Integrated Regulatory Review Services
ITC	International Trade Canada
JEB	John Everett Bates
JRG	Joint Regulatory Group
JRPA	Joint Review Panel Agreement
LEU	Low-Enriched Uranium
L&ILW	Low- and Intermediate-Level Radioactive Waste
LLRWMO	Low-Level Radioactive Waste Management Office
LLW	Low-Level Radioactive Waste
LWE	Liquid Waste Evaporator
LWTS	Liquid Waste Transfer and Storage
MACSTOR	Modular Air-Cooled Storage
MAGS	Modular Above-Ground Storage
MAPLE	Multipurpose Applied Physics Lattice Experiment
MNR	McMaster Nuclear Reactor
MPMO	Major Projects Management Office
NB EMO	New Brunswick Emergency Measures Organization
NB Power	New Brunswick Power Corporation
NCA	Nuclear Cooperation Agreement
NEA	*Nuclear Energy Act*
NEM	Nuclear Emergency Management
NFWA	*Nuclear Fuel Waste Act*
NGS	Nuclear Generating Station
NGO	Non-Governmental Organization
NLA	*Nuclear Liability Act*
NLLP	Nuclear Legacy Liabilities Program
NPD	Nuclear Power Development
NPP	Nuclear Power Plant
NRCan	Natural Resources Canada
NRU	National Research Universal
NRX	National Research Experimental
NSCA	*Nuclear Safety and Control Act*
NS EMO	Nova Scotia Emergency Measures Organization
NSERC	Natural Sciences and Engineering Research Council
NSR	*Nuclear Security Regulations*
NSRDR	*Nuclear Substances and Radiation Devices Regulations*
NSSR	National Sealed Source Registry
NTR	Northern Transportation Route
NWMO	Nuclear Waste Management Organization

OMOE	Ontario Ministry of the Environment
OPG	Ontario Power Generation
OP&P	Operating Policies and Principles
ORC	Ontario Realty Corporation
OSCQ	L'Organisation de la sécurité civile du Québec
PCB	Polychlorinated Biphenyl
PGLTWMF	Port Granby Long-Term Waste Management Facility
PHAI	Port Hope Area Initiative
PHLTWMF	Port Hope Long-Term Waste Management Facility
PTNSR	*Packaging and Transport of Nuclear Substances Regulations*
PTR	Pool Test Reactor
PWQO	Ontario Provincial Water Quality Objectives
RA	Responsible Authority
RCSA	Re-tube Components Storage Area
RMC	Royal Military College
RPR	*Radiation Protection Regulations*
R&T	Retrieval and Transfer
RWOS 1	Radioactive Waste Operations Site 1
SART	Self-Assessment Review Team
SaskEMO	Saskatchewan Emergency Management Organization
SLHHERA	Screening Level Human Health and Ecological Risk Assessment
SMAGS	Shielded Above-Ground Storage
SRECC	Serpent River Region Environmental Committee
SSAC	Canada's State System of Accounting for and Control of Nuclear Materials
SSTS	Sealed Source Tracking System
SRWMF	Solid Radioactive Waste Management Facility
TC	Transport Canada
The Code	Code of Conduct on the Safety and Security of Radioactive Sources
The IAEA Guidance	Guidance on the Import and Export of Radioactive Sources
TLD	Thermoluminescent Dosimeter
TMA	Tailings Management Area
TMF	Tailings Management Facility
TRCA	Toronto Regional Conservation Authority
TRIUMF	TriUniversity Meson Facility
UMMR	*Uranium Mines and Mills Regulations*
UNENE	University Network of Excellence in Nuclear Engineering
URL	Underground Research Laboratory
VLLW	Very-Low-Level Radioactive Waste
VSLLW	Very-Short-Lived Low-Level Radioactive Waste
WAF	Waste Analysis Facility
WFOL	Waste Facility Operating Licence
WL	Whiteshell Laboratories
WMF	Waste Management Facility
WR-1	Whiteshell Reactor-1
WSS	Waste Storage System
WTC	Waste Treatment Centre
WVRB	Waste Volume Reduction Building
WWMF	Western Waste Management Facility
XRF	X-Ray Fluorescence
ZED-2	Zero Energy Deuterium-2

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EXECUTIVE SUMMARY

1.0 Introduction

This report demonstrates how Canada continues to meet its obligations under the terms of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. A collaboration by government, industry and the regulatory body, this document focuses specifically on the progress of long-term management initiatives for spent fuel and radioactive waste in Canada, revisions and updates to Canada's *Second National Report* and comments and issues raised at the Second Review Meeting. Specifically, it includes additional information on:

- Canada's formal radioactive waste classification system,
- inventory of decommissioning waste generated during the reporting period,
- the regulatory hearing process, and
- effluent discharges.

2.0 Canada's key highlights and current priorities

- In June 2007, the Government of Canada selected the Adaptive Phased Management (APM) approach, recommended by the Nuclear Waste Management Organization (NWMO), for the long-term management of Canada's nuclear-fuel waste. (For more information about the NWMO, see sections G.17 and K.4.)

- The Government of Canada committed $520 million over five years to launch a long-term strategy for dealing with nuclear legacy liabilities at Atomic Energy of Canada Limited (AECL) sites, specifically Chalk River Laboratories, Whiteshell Laboratories and the three prototype reactors. The work was initiated in April 2006. (For more information on the Nuclear Legacy Liabilities Program (NLLP), see section K.5.2.)

- Both an environmental assessment (EA) and a regulatory review process for a site preparation and construction licence are underway for a deep geologic repository for the long-term management of Ontario Power Generation's low- and intermediate-level radioactive waste. (For more information, refer to section K.5.1.)

- In March 2007, the Government of Canada announced its decision on the EA for the Port Hope Project, one of two projects that address the clean-up and long-term management of historic low-level radioactive waste in the Port Hope area. The EA decision for the second project – the Port Granby Project – is expected in 2009. (See section K.5.3.1 for more information.)

- On April 2, 2007, the Government of Canada and the Province of Saskatchewan announced the first phase of the clean-up of closed uranium-mine and mill sites – principally Gunnar and Lorado – in northern Saskatchewan. (For more information, refer to Annex 8.1.1.2.)

- In 2008, the revised *Nuclear Substances and Radiation Devices Regulations* (NSRDR) came into effect. The revised regulations include clearance levels that are consistent with the International Atomic Energy Agency's (IAEA) recommendations. (For more information, see section E.3.2.)

- On January 1, 2006, the regulatory body implemented a Sealed Source Tracking System (SSTS) and a National Sealed Sources Registry (NSSR) for Category 1 and 2 sources. Seven months later, the CNSC also launched a secure Web site for reporting SSTS transactions, using the Government of Canada's "E-pass" technology. The NSSR is being expanded in 2008 to include Category 3, 4 and 5 sources. (For more information, refer to section J.4.)

3.0 Progress since the Second Review Meeting

During the peer review of Canada's *Second National Report* in 2006, Contracting Parties to the Second Review Meeting identified long-term waste management challenges and solutions. The following is an update on progress made in addressing these items:

3.1 Continue the progress for the long-term management by:

a. sustaining the momentum for the implementation of long-term management approaches,
b. fostering relationships gained through stakeholder consultation,
c. maintaining a high level of expertise,
d. ensuring that there are adequate human resources to implement future work,
e. increasing regulatory efforts necessary to support future industry initiatives, and
f. continuing the production of supporting regulatory documentation.

3.1 (a) Sustaining momentum for the implementation of long-term management approaches

The following are examples of how momentum has been sustained for the implementation of long-term management approaches.

<u>NWMO</u>
The NWMO received approval from the Government of Canada to begin implementing the APM approach for the long-term management of spent fuel. (See sections G.17 and K.4.)

<u>Ontario Power Generation (OPG)</u>
An EA and a regulatory review process for a site-preparation and construction licence are underway for a deep geologic repository for the long-term management of Ontario Power Generation's low- and intermediate-level radioactive waste. (For more information, refer to section K.5.1.)

<u>AECL</u>
The Government of Canada initiated the NLLP to deal with legacy radioactive waste and decommissioning liabilities at AECL sites, specifically Chalk River Laboratories, Whiteshell Laboratories and the three prototype reactors. The program includes the development and construction of the infrastructure required to characterize, condition, treat, process, package and store waste, as well as implement long-term solutions. These facilities will also manage the low- and intermediate-level radioactive waste generated by AECL's ongoing operations, as well as that accepted from third party generators. (For information on AECL's long-term management strategy for low- and intermediate-level waste, refer to section K.5.2.)

3.1 (b) Fostering relationships gained through stakeholder consultation

The following are examples of how relationships have been fostered through stakeholder consultation and what will be done to further develop these relationships.

<u>NWMO</u>
Through continued commitment to dialogue and collaboration, the NWMO is building on the extensive relationships developed during the 2002–05 study phase. The NWMO continues to work with citizens, communities, all three levels of government, Aboriginal organizations, NGOs, industry and others. Since the Government's decision issued in June 2007, the NWMO has been inviting stakeholder input on what priorities NWMO should set as an implementer. The organization convened meetings and briefings, invited comments through the Web site, surveys and e-dialogues, and organized Citizen Panels in all four nuclear provinces with a view to understanding expectations for the NWMO's early implementation phase. A five-year plan was issued for public review and comment as the foundation for the NWMO's new mandate.

Future phases of engagement will focus on design and implementation of a siting process. A particular focus will be expanding relationships at the regional and local levels to support the development and initiation of the siting process in the four nuclear provinces (Ontario, New Brunswick, Quebec and Saskatchewan). A discussion document is being prepared to initiate a multi-party dialogue in 2008 on the design process for selecting a site, the initial framework of objectives and principles and key issues to be considered. With this input, the NWMO plans to draft a siting-process proposal for public review and confirmation in 2009.

Low-Level Radioactive Waste Management Organization (LLRWMO)
The LLRWMO's work under the direction of Natural Resources Canada (NRCan) entails extensive stakeholder relations and communications, negotiation and accommodation of public client needs, as well as thoughtful planning. In communities where small volumes of waste are present, the LLRWMO will continue to strive to clean up the waste and either remove it or manage it in-situ, following NRCan's process of involving communities in the development of long-term solutions. The LLRWMO strives to maintain stakeholder confidence through open and transparent communications and engagement techniques.

Canadian Nuclear Safety Commission (the CNSC)
Part of the regulatory body's mandate is to disseminate information to all stakeholders. Since the last reporting period, the CNSC has established a Non-Governmental Organization Regulatory Affairs Committee to communicate and consult with NGOs on nuclear regulatory and policy matters. In addition to this forum, the CNSC also established links with an association of host communities of major nuclear facilities in early 2007. To ensure the needs of future stakeholders are met, the CNSC is proactively contacting communities likely to become involved in nuclear activities (such as mining and milling and waste management repositories) in the next decade.

3.1 (c) Ensuring that there are adequate human resources to implement future work

The following are examples of how organizations maintain a high level of expertise and ensure adequate human resources are available to implement future work.

NWMO
The NWMO has begun to broaden and strengthen the organization's skills and capabilities to implement APM, and further growth is planned. APM involves a lengthy period of program development and operation and technical and social research program to ensure the human capacity to manage the implementation of APM today and in the future. In addition to maintaining in-house staff capability, NWMO is developing specialist networks with universities and the consulting community within Canada. Joint research, development and demonstration programs are underway internationally. Planned research programs play an important role in enabling Canada to benefit from leading technological innovation, while, at the same time, securing institutional memory, knowledge transfer and the technical capacity of the workforce required to implement APM in future years. The development of a youth-engagement strategy further recognizes the inter-generational nature of this work.

LLRWMO
Following NRCan's policy and funding priorities, the LLRWMO will continue to respond to Canada's needs for historic low-level radioactive waste (LLW) management on a project-by-project basis. To accomplish this goal, the LLRWMO relies on its staff's expert core capabilities, which add value to the work of private sector contractors engaged to help execute specific projects. As an advisor and responder to LLW issues, and recognizing logistical requirements of its reactive community programs, the LLRWMO sustains and adjusts resource strength to maintain corporate knowledge and ensure appropriate procedures are developed, maintained and followed. The LLRWMO also maintains the human resources required to operate ongoing monitoring, inspection and environmental remediation programs across Canada. This maintenance of expertise in various fields not only makes the LLRWMO a knowledgeable consumer of contracted services, but also permits the specialized and professional development of products and projects for clients and stakeholders.

OPG
OPG's Nuclear Waste Management Division is currently comprised of approximately 300 full-time employees. Staffing demands have increased during the past three years and are expected to keep rising due primarily to attrition as a result of retirements. OPG recruited 36 personnel in 2005, 27 in 2006, 72 in 2007 and 41 between January and June of 2008. Staffing of the new Darlington Waste Management Facility, combined with attrition at the other nuclear waste facilities, accounts for the 2007 increase in recruitment. Skilled and semi-skilled tradespeople were recruited from within OPG, with an increasing emphasis on the external labour marketplace. Technical and

engineering positions have been primarily filled through external selections and supplemented by university graduates hired through OPG's University Graduate Training Program. With continued emphasis on succession management, workforce planning and staff development in the Nuclear Waste Management Division is positively positioned to meet its qualified staffing requirements for both the short and long term. (For information on OPG's initiatives, refer to section F.3.3.)

The CNSC
Staff recruitment and retention has been one of the CNSC's key strategic objectives for several years. The current recruitment and retention strategy is now being reviewed, given the rapid growth of the organization to fulfill its mission. The CNSC faces challenges posed by an increasingly tight labour market, aging workforce and staff turnover. To overcome these challenges, the CNSC is emphasizing learning and development and focusing not only on experienced candidates, but also on junior, entry-level staff. Since the last reporting period, the CNSC's staff has grown by 30 percent. (See section E.8.2.)

3.1 (d) Increasing the regulatory efforts necessary to support future industry initiatives

Natural Resources Canada
The Government of Canada recently created the Major Projects Management Office (MPMO) within NRCan. The MPMO is a Government of Canada organization, whose role is to help improve the regulatory system with respect to major resource projects and provide overarching project management and accountability for major resource projects in the federal regulatory review process. The MPMO serves as the single point of entry into the federal regulatory process for all stakeholders. It provides guidance to project proponents and other stakeholders, coordinates project agreements and timelines between federal departments and agencies, and tracks and monitors the progression of major resource projects through the federal regulatory review process.

The MPMO will monitor the federal regulatory review process for Ontario Power Generation's (OPG) Deep Geologic Repository (DGR). A work plan was developed with consideration given to the draft Joint Review Panel Agreement (JRPA) and the draft Aboriginal Consultation. The work plan is intended to improve the accountability, transparency, timeliness and predictability of the federal regulatory review process for the OPG DGR.

3.1 (e) Continuing production of supporting regulatory documentation

The CNSC has continued its production of support documentation, which leads to additional regulatory policies, standards and guides. Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management,* was published in December 2006. (Information on Regulatory Documentation is included in section E.3.3, and a list of regulatory documents is found in Annex 3.)

3.2 Financial guarantees

The CNSC's personnel have been working on the development of a new comprehensive policy concerning financial guarantees. While all major licensees with operating facilities have financial guarantees in place, the CNSC's personnel are currently reviewing the need for the broader application of financial assurances to all facilities and other licensed activities that currently are not required to post financial guarantees. The CNSC's personnel are also considering the need for financial guarantees for earlier phases of the licensing process, where financial assurances have previously not been required. Section F.4.3 provides further information on this initiative.

3.3 Approvals required for the Port Hope Area Initiative (PHAI) and the Deep Geologic Repository (OPG)

a) Port Hope Area Initiative
As reported in the *First National Report*, the Initiative began on March 29, 2001. The PHAI consists of two waste management projects: the Port Hope Project and the Port Granby Project.

At the time of writing this report, the Port Hope Project environmental assessment (EA) process has been completed, and the licensing process is well advanced. If all licensing documents are submitted by October 2008, it is estimated that the project could proceed to a licensing hearing in June 2009.

The EA Study Report (EASR) for the Port Granby Project was submitted in August 2007 to the Responsible and Federal Authorities (RAs and FAs). The proponent, LLRWMO, is currently working to complete an addendum to the EASR, addressing the comments from the RAs and FAs. For more information on the PHAI refer to section K.5.3.1

b) Deep Geologic Repository
The last report noted that OPG had announced its intention to develop a long-term approach for the current and future low- and intermediate-level radioactive waste from its 20 CANDU reactors. The approach ensures the waste's long-term isolation from the environment, without burdening future generations with its caretaking.

In December 2005, OPG submitted a letter of intent to construct the Deep Geologic Repository (DGR) to the regulatory body, thus initiating the EA process. The EA process is now underway, coincident with further geoscientific site investigations, conceptual design work and safety analyses. OPG submitted an application for a site preparation and construction licence in August 2007. The regulatory review of this application will be conducted in parallel with the EA review.

The current project schedule has the Environmental Impact Assessment being submitted in 2011 and a site-preparation and construction licence being issued in 2012. Earliest in-service is expected in 2018. (Further information on OPG's DGR can be found section K.5.1.)

3.4 Decommissioning old structures

The following is an update on the decommissioning activities, as reported in Canada's *Second National Report*. For information on decommissioning activities, please refer to Annex 7.

a) Cluff Lake
The majority of the decommissioning was completed in 2006, after two years of work to fill the Claude pit, demolish the mill, cover the tailings management area and re-slope and cover waste rock piles. (For more information on Cluff Lake decommissioning, including pictures, refer to Annex 7.6.)

b) AECL Facilities
Whiteshell Laboratories (WL)
WL has continued the activities planned in the initial phase of decommissioning, including those directed toward the shutdown and decontamination of nuclear and radioisotope laboratory buildings and facilities, with the aim of placing them in a safe, secure, interim end-state. Specifically, four buildings have been decommissioned and demolished at WL.

Decommissioning work at WL was accelerated in 2006, in keeping with the new long-term strategy adopted by the Government of Canada under the NLLP. In March 2008, AECL applied to renew the WL licence beyond 2008. The licence renewal application reflects the accelerated strategy, with decommissioning being completed in the period leading up to approximately 2024, with exception of the Whiteshell Reactor-1 (WR-1) and the Waste Management Area.

Chalk River Laboratories (CRL)
AECL submitted a project description to decommission the NRX ancillary buildings over several years. One or two structures would be decommissioned in any given year. The final end-state involves the complete removal and site remediation for some buildings, while others may be partially removed and taken to an interim end-state. The goal is to return the land occupied by all the buildings to the CRL-site landlord by 2025.

An EA was completed in 2007 for the decommissioning of the NRX fuel bays (A and B). The regulatory body approved two Advanced Decommissioning Work Packages to proceed with the removal of water from the A and B bays and approximately 30 metres of wooden building structure over the bays, and so create a fire separation between the NRX Fuel bay building and NRX Reactor. The A bays were cleaned to the best possible extent and were emptied in 2007. Future work will include the decontamination and removal of a 30-metre section of the building, to be completed in 2008. Sections of the B bays were drained and filled with sand, while the remaining sections were refilled with water. The emptying of the B bays will commence once final work is completed on the A bays. Lessons learned from the A bays will be incorporated into planning for the B bays. An application for decommissioning approval is expected in 2009.

The EA process for the Pool Test Reactor (PTR) was completed in 2007. Lessons learned from the emptying of the NRX fuel rod bay will be incorporated into the PTR planning documentation. An application for decommissioning approval is expected in 2010.

A separate EA process is currently underway for the Plutonium Tower, Plutonium Recovery Laboratory and the Waste Water Evaporator. Also, a decision about the decommissioning of the Heavy Water Upgrade Plant (HWUP) is expected in the spring of 2008. An application for decommissioning approval is expected in 2010.

NPD, Douglas Point and Gentilly-1
Three prototype power reactors (NPD, Douglas Point and Gentilly-1) have been partially decommissioned and put into a safe Storage-with-Surveillance state, pending final decommissioning. AECL owns and manages these three reactors under licences from the regulatory body. The NLLP (see section K.5.2) funds the management and decommissioning planning for the prototype reactors.

c) Research Reactor
The research reactor at Dalhousie University is still operational. A Detailed Decommissioning Plan and supporting documentation had not yet been submitted to the Canadian regulator.

d) Bruce Heavy Water Plant (BHWP)
The demolition of the BHWP was completed in 2006. The only standing activity associated with the demolition is the remediation of oil-contaminated soil from the effluent lagoons. The contaminated soil was removed from the lagoons and put into bioremediation cells during the summer of 2006. These remediation cells should be removed from the site in November 2008. (See Annex 7.7 for further information on the decommissioning.)

3.5 Progress on major projects

The Fuel Packaging and Storage (FPS) Project
The FPS Project was initiated to construct a facility to store certain legacy research-reactor fuel, along with the associated fuel drying and repackaging equipment. The facility is designed to store the older, experimental fuels from approximately 100 tile holes located at the Chalk River Laboratories, which are the most problematic and degraded fuel and storage conditions. The storage structure will be engineered for a life of at least 50 years and will provide safe and interim storage for the packaged fuel until a long-term storage facility is available. A decision on the EA is expected in the spring of 2008 and an application for construction approval is expected at the end of 2008.

Liquid Waste Transfer and Storage Project
In 2004, AECL initiated the Liquid Waste Transfer and Storage Project (LWTS), which is part of the Stored Liquid Waste Remediation Project at CRL. LWTS is being implemented under the NLLP (see section K.5.2.2) and involves the design, licensing, construction and commissioning of a new liquid waste storage facility to hold approximately 300,000 litres of legacy liquid waste, including high-level radioactive waste from medical isotope production and fuel reprocessing experiments. These liquids are currently stored in 21 tanks, which require replacement. The project consists of two major engineered systems: a Waste Storage System (WSS), and a Retrieval and Transfer (R&T) System. Conceptual design activities and an EASR, have been completed. The design of the WSS will be completed in early 2008 and an application for construction approval is expected at the end of 2008.

3.6 CSA's formal waste classification scheme to be considered

In March 2008, the Canadian Standards Association (CSA) developed – in collaboration with industry, government and the regulatory body – a standard that includes a radioactive waste-classification system. The development of the radioactive waste classification system took into account both the International Atomic Energy Agency (IAEA) standards and the needs of the Canadian industry. The radioactive waste-classification system described below recognizes four main classes of radioactive waste:

- High-level Radioactive Waste (see section B.7.1)
- Intermediate-level Radioactive Waste (see section B.7.2)
- Low-level Radioactive Waste (see section B.7.3)
- Uranium Mine and Mill Waste (see section B.7.4)

Sub-classes for low-level wastes are also identified to provide better guidance on appropriate waste-management needs. (See section B.7 for more information.)

3.7 Amendment to regulations on exemption and clearance

In order to harmonize Canada's regulatory approach for the exemption and clearance of radioactive material with international practices, CNSC amended the NSRDRs to consider the IAEA Basic Safety Standards, as well as the most recent guidance from the IAEA on the concepts of exemption, exclusion and clearance. The amendments, following extensive stakeholder input, were approved by the Governor-in-Council, and subsequently published in the *Canada Gazette Part II*. The amended regulations came into force on April 17, 2008. (Refer to section E.3.2 for more information.)

3.8 NWMO's recommendation for managing Canada's nuclear fuel waste

NWMO's first mandate was to study options for the long-term management of spent fuel and make recommendations on proposed management methods to the Government of Canada by November 15, 2005. In 2005, NWMO completed its study and recommended APM to the Government of Canada, the end-point of which is a deep repository in an appropriate geologic formation. On June 14, 2007, the Government accepted NWMO`s recommendation. With that Government decision, NWMO has assumed responsibility for implementing the APM. (For more information on this long-term management plan for Canada's spent fuel, refer to sections G.17 and K.4.)

4.0 Conclusion

Spent fuel and radioactive waste in Canada are currently managed in storage facilities, which are safe, secure and environmentally sound. Canada recognizes that enhanced long-term management approaches will be required for its spent fuel and radioactive waste. This *Third National Report* identifies several key initiatives that demonstrate Canada's commitment to identifying and implementing long-term management approaches that do not place undue burden on future generations.

SECTION A – INTRODUCTION

A.1 Scope of the section

This section is a general introduction to the main themes of the report.

A.2 Introduction

Canada's federal government has jurisdiction over nuclear energy, and Natural Resources Canada (NRCan) is the department responsible for nuclear energy policy. The Government of Canada has long funded nuclear research and supported the development and use of nuclear energy and related applications. As a result of this investment:

- nuclear energy now supplies about 15 percent of Canada's electricity,
- cancer therapies and diagnostic techniques are improved,
- the nuclear industry contributes billions of dollars a year to Canada's gross domestic product and accounts for more than 30,000 highly skilled jobs, and
- Canada has become the world's largest supplier of uranium, which continues to rank among the top 10 metal commodities in Canada for value of production.

The federal government provides $100 million in annual funding to AECL's Chalk River Laboratories (CRL), which undertakes research and development activities related to CANDU (Canadian Deuterium Uranium) technology. In addition to this base level funding, the federal government also provides funding to renew infrastructure at CRL and support the development of the Advanced CANDU Reactor (ACR).

Radioactive waste has been produced in Canada since the early 1930s, when the first radium and uranium mine opened in Port Radium, Northwest Territories. Pitchblende ore was transported from the Port Radium mine to Port Hope, Ontario, where it was refined to produce radium for medical purposes and, later, uranium for nuclear fuel and military applications. Research and development on the application of nuclear energy to produce electricity began in the 1940s at CRL. At present, radioactive waste is generated in Canada from the various stages and uses associated with the nuclear fuel cycle:

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

The Government of Canada gives high priority to the safety of persons and the protection of the environment from the various operations of the nuclear industry, and has put in place modern legislation that provides the basis for Canada's comprehensive and robust regulatory regime. Canada's nuclear regulatory body is the Canadian Nuclear Safety Commission (the CNSC). In addition to NRCan and the CNSC, the major federal government organizations involved in the Canadian nuclear industry include:

- Health Canada (HC) – recommends radiological protection standards and monitors occupational radiological exposures.
- Transport Canada (TC) – develops and administers policies, regulations and services for the Canadian transportation system, including the transportation of dangerous goods.

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

- Canadian Environmental Assessment Agency (CEA Agency) – contributes to both sustainable development and ensures public participation in the environmental assessment process. CEA Agency is responsible for the administration of the *Canadian Environmental Assessment Act* (CEA Act) and its regulations.

- The Major Projects Management Office (MPMO) – provides overarching project management and accountability for major resource projects in the federal regulatory review process, and to facilitate improvements to the regulatory system for major resource projects. The MPMO serves as the single point of entry into the federal regulatory process for all stakeholders, and it also works collaboratively with other departments and agencies where the federal regulatory process for major resource projects can be improved, both in the short- and long-term.

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

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

A.3 Nuclear substances

Under the NSCA, the CNSC regulates nuclear substances, in order to protect human health and the environment. The nuclear substances defined in the NSCA include any radioactive substance, plus deuterium, or any of their compounds, as well as any substance defined by regulations as being required for the production or use of nuclear energy.

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

A.4 Canadian philosophy and approach to safety

Canada actively promotes and regulates safety within the nuclear sector. Canada's approach is based upon several factors, including the review of international standards, (i.e. IAEA standards and guides), improvements to regulatory policies and standards (i.e., Regulatory Policy P-299). Canada considers the adoption of international recommendations, such as those regarding radiological dose limits to the public and workers in International Commission on Radiological Protection Publication 60, *Recommendations of the International Commission on Radiological Protection* (ICRP-60, 1990), as well as protection of the environment. For example, 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 derived from specific licence conditions (such as the Derived Release limits). Other standards, established by organizations like the CSA, or the American Society of Mechanical Engineers (ASME), may also be adopted by the CNSC.

The Commission Tribunal sets the standards and conditions; it is then the responsibility of the person in possession of the associated nuclear substance, or the operator of the associated facility to ensure the safety. For example, it is the licensee's responsibility to demonstrate to the satisfaction of the regulatory body that a spent fuel facility or radioactive waste management facility can and will be operated safely throughout the lifetime of the facility. The regulatory regime is flexible about how licensees comply with regulatory requirement. The licensee must demonstrate how the design meets all applicable performance standards and will continue to do so throughout its design life.

A.5 Fundamental principles

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

- lifecycle responsibility and licensing,
- in-depth defence, and
- multiple barriers.

A.6 Main safety issues

The two main safety issues addressed in this report are interim storage and historical and contaminated lands.

Currently, interim storage is being conducted in a safe manner. The Canadian nuclear industry and the Canadian government are developing long-term waste management solutions that will protect health, safety, security and the environment. Key initiatives underway are described in section K. Some of the most important challenges will be to bring these initiatives to fruition and develop and implement appropriate long-term solutions that have the confidence of the public.

Historical and contaminated lands have presented the Canadian and provincial governments with challenges to developing and implementing appropriate remedial strategies and long-term waste management solutions. Several initiatives have been completed or are underway to address theses sites, as described in sections H.6.1 and K.5.3.

A.7 Survey of the main themes

The main themes in this report are:

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

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

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

- The Canadian regulatory body has sufficient independence, authority and resources to ensure compliance and enforcement of regulatory safety requirements that pertain to the management of spent fuel and radioactive waste.

- Industry and various levels of government are engaged in a number of initiatives to develop and implement long-term solutions for spent fuel and radioactive waste, as well as clean up of wastes from past practices such as uranium mining and processing.

SECTION B – POLICIES AND PRACTICES

B.1 Scope of the section

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

B.2 Introduction

Under the current legislative and regulatory framework, spent fuel is considered to be another form of radioactive waste. As a result, legislation and policies on managing radioactive waste apply equally to spent fuel as to other forms of radioactive waste.

B.3 Legislative instruments

Federal legislation that regulates and oversees the nuclear industry, including the management of radioactive waste and spent fuel, is comprised of the NSCA, NFWA, NLA, and the NEA (described in Annex 2). The nuclear industry is also subject to the CEA Act, CEPA and the *Fisheries Act*.

A number of federal government departments are involved in administering these legislations. Where multiple regulators are involved, the CNSC establishes joint regulatory groups to coordinate and optimize the regulatory effort.

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

B.4 National framework for radioactive waste management

The 1996 Government of Canada *Policy Framework for Radioactive Waste* sets the stage for institutional and financial arrangements to manage 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 and regulate and oversee radioactive waste producers and owners so that they meet their operational and funding responsibilities in accordance with approved long-term waste management plans, and

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

The policy framework recognizes that arrangements may be different for the four broad categories of radioactive waste found in Canada, namely spent fuel waste, low- and intermediate-level radioactive waste and uranium-mine waste rock and mill tailings.

The Canadian Institutional Framework is shown in Figure B.1.

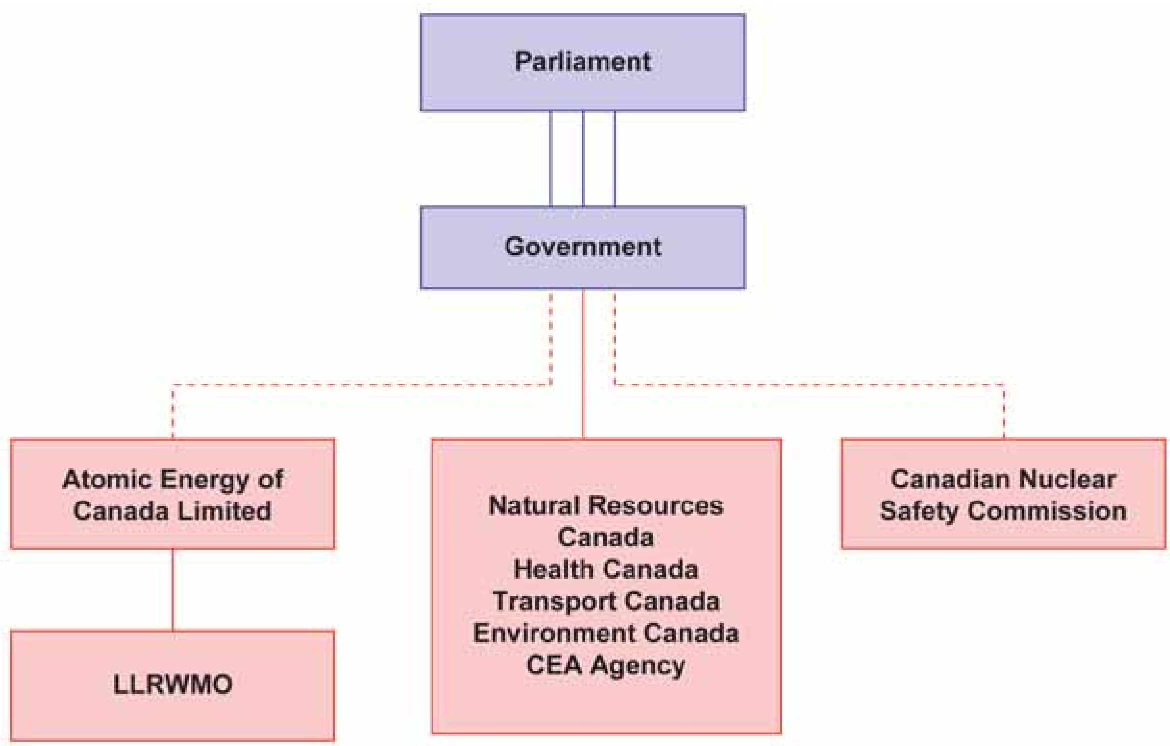


Figure B.1 – The Canadian institutional framework

NRCan is the lead Government department responsible for the development and implementation of uranium, nuclear energy and radioactive waste management policies. It also administers the NFWA and has overall responsibility for the management of historic waste. The latter term refers to wastes that were managed in the past in a manner no longer considered acceptable, for which the current owner cannot be reasonably held responsible, and for which the federal government has assumed responsibility for long-term management.

A number of other federal departments have been assigned roles and responsibilities related to the safe management of spent fuel and radioactive waste, including Health Canada (HC), Environment Canada (EC) and the CEA Agency. (Additional information on all these departments and organizations, as shown in Figure B.1, is provided in Annex 1.)

AECL and the CNSC are connected to the Government with dashed lines to illustrate their arms-length relationships. They both report to Parliament through a Minister within the government. AECL is a Crown corporation, owned entirely by the Government of Canada and run by a Board of Directors. AECL's mandate includes the management of the waste it generates from ongoing research, legacy radioactive waste and decommissioning liabilities on its properties, as well as for the waste it accepts for long-term management from non-utility radioactive waste producers across Canada on a fee-for-service basis. AECL also staffs and manages the Low-Level Radioactive Waste Management Office (LLRWMO), which is the national agent for the clean-up and management of Canada's historic waste. The LLRWMO is operated via a Memorandum of Understanding between NRCan and AECL, whereby NRCan provides the funding and policy direction for the LLRWMO.

The CNSC is Canada's independent nuclear regulatory body. Its mission is to regulate the use of nuclear energy and materials to safeguard the health, safety and security of the public, protect the environment and respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC's regulatory decision process is fully independent from the Government of Canada.

B.5 Regulatory policy on managing spent fuel and radioactive waste

The CNSC issued Regulatory Policy P-290, *Managing Radioactive Waste*, in July 2004, following extensive consultation with the public and industry stakeholders. The policy outlines the philosophy and six principles that govern the CNSC's regulation of radioactive waste. It is fully consistent with the federal *Policy Framework for Radioactive Waste. The* CNSC Regulatory Policy P-290 identifies the need for long-term management of radioactive and hazardous waste that arises from licensed activities.

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

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

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

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

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

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

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

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

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

- promote harmonized regulation and consistent national and international standards for the management of radioactive waste, and

- achieve conformity with the measures of control and international obligations to which Canada has agreed concerning radioactive waste."

B.6 Regulatory Guide G-320: *Assessing the Long-Term Safety of Radioactive Waste Management*

Published in December 2006, Regulatory Guide G-320 helps licensees and applicants assess the long-term impact that radioactive waste storage and disposal methods have on the environment and the health and safety of people. Specifically, the guide addresses:

- assessment approaches, structures and methodologies,
- level of detail of assessments,

- confidence to be placed in assessment results,
- applying radiological and non-radiological criteria,
- defining critical groups for impact assessments,
- selecting timeframes for impact assessments,
- setting post-decommissioning objectives,
- long-term care and maintenance considerations, and
- use of institutional controls.

However, it does not address social acceptability or economic feasibility of long-term management methods, or the assessment of facility operations. A copy of the guide is available at nuclearsafety.gc.ca.

B.7 Classification of radioactive waste in Canada

Established in 1919, the Canadian Standards Association (CSA) is a not-for-profit organization composed of representatives from government, industry and consumer groups. Its primary product is safety and performance standards, including those for electrical, electronic and industrial equipment, boilers and pressure vessels, compressed gas handling appliances, environmental protection and construction materials. The association also provides training materials and information products. CSA developed the CAN/CSA Z299 series of quality assurance standards, which are still used today and represent an alternative to the ISO 9000 series of quality standards.

Since the last report period, the CSA – in collaboration with industry, government and the regulatory body – developed a standard that includes a radioactive waste classification system, CSA 293.3-08, which takes into account the IAEA Safety Guide DS-390, *Radioactive Waste Classification*, and the needs of the Canadian industry. The standard was published in March 2008. The radioactive waste-classification system described below recognizes four main classes of radioactive waste:

- High-level Radioactive Waste (see section B.7.1)
- Intermediate-level Radioactive Waste (see section B.7.2)
- Low-level Radioactive Waste (see section B.7.3)
- Uranium Mine and Mill Waste (see section B.7.4)

Sub-classes for low-level wastes are also identified to provide better guidance on the appropriate waste management needs.

Organization of Classification System

The waste classification system is organized according to the degree of containment and isolation required to ensure safety in the short- and long-term. It also takes into consideration the hazard potential of different types of radioactive waste.

A definitive numerical boundary between the various categories of radioactive waste (primarily low- and intermediate-level) cannot be provided, since activity limitations differ between individual radionuclides or radionuclide groups and will be dependent on both short- and long-term safety-management considerations. For example, a contact dose rate of two mSv/h has been used, in some cases, to distinguish between low-and intermediate-level radioactive waste.

The following sections provide an overview of the four main classes of radioactive waste in Canada:

B.7.1 High-Level Radioactive Waste (HLW)

HLW is used (irradiated) nuclear fuel that has been declared radioactive waste or waste that generates significant heat (typically more than two kW per cubic metre) via radioactive decay. In Canada, irradiated nuclear fuel is a more accurate term for spent fuel, as discharged fuel is considered a waste material even when it is not fully spent. In spite of the name difference, the term ‘spent fuel’ is meant in this report to be consistent with the terminology of the Joint Convention.

Spent fuel is associated with penetrating radiation, which requires shielding. Furthermore, spent fuel contains significant quantities of long-lived radionuclides, meaning that long-term isolation is also required. Waste forms derived from spent fuel (e.g. nuclear fuel reprocessing wastes) can exhibit similar characteristics and may be considered HLW.

Placement in deep, stable geologic formations is considered to be the preferred option for the long-term management of HLW.

B.7.2 Intermediate-Level Radioactive Waste (ILW)

ILW is waste that typically exhibits sufficient levels of penetrating radiation to warrant shielding during handling and interim storage. This type of radioactive waste generally requires little or no provision for heat dissipation during its handling, transportation and long-term management. However, because of its total radioactivity level, some ILW may have heat generation implications in the short term, (i.e. refurbishment waste).

<u>Identification of ILW</u>
ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods beyond several hundred years (e.g. beyond 300 to 500 years). IWL would also include alpha-bearing radioactive waste (wastes containing one or more alpha emitting radionuclides, usually actinides) in quantities above the levels acceptable for near surface repositories.

ILW is sometimes subdivided into short-lived (ILW-SL) and long-lived (ILW-LL), depending on the quantity of long-lived radionuclides present.

B.7.3 Low-Level Radioactive Waste (LLW)

LLW contains material with radionuclide content above established clearance levels and exemption quantities, and generally limited amounts of long-lived activity. It requires isolation and containment for up to a few hundred years. LLW generally does not require significant shielding during handling and interim storage.

<u>Very-Short-Lived Low-Level Radioactive Waste (VSLLW)</u>
VSLLW is waste that can be stored for decay for up to a few years and subsequently cleared for release. This classification includes radioactive waste containing only short half-life radionuclides, of the kind typically used for research and biomedical purposes. Examples of VSLLW are Iridium-192 and Technecium-99m sources and industrial and medical radioactive waste that contains similar short half-life radionuclides.

Generally, the main criterion for VSLLW is the half-life of the predominant radionuclides. In practice, the management of VSLLW should only be applied to radionuclides with a half-life of 100 days or less.

<u>Very-Low-Level Radioactive Waste (VLLW)</u>
VLLW has a low hazard potential, but is nevertheless above the criteria for exemption. Long-term waste management facilities for VLLW do not usually need a high degree of containment or isolation. A near surface repository with limited regulatory control is generally suitable. Typical, VLLW includes bulk material, such as low-activity soil and rubble, decommissioning wastes and some uranium-contaminated wastes.

B.7.4 Uranium mine and mill waste

Uranium mine waste rock and mill tailings are a specific type of radioactive waste generated during the mining and milling of uranium ore and the production of uranium concentrate. In addition to tailings, mining activities typically produce large quantities of mineralized and un-mineralized waste rock, excavated to access the ore body. The tailings and mineralized waste rock contain significant concentrations of long-lived radioactive elements, namely thorium-230 and radium-226.

B.8 Operational responsibilities for long-term management

While numerous government departments, agencies, hospitals, universities and industry members are involved in the management of radioactive waste, only a limited number of organizations are involved in long-term management. Figure B.2 shows the organizations responsible for the long-term management of spent fuel and radioactive waste in Canada.

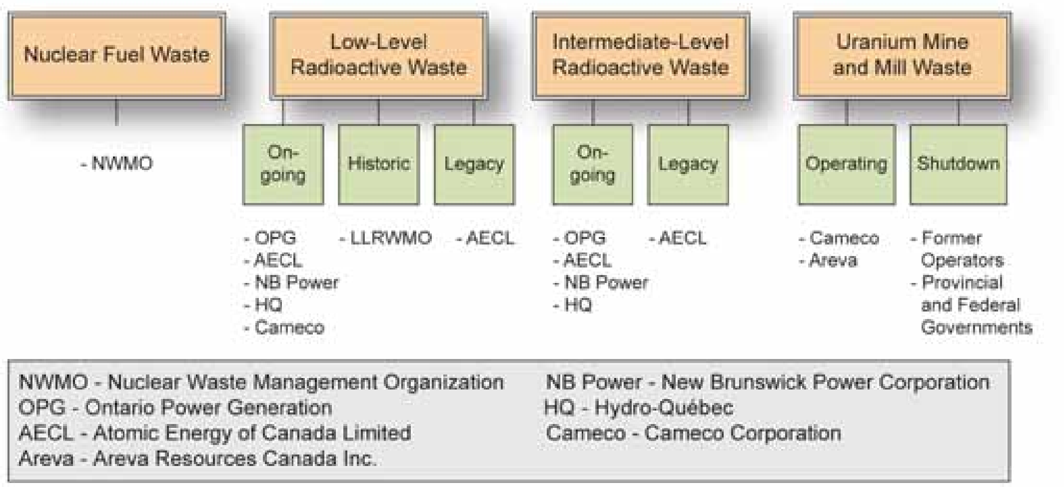


Figure B.2 – Organizations responsible for the long-term management of spent fuel and radioactive waste

The NWMO is responsible for implementing the Government of Canada's APM approach to the long-term management of spent fuel. (See sections G.17 and K.4.)

OPG, NB Power and HQ are responsible for the long-term management of low- and intermediate-level radioactive waste generated from nuclear reactor operations. This includes the spent fuel generated at their respective reactor sites until the NWMO is ready to accept the waste for management in facilities constructed under the APM approach. OPG is also responsible for the long-term management of low- and intermediate-level waste and spent fuel generated at the Bruce Power Generating Station. (Refer to section K.5.1 for information on OPG's Deep Geologic Repository for the long-term management of its low- and intermediate-level waste.)

AECL is responsible for the long-term management of low- and intermediate-level radioactive waste generated by WL, CRL and the three partially decommissioned prototype reactors (Gentilly-1, NPD and Douglas Point), as well as for the low- and intermediate-level waste it accepts from other Canadian licensees on a fee-for-service basis. AECL is responsible for spent fuel, including research reactor fuel, until the NWMO is ready to accept the waste for management in facilities constructed under the APM approach, as well as for used CANDU fuel sent to its laboratories for examination. (For information on AECL's long-term waste management strategy for its low- and intermediate-level waste, refer to section K.5.2.)

The LLRWMO manages historic waste on behalf of the Government of Canada. (See sections H.6.1 and K.5.3 and K.6.2.)

Cameco and AREVA manage the only operating uranium mines and mills in Canada (see Annex 6). Inactive uranium mines and mills sites are located in Ontario, Northwest Territories and Saskatchewan, as described in Annexes 7 and 8.

The term ‘inactive’ is used to describe several different types of inventories, including:

- tailings sites that are currently being decommissioned (e.g. Cluff Lake),

- tailings sites at operating mill sites where closure activities are in progress (e.g. Rabbit Lake and Key Lake), and

- tailings sites at former milling locations. These include recently decommissioned sites with engineered tailings containment systems, such as some of the Denison Mines and Rio Algom sites in the Elliot Lake area, as well as sites that date back to the earliest era of nuclear energy production in Canada, when tailings were deposited in lakes or low areas or lakes (e.g. Port Radium).

All of these inactive sites are either already the CNSC licensed or in the process of becoming licensed. Thus, the site owners are responsible for monitoring and any future remedial work that may be required to protect human health and safety or the environment. Two former uranium mine tailing sites in Saskatchewan have yet to be fully decommissioned: the Gunnar and Lorado sites. The provincial government will decommission the sites, as described in Annex 8.1.1.2.

B.9 Management practices for spent fuel

Spent fuel consists of irradiated fuel bundles removed from commercial, prototype and research nuclear reactors. Three provincial nuclear utilities, namely OPG, HQ and NB Power, own about 98 percent of the spent fuel in Canada. AECL owns the remaining two percent. Spent fuel waste includes nuclear fuel waste, as well as any research reactor fuel waste that is not in the form of a CANDU fuel bundle.

Canada does not have a long-term waste management facility for spent fuel. All spent fuel is currently held in interim wet or dry storage at the generating stations where it is produced. Spent fuel discharged from CANDU reactors is placed into special wet storage bays for several years, depending on site-specific needs, and is eventually transferred to an interim dry storage facility. Three designs of dry storage containers are used in Canada:

- AECL silos,
- AECL MACSTOR
- OPG dry storage Containers

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

To address the long-term management of spent fuel, the three major waste owners – OPG, HQ and NB Power – established the NWMO in 2002, under the NFWA.

NWMO’s first mandate was to study options for the long-term management of spent fuel and recommend a management option to the Government of Canada, by November 15, 2005. In 2005, NWMO completed its study and recommended APM to the Government of Canada, the end-point of which is a deep repository in an appropriate geologic formation. On June 14, 2007, the Government adopted NWMO`s recommendation. Following this decision, NWMO assumed responsibility for implementing the APM. (For a full description of this long-term management plan for Canada’s spent fuel, refer to sections G.17 and K.4.)

B.10 Management practices for low- and intermediate-level radioactive waste

In Canada, low- and intermediate-level radioactive waste refers to all forms of radioactive waste, except for spent fuel and waste derived from uranium and thorium mining and milling.

OPG, which owns 20 of Canada’s 22 CANDU reactors, is responsible for approximately 77 percent of the low- and intermediate-level radioactive waste generated in Canada annually. AECL produces approximately 17 percent of the annual volume through its research and development activities at CRL and on-site decommissioning activities. AECL also accepts low- and intermediate-level radioactive waste from a number of small producers and users of radioactive materials for long-term management, which amounts to a further three percent of Canada's annual volume. The other two CANDU reactors, owned by NB Power and HQ, and Cameco Corporation's uranium processing and conversion facilities in Ontario generate most of the remaining waste. The owners of low- and intermediate-level radioactive waste all manage and operate storage facilities for their wastes. In addition, the two major waste owners, OPG and AECL, are pursuing long-term management solutions.

With regard to electricity generation, OPG's low- and intermediate-level radioactive waste from its CANDU reactors is safely stored in a central location at the Western Waste Management Facility at the Bruce Nuclear Power Development (BNPD) site in Kincardine, Ontario. OPG entered into an agreement with the Municipality of Kincardine on October 13, 2004, to host a Deep Geologic Repository designed to hold current and future low- and intermediate-level radioactive waste from OPG and Bruce Power's 20 CANDU reactors. (More information on this initiative is provided in section K.5.1.) NB Power and HQ have their own low- and intermediate-level radioactive waste-storage facilities at their reactor sites.

Regarding research and development, AECL has waste storage facilities at its two laboratory sites – CRL and Whiteshell Laboratories, as well as at its three prototype reactor sites. Storage facilities include modular, above-ground storage structures, concrete bunkers and tile holes. AECL also, accepts low- and intermediate-level radioactive waste from small generators, such as hospitals, universities and small industries on a fee-for-service basis.

As described in section K.5.2, the Government of Canada initiated the Nuclear Legacy Liabilities Program to deal with legacy radioactive waste and decommissioning liabilities at AECL sites. The program involves developing and constructing the infrastructure required to characterize, condition, treat, process, package and store legacy waste and implement long-term solutions. The low- and intermediate-level radioactive waste that AECL's ongoing operations generate, as well as that accepted from third party generators, will also be managed in these facilities.

Radioactive waste, such as that from hospital nuclear medicine departments and universities, contains only small amounts of radioactive materials with short half-lives. The radioactivity of this waste normally decays within hours, days or months. Institutions such as hospital nuclear medicine departments and universities have implemented delay-and-decay programs, after which waste can be treated using conventional means.

Canada has significant volumes of low-level radioactive waste (LLW), referred to as historic waste, which was once managed in the past in a manner that is no longer considered acceptable, and for which the current owner cannot be reasonably held responsible. Canada's historic waste inventory consists largely of radium and uranium contaminated soils. The Government of Canada has accepted responsibility for the long-term management of this waste.

The bulk of Canada's historic LLW is located in the southern Ontario communities of Port Hope and Clarington. These wastes and contaminated soils amount to roughly 2 million cubic metres, and relate to the historic operations of a radium and uranium refinery in the Municipality of Port Hope, dating back to in the 1930s. While the LLW materials under management do not pose an immediate unacceptable risk to human health and the environment, there is general consensus in the local community – as well as in professional and regulatory communities – that the in-situ management systems presently implemented are not a suitable long-term solution.

In March 2001, the Government of Canada and the local municipalities agreed to community-developed proposals as potential solutions for the clean-up and long-term management low-level radioactive wastes in the Port Hope area, thereby launching the Port Hope Area Initiative (PHAI). (The PHAI and other initiatives that deal with historic waste are described in section K.5.3.)

The LLRWMO has been ensuring the safe management of the LLW until the implementation of the PHAI is complete. At some sites, decontamination has proven to be technically and economically feasible. The management methods used included packaging the LLW in drums and consolidating the material into engineered, above-ground containment cells on access controlled sites. Regular inspection and monitoring verify the continued safety of these sites.

B.11 Management practices for uranium mine waste rock and mill tailings

Uranium mining and milling processes generate two major sources of radioactive waste: mine waste rock and mill tailings.

Over 200 million tonnes of uranium mill tailings have been generated in Canada since the mid-1950s. There are 25 tailings sites in Ontario, Saskatchewan and the Northwest Territories (Figure B.3). 22 of these sites no longer receive waste material. The three remaining operational tailings management facilities are located in Saskatchewan. The ore mined at McArthur River is transported to Key Lake for milling, as there are no tailings management areas at the McArthur Mine site. Both operational and inactive uranium tailings sites are the joint regulatory responsibility of the CNSC and the provinces and territories where they the sites are located.

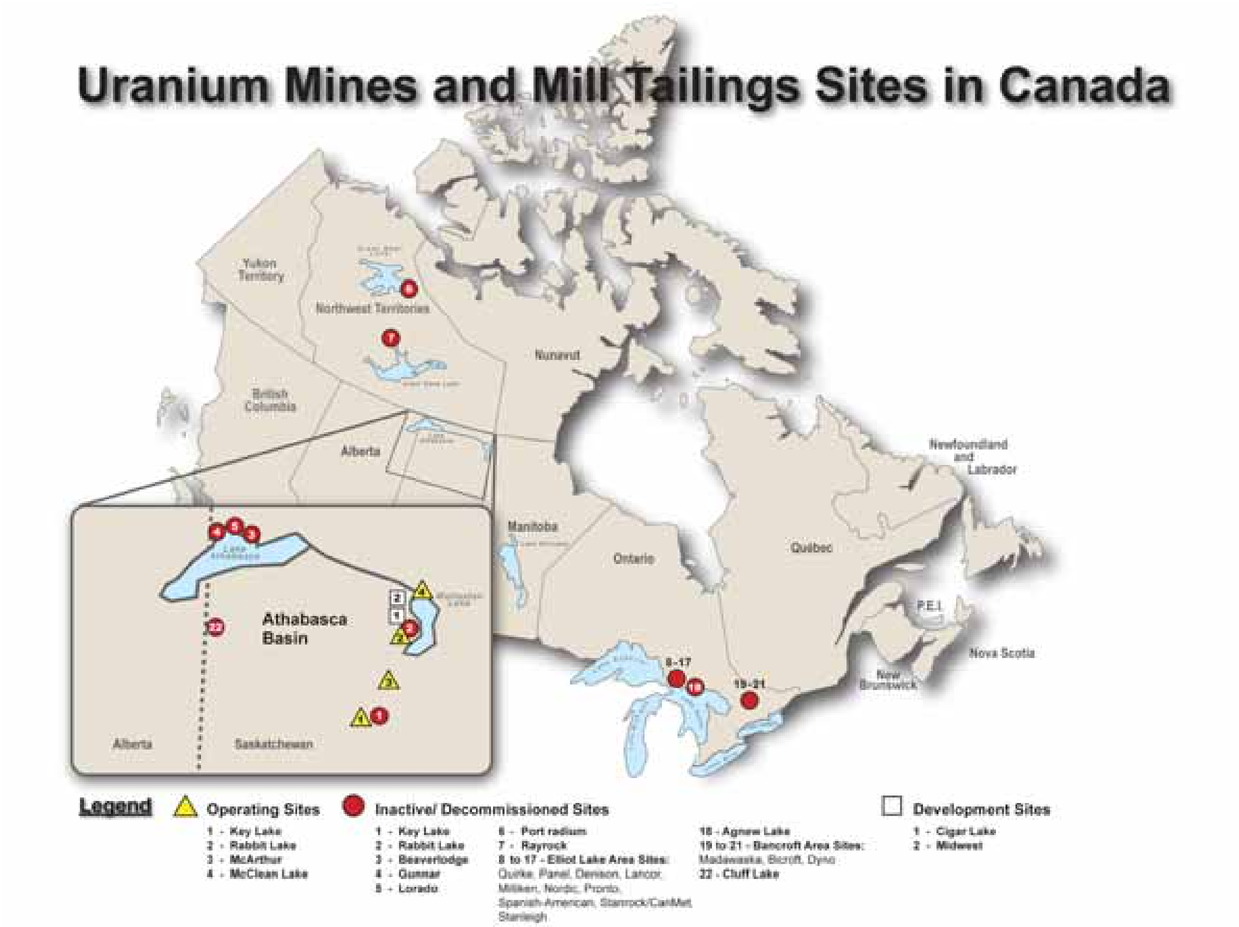


Figure B.3 – Location of operating, inactive and proposed uranium mines and mills

Historically, tailings were used as backfill in underground mines, deposited directly into lake basins or placed in low areas on the ground surface and confined by dams, which were either permeable or water-retaining. Surface tailings could be left bare, covered with soil or flooded, and some bare or covered tailings may have been vegetated. In response to evolving regulatory requirements, the containment structures for surface tailings have become much more rigorously engineered for long-term storage and stability. Tailings management methods at operational facilities include chemically treating tailings to control their mineralogy, prior to placing them in hydrostatically contained Tailings Management Facilities, converted from mined-out open pits.

In addition to the tailings produced from milling uranium ore, millions of cubic metres of waste rock are excavated to gain access to ore. At the Athabasca Basin open-pit sites, most of this waste rock is sandstone, which is environmentally benign and suitable for surface disposal. However, some of the waste rock contains either low-grade, uneconomic ore or significant concentrations of accessory minerals. If left exposed on the surface indefinitely, this *special waste rock* could generate acid or release contaminants at rates that could impact the local environment. The current method of managing special waste rock is to either blend it with high-grade ore for processing or isolate it from atmospheric conditions (e.g. locating it at the bottom of a flooded pit), thus keeping it in an environment similar to that from which it was mined and preventing oxidation reactions.

The inventory of nuclear substances in some inactive uranium tailings management areas can result in these areas being licensed as Class I Nuclear Facilities under the *Class I Nuclear Facilities Regulations*, pursuant to the NSCA. (Refer to section E.3.2.) This has implications for the licensing requirements and long-term management of such facilities. Those responsible for inactive tailings management areas with smaller inventories can be licensed for possession of nuclear substances. These inactive tailings disposal areas and facilities will remain under the CNSC licence control in the absence of a suitable alternative. The Province of Saskatchewan, however, has developed such an alternative for decommissioned mining sites (not limited to uranium) on Crown land in that province (see section H.10.3).

Current management practices for licensed facilities use a lifecycle planning process. A preliminary decommissioning plan and financial guarantees for decommissioning are integral to the licence approval process. All phases in the lifecycle of a facility are subject to the environmental assessment process.

SECTION C – SCOPE OF APPLICATION

C.1 Scope of the section

This section addresses Article 3 (Scope of Application) of the Joint Convention. It provides Canada's position on reprocessing spent fuel, naturally-occurring radioactive waste and military and defence programs.

C.2 Introduction

While neither the NSCA nor its associated regulations define radioactive waste, Regulatory Policy P-290, *Managing Radioactive Waste*, asserts that radioactive waste is "any liquid, gaseous or solid material that contains a nuclear substance, as defined in section 2 of the NSCA and for which the owner of the material foresees no further use and the owner had declared as waste. By definition, a radioactive waste may contain non-radioactive constituents." Radioactive waste is therefore regulated in the same manner as all other materials that contain a nuclear substance. All radioactive waste, whether from a large nuclear facility or a small-scale user, is subject to the Joint Convention, with the exception of:

- reprocessed spent fuel,
- naturally-occurring radioactive materials, and
- military and defence programs.

C.3 Reprocessed spent fuel

Given Canada's large natural resource of uranium, the nuclear industry has not deemed it necessary to reprocess spent fuel at this time. Therefore, pursuant to Article 3(1) of the Joint Convention, Canada declares that reprocessing activities are not part of Canada's spent fuel management program and so are not included in this report. Note, however, that CRL did reprocess spent fuel from the 1940s to the 1960s, to extract plutonium. The wastes from these activities are discussed in this report.

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

C.4 Naturally-occurring radioactive materials

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

- provisions the pertain to the transport of radioactive materials, and

- in the case of naturally-occurring radioactive material listed in the schedule to the *Nuclear Non-proliferation Import and Export Control Regulations*, provisions that govern the import and export of radioactive materials.

In accordance with Article 3(2) of the Joint Convention, only non-exempt naturally-occurring radioactive are discussed in this report, namely radium bearing wastes resulting from the former radium industry, and tailings and waste rock from uranium mines and mills.

C.5 Department of National Defence programs

Although, under Section 5 of the NSCA, the Department of National Defence's programs are not subject to the NSCA or its associated regulations, the Royal Military College of Canada (RMC) slowpoke reactor is, because it is operated as a research reactor (see section H.3.6). Therefore, in accordance with Article 3(3), the RMC slowpoke reactor is the only military or defence program to be addressed in this report.

C.6 Discharges

In accordance with Articles 3(4), 4, 7, 11, 14, 24 and 26, the management facilities of spent fuel, radioactive waste and uranium mines and mills are regulated throughout their entire lifecycle – from site preparation and construction to operation, decommissioning and finally abandonment. At each licence stage, operations must be carried out such that the dose to workers and the public must be as low as reasonably achievable, given economic and social factors. Occupational and public radiological exposure limits derive from internationally accepted standards such as those of the ICRP.

In addition, an environmental monitoring program must be in place to ensure that all reasonable precautions are taken to protect the environment and control the release of radioactive and hazardous substances into the environment at each licensing stage. Limits on the controlled release of gaseous or liquid wastes or solid materials have been adopted from complementary regulatory regimes such as the Provincial Water Quality Objectives or Metal Mining Limits for Liquid Effluent Releases, and derived from specific licence conditions, including the Derived Release limits.

For more information on discharges and ALARA, refer to section F.6. Radiological effluent discharge levels at licensed facilities are outlined in Annexes 4 through 8.

SECTION D – INVENTORIES AND LISTS

D.1 Scope of the section

This section addresses Article 32 (Reporting) (2) of the Joint Convention. It provides a list of the various spent fuel and radioactive waste management facilities in Canada, and indicates the total inventory of each of the waste categories. Each licensee is required to develop and implement an accountability system, including the appropriate records. This system and associated records are subject to regulatory oversight. The requirements Safety Series 115 Part IV.17 are addressed in this section. Maps showing the location of radioactive waste management sites in Eastern, Central and Western Canada are attached in sections D.8 and D.9.

D.2 Inventory of spent fuel in Canada

D.2.1 Spent fuel wet storage inventory at nuclear reactor sites

Almost all nuclear generating stations and research reactor sites store spent fuel waste on-site in irradiated fuel bays (wet storage), pending transfer to a dedicated spent fuel dry storage centre. Table D.1 inventories the number of spent fuel bundles in wet storage in Canada, and Table D.2 the spent fuel in dry storage.

Table D.1 – Inventory of spent fuel in wet storage in Canada as of December 31, 2007

Site	Number of Fuel Bundles in Wet Storage	Kilograms of Uranium[5]
Bruce A and B Nuclear Generating Stations	745,686	14,182,790
Darlington Nuclear Generating Station	322,757	6,163,294
Gentilly-2 Nuclear Generating Station	37,037	705,735
Pickering A and B Nuclear Generating Station	394,862	7,833,555
Point Lepreau Nuclear Generating Station	35,070	673,223
McMaster Nuclear Research Reactor (MNR)	40[1]	8.4[4]
Chalk River Laboratories (CRL) – National Research Universal (NRU)	367[1]	3,271[3]

Table D.2 – Inventory of spent fuel in dry storage facilities in Canada as of December 31, 2007

Site	Number of Fuel Bundles in Dry Storage	Kilograms of Uranium [5]
CRL Waste Management Area (WMA) G (Nuclear Power Demonstration Fuel)	4,853	9,817
CRL WMA B (Research Reactor Fuel)	4,723[1]	5,310[2]
Douglas Point Waste Management Facility	22,256	299,827
Gentilly-1 Waste Management Facility	3,213	67,595
Gentilly-2 Waste Management Facility	70,200	1,331,227
Pickering Waste Management Facility	176,544	3,506,819
Point Lepreau Waste Management Facility	81,000	1,553,282
Western Waste Management Facility (located at Bruce Site)	107,900	2,051,798
Whiteshell Laboratories	2,268	21,540

[1] For research reactors, inventory is reported as the number of research rods, fuel assemblies, units or items.
[2] CRL's spent fuel stored in tile holes has been estimated in kilograms of uranium.
[3] Natural, depleted and enriched uranium as of May 7, 2007.
[4] Enriched uranium fuel as of May 25, 2007.
[5] Reported as spent fuel (depleted or enriched fuel), unless otherwise noted.

D.3 Radioactive waste inventory

D.3.1 Radioactive waste management facilities

The table below (Table D.3) describes the low- and intermediate-level waste being stored, the waste management methods, and the inventory of low- and intermediate-level waste in storage at each facility in Canada.

Table D.3 – Inventory of radioactive waste management for low-level radioactive waste (LLW) and intermediate-level radioactive waste (ILW) in Canada (as of December 31, 2007)

Radioactive Waste management or Nuclear Fuel cycle Facility	Company Name or Responsible Party	Description of Stored Waste	Storage Method	On-site Waste Inventory as of December 31, 2007			
				ILW		LLW	
				Volume (m^3)	Activity (TBq)	Volume (m^3)	Activity (TBq)
Western Waste Management Facility (WWMF)	OPG	Interim storage of low- and intermediate-level reactor waste generated at Bruce A and B, Darlington and Pickering A and B.	ILW: in-ground storage structures, including trenches, tile holes and in-ground containers, and above-ground storage structures, including a re-tube waste-storage building and quadricells. LLW: above-ground low-level storage buildings.	9,340	39,685	66,040	91
Pickering Waste Management Facility	OPG	Re-tube reactor waste from refurbishment.	ILW: dry storage modules (DSM).	950	17,900	nil	nil
Gentilly-2	HQ	Operational reactor waste.	ILW: ASDR (concrete cells). LLW: ASDR (concrete cells).	33.17	52.52	760	4.64
Point Lepreau	NB Power	Operational reactor waste.	ILW: quadricells. LLW: concrete vaults.	24	293	1647	0.6
Chalk River Laboratories	AECL	Research reactor and isotope production waste, as well as external waste.	ILW: tile holes and bunkers. LLW: sand trenches, low-level storage buildings, above-ground stockpiles and Modular Above-Ground	18,221[6]	n/a	95,299[6]	n/a

Radioactive Waste management or Nuclear Fuel cycle Facility	Company Name or Responsible Party	Description of Stored Waste	Storage Method	On-site Waste Inventory as of December 31, 2007			
				ILW		LLW	
				Volume (m^3)	Activity (TBq)	Volume (m^3)	Activity (TBq)
			Storage (MAGS). I & LLW: Shielded modular above-ground storage (SMAGS).	764[7]	n/a	n/a[7]	n/a
Port Hope Conversion Facility	Cameco	Non-combustible process waste.	LLW: 205-litre drums.	nil	nil	6,650	n/a
Blind River Refinery	Cameco	Non-combustible process waste.	LLW: 205-litre drums.	nil	nil	1,900	n/a
Whiteshell Laboratories	AECL	Research reactor waste.	ILW: in-ground concrete bunkers. LLW: above-ground concrete bunkers.	863	2,942	19,885	333
RWOS 1	OPG	Low- and intermediate-level waste from Douglas Point.	ILW: in-ground storage structures, including trenches and lined tile holes. LLW: trenches.	10	24[8]	630	1[8]

[6] Volumes are based on method of storage and do not necessarily represent the actual breakdown of waste into intermediate and low-level.

[7] SMAGS Unit 1 was put in service in 2008. The waste volume reported in the table was temporarily stored until Unit 1 was completed and then transferred to SMAGS Unit 1 in 2008.

[8] RWOS 1 activity estimated from total of 25 TBq on the basis of 95 percent of activity in ILW and five percent in LLW.

Table D.4 describes the radioactive waste from past practices that is stored at each site and how it is managed.

Table D.4 – Management of low-level radioactive waste (LLW) from past practices

Site Name or Location	Licensee or Responsible Party	Description of Stored Waste	Storage Method	LLW	
				Volume (m^3)	Activity (TBq)
Port Hope	LLRWMO	Contaminated soils.	LLW: above-ground mounds.	720,000	n/a
Welcome	Cameco	Wastes and contaminated soils.	LLW: burial.	480,000	n/a
Port Granby	Cameco	Wastes and contaminated soils.	LLW: burial.	440,000	n/a
Northern Transportation Route	LLRWMO	Contaminated soils.	LLW: soil stored in various areas.	10,000	n/a
Fort McMurray, Alberta	LLRWMO	Contaminated soils.	LLW: above-ground, consolidated mound.	43,000	n/a
Greater Toronto Area	LLRWMO Toronto Regional Conservation Authority (TRCA) Ontario Realty Corporation (ORC)	Radium contaminated soils. Radium contamination fixed to structural elements in buildings.	In-situ -Fenced-in areas Isolation behind a double wall and ceiling. Above-ground consolidated mounds	13,500	n/a
Deloro Mine Site	Ontario Ministry of the Environment (OMOE)	Contaminated soils and historical tailings.	In-situ. (Fenced-in area)	37,500	6.3

Table D.5 inventories the low- and intermediate-level radioactive waste resulting from decommissioning activities at Canadian facilities, as of December 31, 2007. Note that the Cluff Lake site, which is currently being decommissioned, is included in Table D.7.

Table D.5 – Low- and intermediate-level radioactive waste (LLW and ILW) in Canada from decommissioning activities (as of December 31, 2007)

Site Name or Location	Company Name or Responsible Party	Description of Stored Waste	Storage Method	On-site Waste Inventory as of December 31, 2007			
				ILW		LLW	
				Volume (m^3)	Activity (TBq)	Volume (m^3)	Activity (TBq)
Whiteshell Laboratories	AECL	Decommissioning waste (January 1, 2005 to December 31, 2007)	ILW: in-ground, concrete bunkers. LLW: above-ground, concrete bunkers.	1.3	0.011	231	0.049
Chalk River Laboratories	AECL	Decommissioning waste (January 1, 2005 to December 31, 2007)	ILW: tile holes and bunkers. LLW: MAGS.	49[9]	n/a	123[9]	n/a
Douglas Point Waste Management Facility	AECL	Decommissioned reactor waste.	Reactor building.	61	n/a	62	77
Nuclear Power Demonstration Waste Management Facility	AECL	Decommissioned reactor waste.	LLW: reactor building.	nil	nil	30	2,000[10]
Gentilly-1 Waste Management Facility	AECL	Decommissioned reactor waste.	Reactor building.	27	n/a	927	243

[9] Volumes are based on method of storage, and do not necessarily represent the actual breakdown of waste into low- and intermediate level radioactive waste.

[10] Volume does not include reactor components, such as shielding and heat transport systems, in the reactor buildings.

D.4 Uranium mining and milling waste

Uranium mining and milling generates two main forms of waste: tailings and waste rock. Historically, waste rock has been either stockpiled above-ground or used as backfill in underground mines. Today, mineralized *special waste rock* is segregated and managed with due consideration given to the hazards associated with mineralization and particular contaminants. Tailings are managed in engineered Tailings Management Facilities (TMFs). The unit of measure used in this report for uranium mine and mill wastes is tonne of dry mass, as this is the same unit used in the mining industry to track and report materials.

D.4.1 Operational mine and mill sites

Table D.6 details the uranium tailings and waste rock in storage at operational mine sites in Canada.

Table D.6 – Uranium tailings and waste rock at operational mine sites (as of December 31, 2007)

Operating Tailings Sites	Company Name or Responsible Party	Storage Method	On-site Waste Inventory as of December 31, 2007		
			Tailings	Waste Rock	
			Mass (tonnes)	Mineralized (tonnes)	Non-Mineralized (tonnes)
Key Lake	Cameco	Tailings management area stores tailings from Key Lake and McArthur River.	3,090,000[11]	1,720,000	64,980,000
Rabbit Lake	Cameco	Tailings management area holds tailings from Rabbit Lake and Cigar Lake.	6,750,000[11]	2,310,000	23,040,000[12]
McClean Lake Operations	AREVA	In-pit tailings management facility stores tailings from McClean Lake. This facility will soon be used for tailing from Cigar lake and Midwest as well.	1,246,800	5,900,000	51,700,000
McArthur River	Cameco	No tailings on-site. Ore is transported to Key Lake for milling.	nil	140,000	1,470,000
Cigar Lake	Cameco	No tailings on-site. Once operational, ore will be transported to McClean Lake and Rabbit Lake for milling.	nil	3,700	430,000

[11] Operational facility (see Table D.7 for inactive, on-site tailing management facilities)
[12] The amount of non-mineralized waste rock at Rabbit Lake is significantly higher than reported in 2005, due to an error (B-zone pile was not included).

D.4.2 Inventory of uranium mine and mill waste at inactive tailings sites

Table D.7 inventories waste rock and mill tailings at tailing sites that are no longer operational. As illustrated in Table D.6., there are operational tailings facilities at Key Lake and Rabbit Lake. 'Inactive', in this context, refers to several different types of inventories described in section B.8. Note that, while the waste rock inventory is provided for the Cluff Lake site and included in Table D.6 for the Rabbit Lake and Key Lake sites, it is generally not available for the older sites.

Table D.7 – Uranium tailings and waste rock at decommissioned and inactive tailings sites (as of December 31, 2007)

Site Name or Location	Company Name or Responsible Party	Storage Method	On-site Waste Inventory as of December 31, 2007		
			Tailings	Waste Rock	
			Mass (tonnes)	Mineralized (tonnes)	Non-Mineralized (tonnes)
Decommissioning Tailings Sites					
Cluff Lake	AREVA	Surface.	3,230,000	n/a[13]	18,400,000
Inactive Tailings Sites					
Key Lake	Cameco	Above-ground tailings management facility.	3,590,000	n/a	n/a
Rabbit Lake	Cameco	Above-ground tailings management facility.	6,500,000	n/a	n/a
Beaverlodge	Cameco	Above-ground tailings and mine backfill.	10,100,000[14]	n/a	4,800,000
Gunnar	Saskatchewan Research Council	Above-ground tailings.	4,400,000	n/a	n/a
Lorado	Saskatchewan Research Council	Above-ground tailings.	360,000	n/a	n/a
Port Radium	Indian and Northern Affairs Canada	Above-ground tailings in four areas.	907,000	n/a	n/a
Rayrock	Indian and Northern Affairs Canada	Above-ground tailings in North and South tailings piles	71,000	n/a	n/a
Quirke 1 and 2	Rio Algom Ltd.	Flooded, above-ground tailings.	46,000,000	n/a	n/a
Panel	Rio Algom Ltd.	Flooded, above-ground tailings.	16,000,000	n/a	n/a
Denison	Denison Mines Inc.	Flooded, above-ground tailings in two areas.	63,800,000	n/a	n/a

Site Name or Location	Company Name or Responsible Party	Storage Method	On-site Waste Inventory as of December 31, 2007		
			Tailings	Waste Rock	
			Mass (tonnes)	Mineralized (tonnes)	Non-Mineralized (tonnes)
Spanish American	Rio Algom Ltd.	Flooded, above-ground tailings.	450,000	n/a	n/a
Stanrock/Can-Met	Denison Mines Inc.	Above-ground tailings.	5,750,000	n/a	n/a
Stanleigh	Rio Algom Ltd.	Flooded, above-ground tailings.	19,953,000	n/a	n/a
Lacnor	Rio Algom Ltd.	Above-ground tailings.	2,700,000	n/a	n/a
Nordic	Rio Algom Ltd.	Above-ground tailings.	12,000,000	n/a	n/a
Milliken	Rio Algom Ltd.	Tailings management area.	150,000	n/a	n/a
Pronto	Rio Algom Ltd.	Above-ground tailings.	2,100,000	n/a	n/a
Agnew Lake	Ontario Ministry of Northern Development and Mines	Lake-vegetated, above-ground tailings.	510,000	n/a	n/a
Dyno	EnCana West Limited	Above-ground tailings.	600,000	n/a	n/a
Bicroft	Barrick Gold Corp.	Above-ground tailings in two areas	2,000,000	n/a	n/a
Madawaska	Madawaska Mines Ltd.	Above-ground tailings in two areas	4,000,000	n/a	n/a

[13] Not available. Note that much of the mining at Cluff Lake predated current waste segregation practices.
[14] Includes 4,300,000 tonnes placed underground.
Notes: n/a = not available

Figure D.8 – Map of radioactive waste management sites in Eastern Canada

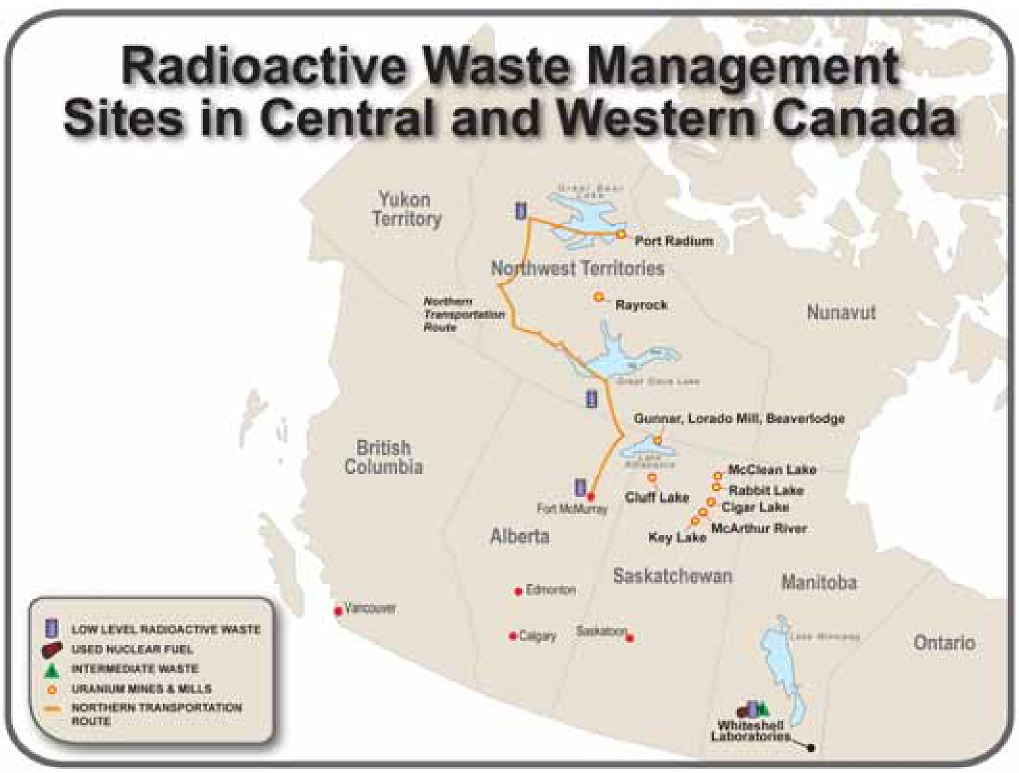


Figure D.9 – Map of radioactive waste management sites in Central and Western Canada

SECTION E – LEGISLATIVE AND REGULATORY SYSTEMS

E.1 Scope of the section

This section addresses Articles 18 (Implementing Measures), 19 (Legislative and Regulatory Framework) and 20 (Regulatory Body), of the Joint Convention, as well as requirements set out in Articles 19 and 20 of the IAEA Safety Standard GS-R-1, *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety*. Specifically, this section describes Canada's legislative and regulatory framework, regulatory body and approach to licensing radioactive material.

The NSCA provides the regulatory body with a mandate to establish and enforce national standards in the areas of public health, and safety, and environmental protection. It also establishes a basis for implementing Canadian policy and fulfilling Canada's obligations with respect to the non-proliferation of nuclear weapons. The NSCA sets out a formal system for review and appeal of decisions and orders made by the Commission Tribunal, designated officers and inspectors. It should be noted that the Commission Tribunal has legal authority to hear witnesses, take evidence and control its own proceedings. Additionally, the NSCA empowers the Commission Tribunal to require financial guarantees, to order remedial action in hazardous situations, and to require responsible parties to bear the costs of decontamination and other remedial measures.

E.2 Establishment of the Canadian legislative and regulatory framework

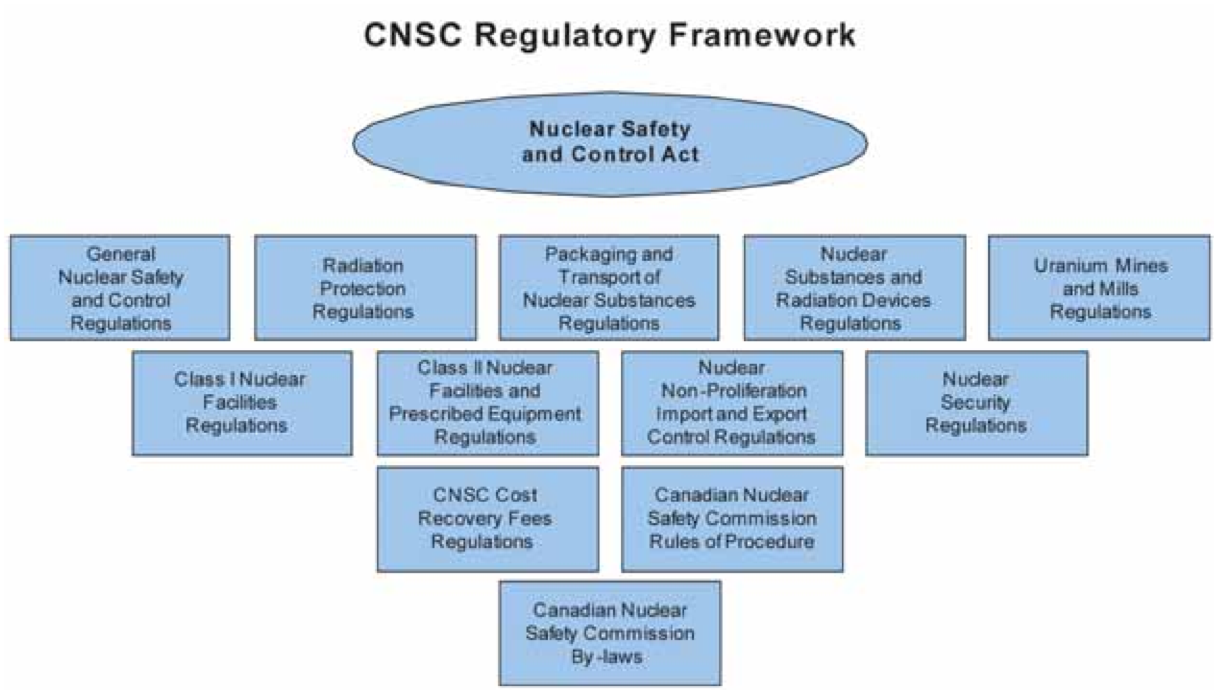
In Canada, matters that relate to nuclear activities and substances are under the jurisdiction of the federal government. NRCan has been charged with setting Canada's nuclear policies, including those concerning radioactive wastes. The *Policy Framework for Radioactive Wastes* establishes the roles and responsibilities of the federal government and waste producers. In particular, the federal government guides, oversees and regulates radioactive waste producers.

Section 9 of the NSCA states the objects of the NSCA and grants regulatory authority to the Commission Tribunal over the use of nuclear materials. The CNSC's responsibilities include the issuing licences, making regulations and enforcing compliance.

A list of the various federal organizations and acts that relate directly to Canada's nuclear industry is provided in Annexes 1 and 2. A detailed description of the regulatory body, its structure, operations and regulatory activities is provided in Annex 3.

E.3 National safety requirements

The NSCA is the foundation of Canada's regulatory framework, depicted in Figure E.1. All regulations are based on the NSCA.



E.3.1 Nuclear Safety and Control Act (NSCA)

In the Canadian Parliamentary system, the federal Cabinet – on the advice and recommendation of the appropriate Minister – makes the decision to introduce government legislation into Parliament. The NSCA was passed by Parliament on March 20, 1997, and became law in May 2000. 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 all the nuclear industry developments since 1946. These developments include health and safety standards for new energy workers, environmental protection measures, security regarding nuclear facilities, and public input into the licensing process. The NSCA can be viewed at: nuclearsafety.gc.ca

The NSCA establishes the CNSC as an independent regulatory body, responsible for regulating the use of nuclear material in Canada, including the nuclear fuel cycle. The CNSC is comprised of the Commission Tribunal, which makes licensing decisions, and the CNSC's personnel organization, which prepares recommendations to the Commission Tribunal, exercises delegated licensing and authorization powers and assesses licensee compliance with the NSCA, the Act's associated regulations and licence conditions. The NSCA gives the CNSC the power to make regulations, as shown in section E.3.2 below.

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

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

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

According to the Parliamentary Directive issued to the CNSC in December 2007, the CNSC now readily takes into account the health of Canadians in regulating the production, possession and use of nuclear substances, in order to ensure the necessary protection of the health of Canadians at times when a serious shortage of medical isotopes – in Canada or around the world – puts the health of Canadians at risk.

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

- radiation dose limits that are consistent with International Commission on Radiological Protection (ICRP) recommendations,
- regulations that govern the transport and packaging of nuclear materials, and
- specifications for enhanced security at nuclear facilities, including spent fuel dry storage and radioactive waste-management facilities.

The CNSC also has responsibilities under the NLA. The regulatory body conducts environmental assessments under the CEA Act and implements Canada's bilateral agreement with the IAEA on nuclear safeguards verification. As a model of regulatory efficiency, the CNSC oversees the entire nuclear cycle and all aspects of nuclear safety in Canada.

E.3.2 Regulations issued under the NSCA

As illustrated in Figure E.1, there are nine safety-related regulations issued under the NSCA:

1. *General Nuclear Safety and Control Regulations*,
2. *Radiation Protection Regulations*,
3. *Class I Nuclear Facilities Regulations*,
4. *Class II Nuclear Facilities and Prescribed Equipment Regulations*,
5. *Uranium Mines and Mills Regulations*,
6. *Nuclear Substances and Radiation Devices Regulations*,
7. *Packaging and Transport of Nuclear Substances Regulations*,
8. *Nuclear Security Regulations*, and
9. *Nuclear Non-proliferation Import and Export Control Regulations.*

In addition to the safety regulations, the CNSC's *Rules of Procedure* must also be followed. They apply to the public, licensees, the CNSC's personnel and Commission Tribunal members, and govern to the conduct of Commission Tribunal proceedings.

The regulatory regime is flexible about how licensees comply with regulatory requirements.

The regulations require licence applicants to submit information on the environmental effects of their use of both radioactive and non-radioactive hazardous substances. The CNSC then uses this information and consults other federal and provincial regulatory bodies to establish the operating parameters for a specific nuclear facility. Brief descriptions of the regulations are provided below. Note, however, that all of the regulations can be viewed in full at: nuclearsafety.gc.ca

General Nuclear Safety and Control Regulations (GNSCR): outline the information to be included in licence applications; the obligations of licensees and their workers; definitions of prescribed nuclear facilities, equipment and information; and reporting and record keeping requirements. The GNSCR also detail the requirements for an application for a licence to abandon and obligations to provide information on any propose financial guarantees. Note that, while these regulations apply to all licensees, including licensees for management of spent fuel and radioactive waste and decommissioning activities, the naturally-occurring radioactive materials that are not associated with the development, production or use of nuclear energy are exempt.

Radiation Protection Regulations (RPR): contain radiation protection requirements. They apply to all licensees and others who fall under the mandate of the CNSC. The RPR require the development of action levels, which are proposed by the licensee and subject to the regulatory body's approval. Action levels are not intended to be secondary legal limits, but rather checks for the proper operation of a licensee's radiation protection program.

The dose limits are based on the ICRP's 1991 recommendations and apply to all organizations that fall within the CNSC's mandate. Nuclear energy workers (NEWs), for instance, must not be exposed to more than 100 millisievert (mSv) over a five-year period or more than 50 mSv in a single year. The dose limit for pregnant NEWs is much lower, at four mSv per year. Member of the public must not be exposed to more than one mSv per year.

<u>Pregnant Nuclear Energy Workers</u>
In 1990, the ICRP published new dose guidelines of two mSv for pregnant nuclear energy workers. The Canadian regulatory body initially planned to adopt this new recommendation. The new limit, which was 20 percent of the previous one, drew heavy criticism from both the industry and the scientific community. It was widely believed that such an extremely low dose would be very difficult to regulate, and might restrict employment opportunities for female workers in Canada.

As is always the case when there are proposed changes to regulations, the public and industry were given the opportunity to review and comment on them. Public and industry response to the new proposed guidelines for occupational exposure for pregnant workers was made available in September 1992. Five major points were brought forward, of which two were given further consideration: (1) the reassignment of pregnant workers to non-radiation work will present major difficulties and (2) the bioassay programs are not available to show compliance with the intake limit of 0.05 ALI for pregnant NEWs. These concerns led to a second public consultation, which took place in October and November 1992.

Three main concerns were raised in this second round of consultation:

1. Dose limits – while participants generally agreed that it is appropriate to set the same dose limit for a fetus as for a member of general public, they deemed the proposed limit to be too low. Many believed that the risk estimates did not warrant a change to the original 10 mSv limit.

2. Compliance – participants suggested that internal dosimetry would first need to be improved before they could demonstrate compliance with the proposed limit, and that contamination surveys, as opposed to a bioassay, could be used to comply with regulations.

3. Other comments – many participants felt that the social and economic impacts of the proposed changes must be examined, and believed that a mandatory declaration of pregnancy would be an invasion of workers' privacy.

The CNSC heard these concerns and adopted several participants' internal and external dosimetry suggestions. It also issued a document entitled *Revised Proposal for the Dose Limit for Pregnant Radiation Workers*, which increased the proposed dose limit from two to four mSv. This change to the proposed dose limit reflects social concerns raised during the consultative process and accepts that a mother may be willing to accept certain risks.

Though no longer consistent with the ICRP-60 recommendation that the public not be exposed to more than one mSv per year, the revised dose limit is consistent with ICRP's conclusion that, in special circumstances, a higher dose could be allowed, provided that the average over five years does not exceed one mSv per year. IAEA Safety Series No. 115 also states that, in special circumstances, a dose of up to five mSv in a single year is permissible, provided that the average dose over five consecutive years does not exceed one mSv per year.

Both the ICRP and IAEA agree that: (1) five mSv is not a significant conceptus dose; (2) it is reasonable to assume that a child would not be exposed to an additional dose until at least the age of five; (3) there is scientific rationale to support a dose limit of five mSv, and, in special circumstances, a balance of pregnancy limit of five mSv would not pose a detectable risk to a conceptus. Therefore, the Canadian regulatory body's adoption of a four mSv dose limit for the balance of pregnancy mitigates both social and scientific considerations of conceptus risk.

Class I Nuclear Facilities Regulations: detail the information licensees need to supply when applying for different types of Class I nuclear facility licences. Licences are available for stage in the lifecycle of a facility, including site preparation, construction, operation, decommissioning and abandonment. The regulations also address recordkeeping and the certification of reactor operators.

Note that under the NSCA, one of the definitions of a nuclear facility is "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 such a facility is located, a building that forms part of the facility, equipment used in conjunction with the facility and any system for the management, storage or disposal of a nuclear substance. As defined under section 19(a) of the GNSCR, a facility that manages, stores or disposes of radioactive waste and whose resident inventory of radioactive nuclear substances is greater than 10^{15} Bq is a prescribed, Class I nuclear facility.

Class II Nuclear Facilities and Prescribed Equipment Regulations: specify the requirements for prescribed equipment, including low-energy accelerators, irradiators, radiation-therapy installations and equipment that contains only sealed sources.

***Nuclear Substances and Radiation Devices Regulations* (NSRDR)**: apply to all nuclear substances, sealed sources and radiation devices used in Canada that are not included in Class II prescribed equipment. In order to harmonize Canada's regulatory approach for the exemption and clearance of radioactive material with international practices, CNSC amended the NSRDRs to consider the IAEA Basic Safety Standards, as well as the most recent guidance from the IAEA on the concepts of exemption, exclusion and clearance. The amendments, following extensive stakeholder input, were approved by the Governor-in-Council, and subsequently published in the *Canada Gazette Part II*. The amended regulations came into force on April 17, 2008. Further information on exemption and clearance levels is discussed below.

<u>Exemption and Clearance</u>

Some materials excluded from the regulatory process because the associated radioactivity presents such a low risk that control by regulatory processes is not warranted. There are two such categories: radioactive material that never enters the regulatory control regime; and radioactive material that is released from regulatory control. Note that exempt and cleared waste materials may still be subject to other regulations, e.g. transportation regulations.

<u>Exemption</u>

Radioactive materials in the first category are excluded from regulatory control by a process called exemption. Exempted waste is material that contains less than the exemption quantity as defined in section 1 of the NSRDRs. Although still radioactive from a physical point of view, exempted material can be safely disposed of, applying conventional techniques and systems, without specifically considering its radioactive properties.

Clearance
The release of radioactive material from control, on the other hand, is called clearance. Clearance of radioactive material is a management tool, not a waste classification. There are two forms of clearance: unconditional and conditional clearance. Unconditional clearance levels are defined in the amended NSRDRs.

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

Nuclear Security Regulations **(NSR)**: were amended in November 2006 and now align Canadian nuclear facilities with the IAEA's internationally accepted recommendations. In the development of the NSR, the CNSC gave due consideration to threats to Canada's security and included a number of new physical-protection requirements for security sensitive areas, including:

- enhanced security screening of employees and contractors,
- enhanced identification checks of personnel,
- enhanced screening of persons and vehicles when entering or leaving a protected area,
- heightened protection against forced vehicle penetration of protected areas, and
- enhanced intrusion detection for protected areas.

Uranium Mines and Mills Regulations **(UMMR)**: detail the information needed for licence applications for uranium mines and mills, as well as code-of-practice and record keeping requirements and licensee obligations. Licences are available for each stage of a facility's lifecycle, including site preparation, construction, operation, decommissioning and abandonment. UMMR apply to all uranium mines and mills, including management of mill tailings, but not to uranium prospecting or surface-exploration activities.

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

Cost Recovery Regulations: enable the CNSC to recover the actual cost of regulating the nuclear industry equitably through licence fees.

E.3.3 Regulatory documents

The NSCA and its associated regulations provide the basis with regard to regulatory expectations and decisions.

In 2007, the CNSC streamlined and improved its regulatory framework. The organization strengthened the roles and responsibilities of the Regulatory Policy Committee (RPC) to align the CNSC's regulatory framework with its overall strategic direction. In September 2007, the Commission Tirbunal approved a revised regulatory framework for the development and approval of regulations and regulatory documents proposed by the RPC.

The following explanatory text is included in all regulatory documents:

- The CNSC develops regulatory documents under the authority of paragraphs 9(*b*) and 21(1)(*e*) of the NSCA.

- Regulatory documents clarify NSCA requirements and associated regulations, and are an integral part of the regulatory framework for nuclear activities in Canada.

- Each regulatory document aims to disseminate objective regulatory information to stakeholders, including licensees, applicants, public interest groups and the public, and promote consistency in the interpretation and implementation of regulatory requirements.

Additional information on the CNSC's regulatory documents program is available online at: nuclearsafety.gc.ca

As outlined in the CNSC regulatory policy *Regulatory Fundamental* (P-299), the CNSC bases its regulatory requirements on industry, national and international standards and best practices, including those of the IAEA. Canada has actively helped the IAEA develop nuclear safety standards and create technical documents, which outline more specific technical requirements and best practices for radioactive waste management and decommissioning.

A list of the CNSC's regulatory documents is included in Annex 3.6.1. Two of these documents are specific to spent fuel and radioactive waste. Other more generic regulatory documents that relate to action levels, decommissioning, environmental protection and public-information programs may also apply to waste management facilities. The CNSC's regulatory documents for radioactive waste and decommissioning are described below. A complete list of regulatory documents is available at: nuclearsafety.gc.ca

Regulatory Policy P-290, *Managing Radioactive Waste*
The CNSC issued P-290 in July 2004, following extensive consultation with the public, the nuclear industry and other stakeholders. P-290 is discussed in section B.5.

Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management*
The CNSC's Regulatory Policy P-290 identifies the need for long-term management of radioactive waste and non-radioactive hazardous waste arising from licensed activities. In December 2006, Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management*, was published to assist licensees and applicants assess the long-term storage and disposal of radioactive waste. The Guide (discussed in section B.6) was developed using provincial, federal and international documents, following a pre-consultation with the nuclear industry in Canada.

Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*
This document provides guidance on the preparation of plans for the decommissioning of activities licensed by the CNSC. G-219 is described in section F.8.

Regulatory Policy P-319 Financial Guarantees
The CNSC's personnel are considering the development of a revised policy and program for financial guarantees, in consultation with other government stakeholders, which will current international guidance. For more details, please refer to section F.4.3.

E.4 Comprehensive licensing system for spent fuel and radioactive waste management activities

E.4.1 Licensing procedure

Canada maintains the philosophy that licensees is responsible for the safe operations of its facilities. Because licensees make safety related decisions routinely, they must have a robust set of programs and processes in place to ensure adequate protection of the environment, and the health and safety of workers and the public. The CNSC performs regulatory oversight and verifies that licensees and operators comply with regulations.

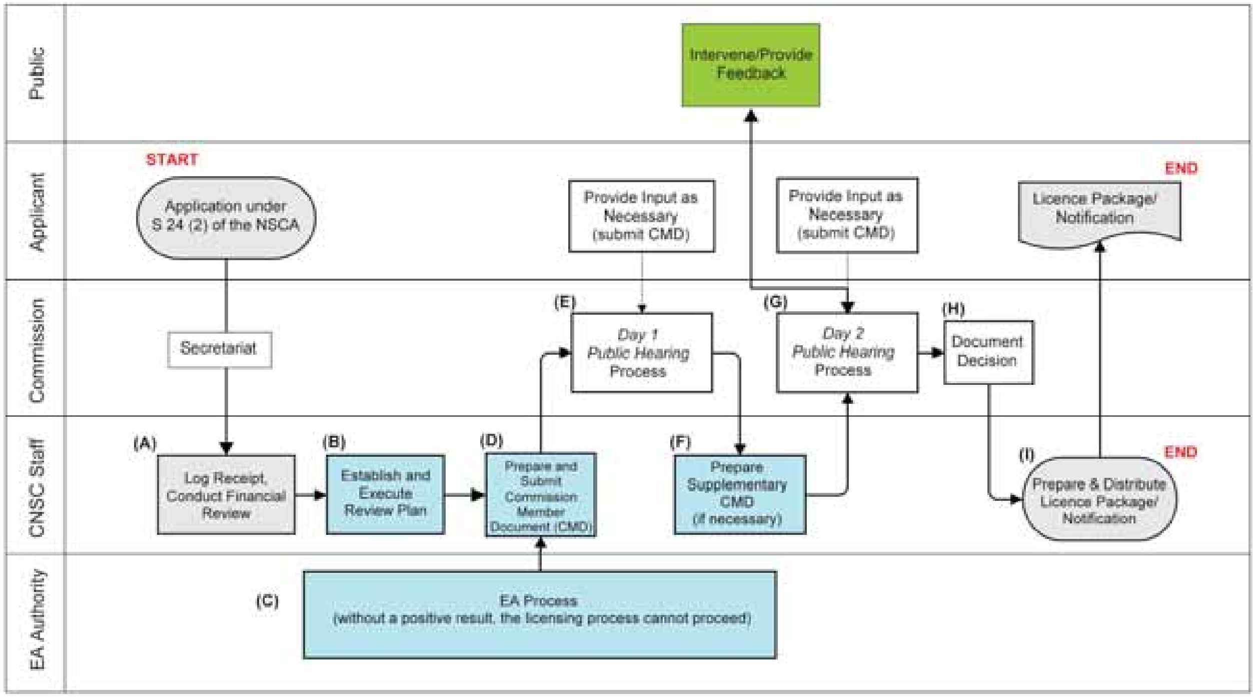


Figure E.2 – The licensing process

Figure E.2 illustrates how an applicant can obtain a licence under the NSCA. First, the applicant must submit either an application for a licence (or letter of intent), or a notification of intent for a project to the CNSC. Applicants must meet general performance criteria, provide information and develop programs in accordance with NSCA regulations to be considered. The CNSC's personnel publish regulatory documents, including policies, guides, standards and notices, which help licensees meet regulatory requirements. Licensees are obligated to adhere to terms and conditions of licence, such as references to standards and decommissioning planning and financial guarantee requirements.

An application for a CNSC licence, including renewals or amendments, may be subject to other legislation and regulations. For example, an Environmental Assessment (EA) under the CEA Act may be required to analyze potential environmental, physical and socio-economic impacts. Note that there are opportunities throughout the EA process for public consultations. The range of stakeholder consultations is determined by possible the environmental impacts and the size and complexity of the project.

Only after positive decision is made on the EA (if one is required) may the Commission Tribunal proceed with making a licensing decision. The Commission Tribunal holds public hearings to consider licence applications for major facilities (see section E.4.3). Under section 37 of the NSCA, the Commission Tribunal can delegate the responsibility for issuing certain types of licences – other than Class I licences and uranium mines and mills – to persons who have been identified as a Designated Officer (DO), which are defined under the legislation. This can include various types of licences, including radioactive waste management facilities that are not defined as Class I nuclear facilities. When a DO is delegated this responsibility, no public hearing occurs, unless the DO refers the decision back to the Commission Tribunal, using a risk based approach. In this case, the Commission Tribunal will evaluate the need to conduct a public hearing, as part of its decision making process.

The CNSC administers its licensing system in cooperation with other federal and provincial government departments and agencies that work in areas such as health, environment, transport and labour.

Once a licence is issued, the CNSC's personnel are responsible for administering the Commission's decision, including the requirement to develop and implement a compliance verification program (see section E.6.3) to ensure that licensees continue to meet their legislative and licence obligations.

E.4.2 Process assessment of a licence application

Early communication with the CNSC can help applicants develop a good understanding of the licensing process, the regulatory requirements for spent fuel and radioactive waste management facilities, and the information to be submitted in support of a licence. Early communication also enables the CNSC to develop a regulatory review, which ensures that qualified personnel are available to carry out the application review.

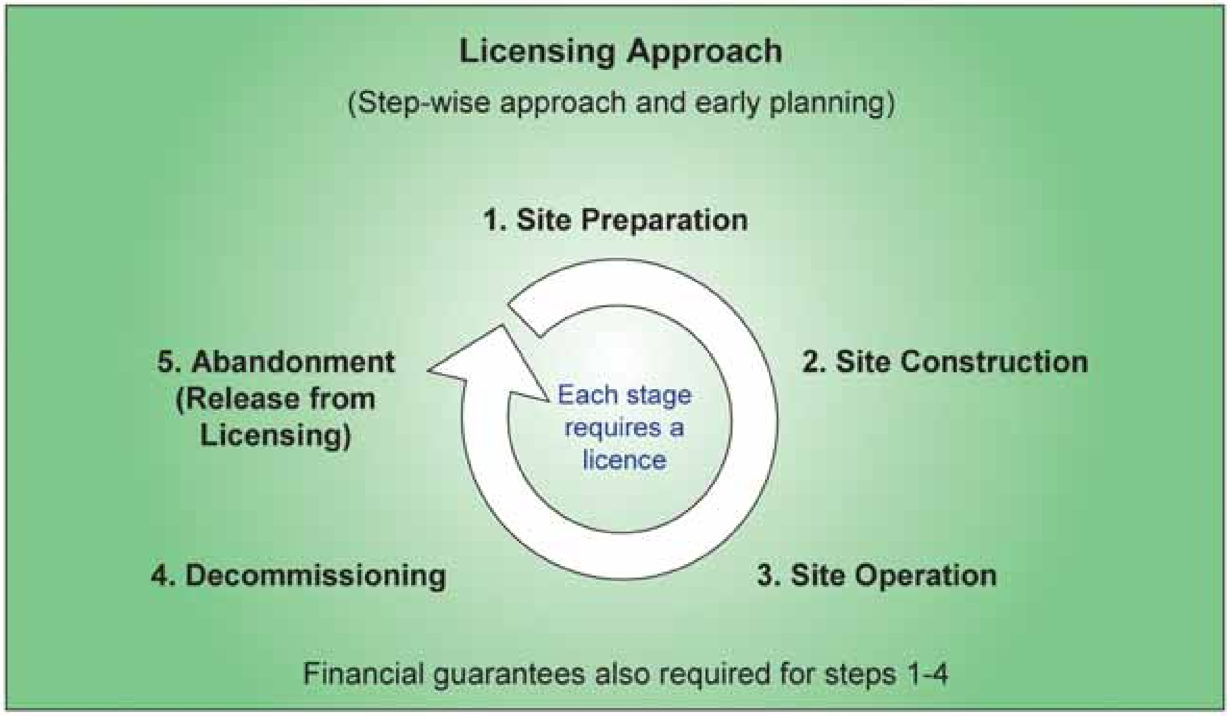


Figure E.3 – The lifecycle of the CNSC's licensing approach

The management of spent fuel, radioactive waste and uranium mine/mill waste is regulated during the entire lifecycle of the facilities – from site preparation, construction and operation to decommissioning and, finally, abandonment. Each phase requires a separate licence.

<u>Licence Application</u>

For a new licence, the regulations require applicants to submit comprehensive information on: their policies and programs, the design and components of the proposed facility, the manner in which the facility is expected to operate, facility operating manuals and procedures, and any potential impacts on the site or surrounding environment. The design must be such that emissions from the facility meet strict limits under normal operating and upset conditions, as applicants are required to identify the manner by which a facility may fail to operate correctly, predict the potential consequences of such a failure, and establish specific engineering measures to mitigate the consequences to tolerable levels. Those engineering measures may include, but are not limited to, multiple barriers to prevent the escape of noxious material. Many of the analyses of potential accidents are complex, covering a very wide range of possible occurrences.

The CNSC's personnel rigorously review all submissions, using existing legislation and the best codes of practice and experience available in Canada and around the world, to ensure regulatory requirements are met. The expertise of the CNSC's personnel covers a broad range of engineering and scientific disciplines. Considerable effort is also spent reviewing the analyses to ensure that predictions are based on well-established scientific evidence and 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 on the activity that the licence will authorize the licensee to carry on, and

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

The comprehensive assessment that takes place during the licensing process may result in defining additional programs and criteria, as a conditions of the licence. Once the CNSC's personnel are satisfied that all of the requirements of the NSCA and its associated regulations are met, and the applicant's documentation is complete and acceptable, a licence recommendation is prepared by the CNSC's personnel for submission to the Commission Tribunal – or a DO – for a decision. The recommended licence may include any necessary conditions that were identified as required during the assessment, including the documentation references submitted in support of the application. By referring to the applicant's documentation, the licence legally binds the applicant to comply with its own procedures and programs, and makes them subject to the CNSC's compliance, verification and enforcement program.

Licences may also contain other terms and conditions, such as references to standards, with which licensees must comply. For example, licensees may be required to observe occupational and public radiological exposure limits 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 derived from specific licence conditions, such as the Derived Release limits. Other standards, established by organizations like the CSA and the American Society of Mechanical Engineers (ASME), may also be adopted by the CNSC.

Joint Regulatory Review Process

Although the nuclear sector is subject to federal jurisdiction through the NSCA, the CNSC utilizes a harmonized or joint review approach with other federal, provincial or territorial departments in such areas as health, environment, transport and labour. The CNSC would expect nuclear facilities to comply with all applicable federal and provincial regulations.

In recognition of this dual reason, the CNSC has established a joint regulatory process. As a lead agency, the CNSC invites other federal and provincial regulatory agencies whose area of responsibility could impact on the proposed nuclear facility to participate in the licensing process. Those that choose to participate become members of a site-specific Joint Regulatory Group (JRG).

This procedure ensures that the legitimate concerns of both federal and provincial agencies are considered in the regulatory process and are reflected, as appropriate, in the licence in the form of site specific requirements. For example, the CNSC and the Saskatchewan departments of Environment and Labour have an administrative agreement that optimizes the participation of the Ministry of Environment (MoE) and the Ministry of Advanced Education, Employment and Labour (Labour) in the administration of the CNSC's regulatory regime. The involvement of Labour and the MoE, in the regulation of Saskatchewan's uranium mines and mills helps to better:

- protect the health, safety and security of Canadians and their environment, and
- harmonize the CNSC, MoE and Labour regulatory requirements and regulatory activities.

Example of a New Licence

The following is an example of a licence issued by the Commission Tribunal after the last report was published. Following public hearings on June 22, 2007 and September 12, 2007, the CNSC issued a Class IB operating licence for Ontario Power Generation's Darlington Waste Management facility. This licence, issued on October 24, 2007, allows OPG to operate a spent fuel dry storage waste management facility at the Darlington Nuclear Generating Station location, on the shore of Lake Ontario and close to Toronto. The licence was issued for a five-year term and requires OPG to submit a mid-term status report on operational performance in January 2010.

Licence Periods
Typical licence terms for radioactive waste management facilities vary from five to ten years in duration.

In 2002, the CNSC introduced flexible licence terms to allow for more risk-informed regulation of spent fuel and radioactive waste management facilities. The CNSC may consider adjusting licence terms based on licensee performance, facility risks and compliance and verification findings. Short licence periods will continue to be an option when licensee performance is unsatisfactory or given other considerations. However, along with longer licence terms being assigned, the Commission Tribunal has requested mid-term or status updates, to allow the Commission Tribunal and the public to stay informed about the facilities' operations and performance. In some cases, such as Rio Algom's waste management facility operating licence, licences have been issued for indefinite terms on the condition that status reports be provided at five-year intervals.

The CNSC's personnel recommend licence periods using a set of consistent factors. These factors include: facility related hazards, the development and implementation of safety programs (see section E.5.3), the implementation of an effective monitoring and maintenance program, licensee experience and performance, *Cost Recovery Fees Regulations* and the facility's planning cycle.

Regardless of the specifics of the licence term, or the schedule of mid-term or status reports, the CNSC's personnel have an obligation to inform the Commission Tribunal of any significant event at a nuclear facility licensed by the CNSC. Should such an event occur, all operational issues must be included in a Significant Development Report (SDR) to be presented to the Commission Tribunal.

Licence Renewals
Applications for licence renewal or amendment require the CNSC to revisit the original documentation and assessment in light of licensee performance and compliance history (see section E.6.1). The CNSC bases its review on performance history, risk and expert judgment, and may add, modify or remove licence conditions.

Since the last report and following public hearings on April 11, 2007, and January 24, 2007, the CNSC renewed a Class IB operating licence for OPG's Western Waste Management Facility. This licence, issued on May 22, 2007, allows OPG to operate a radioactive waste management facility (including spent fuel dry storage) on the location of the Bruce Nuclear Generating Station. The licence was renewed for a 10-year term on the condition that a status report on operational performance be submitted after the third and seventh year of the licence term.

Licence Amendments
Amendments to spent fuel, radioactive waste management and uranium mine and mill licences can modify existing licence conditions, add new licensing requirements or approve revisions to the facility design, its operations or licensee programs referenced in the licence. Examples of such documents include: operating policies and principles (OP&P), station-shift complement, radiation protection requirements and emergency plans. DOs, when delegated by the Commission Tribunal, can typically amend Waste Nuclear Substance licences, before reaching a decision.

Since the last reporting period, the Commission Tribunal amended the Beaverlodge Waste Facility Operating Licence, extending the expiry date to January 25, 2007. On March 7, 2007, the Commission Tribunal also amended the radioactive waste facility operating licence for the Hydro-Québec facility located in Bécancour, Québec.

E.4.3 Information and participation of the public

Public hearings
As discussed in the CNSC Licensing Procedure (see section E.4.1), the NSCA requires that a public hearing be held before a licensing decision is made or whenever it is in the public interest to do so. Public hearing proceedings give non-nuclear organizations and interested members of the public a reasonable opportunity to comment on matters before the Commission Tribunal. The CNSC *Rules of Procedure* (*Rules*) apply to these proceedings and set out the requirements for – among others – the notification of public hearings and publication of decisions from public hearings.

In accordance with the *Rules,* a public hearing may take place on a single day or on two non-consecutive days. Most major decisions are made following a two-day public hearing process. Day one and two may be several months apart (the usual timeframe is 60 days), to allow stakeholders enough time to review the application and recommendations. The CNSC's licensing process is described in Annex 3.

Streamlining

Since the last reporting period, panels of the Commission Tribunal also conducted hearings to increase the efficiency of the Commission Tribunal's operations and maintain the forum's effectiveness. The CNSC's President established several panels of one or more members last year to exercise Commission Tribunal functions. Under the NSCA, not all Commission Tribunal members must be in attendance at a Commission Tribunal activity. A smaller panel of members can exercise certain powers. The Commission Tribunal's use of panels is in line with the practices of other Canadian administrative tribunals.

Abridged hearings

The Commission Tribunal is required to make all decisions with respect to applications to amend licences previously issued by the Commission Tribunal (i.e., for Class I nuclear facilities and uranium mines and mills). Many of these applications regard minor changes and updates that are of low safety significance to a facility's operations and reference documentation. The Commission Tribunal therefore decided, in accordance with Part 2 of the *Rules,* that in such cases, it may be neither efficient nor in the public interest to hold full public hearings.

The Commission Tribunal must also decide on approvals and other requested changes to – or deviations from – licence requirements, when the authority to make such decisions has not been previously delegated to the CNSC's personnel or the changes or deviations are akin to a licence amendment. An abridged hearing process may also be used, when appropriate, for such approvals, changes or deviations.

To consider Class I and uranium mines and mills licence amendments that pose relatively low-risk as fairly, informally and expeditiously as possible, the Commission Tribunal may, in accordance with Rule 3 of the *Rules,* hold hearings over an abridged timeframe and with a reduced notice period and limited opportunity, if any, for interventions. For example, the Commission Tribunal used an abridged hearing process to accept the Environmental Impact Statement for the proposed Port Hope long-term low-level radioactive waste-management project, on January 24, 2007.

Outreach activities

The CNSC's personnel outreach program is described in Annex 3.11.

Public hearings and meetings are fundamental to the CNSC personnel's outreach activities. The Commission Tribunal publishes *Records of Proceedings, including Reasons for Decision* to explain the basis for its licensing decisions. This document, along with other information about the Commission Tribunals' proceedings and decisions, is publicly available at: nuclearsafety.gc.ca The Commission Tribunal also posts the complete transcripts of all public proceedings within days of a hearing or meeting, a best practice confirmed through benchmarking analysis.

Although most hearings are held in Ottawa, an increasing number of affected communities use videoconferencing as a cost effective way to participate. The Commission Tribunal offers teleconference and videoconference services to facilitate access to public hearings and meetings. Since the last reporting period, and as part of the CNSC's ongoing efforts to provide easier access to the Commission Tribunal's proceedings and enhance the visibility of the CNSC, the public can now view live webcasts of all public hearings and meetings through the organization's external Web site. Archived webcasts of past proceedings are also available online for three months following the proceedings. Note that in an effort to encourage public participation, the Commission Tribunal periodically holds licensing hearings relating to large, complex facilities in the local communities.

In 2005–06, the Commission Tribunal conducted 29 hearings. A total of 192 intervenors participated through written and oral submissions. In 2006–07, the Commission Tribunal conducted and documented 49 hearings, where it duly considered submissions from applicants and input from the CNSC's personnel and stakeholders. The Commission Tribunal continued to focus on outreach and community engagement during 2006–07, when it heard presentations and considered written submissions from more than 600 intervenors. In 2007–08, the Commission Tribunal conducted 43 hearings and heard 198 intervenors.

E.5 A system of prohibition of the operation of spent fuel or radioactive waste without a licence

Under section 26 of the NSCA, no person may possess, package, transport, manage, store or dispose of a nuclear substance, except in accordance with a licence issued by the CNSC or when exempted by the regulations. Since all radioactive waste contains nuclear substances, radioactive waste is subject to the NSCA and associated regulations.

E.6 System of institutional control, regulatory inspection and documenting and reporting

E.6.1 General description of compliance program

As stated in section E.4.1, only the Commission Tribunal or a Designated Officer can issue licences to operate spent fuel and waste management facilities.

Section 30 of the NSCA authorizes the CNSC's designated inspectors to carry out inspections and verify licensee compliance with regulatory requirements, including licence conditions. Licensees must have an approved set of programs and processes in place that adequately protect the environment and human health and safety.

The CNSC's Regulatory Policy Compliance (P-211) is implemented through a corporate-wide compliance program, whose output is integral to the operating licence renewal process and which integrates all three compliance elements:

- Promotion to encourage compliance,
- Verification activities to confirm that licensees are complying with safety provisions, and
- Reactive control measures to enforce compliance.

The CNSC rigorously enforces its regulatory requirement through a variety of measures such as inspections, reviews, audits and assessments. The CNSC's personnel:

- apply regulatory requirements in a manner that is fair, predictable and consistent,
- use rules, sanctions, and processes that are securely founded in law and graded 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.

E.6.2 Compliance promotion

The compliance program aims to inform the regulated community of the rationale behind the regulatory regime, disseminate information to regulated areas about regulatory requirements and standards, and design realistic and achievable requirements and standards. Promotional activities include communication and consultation.

The most common communication and consultation activity used to promote compliance consists is regularly scheduled meetings with the licensee, at which ongoing activities and developments, licensing and compliance issues, safety performance, outstanding commitments and emerging issues are discussed. Generally, compliance verification activities also result in follow-up meetings. The frequency of planned meetings varies by licensee, facility and risk level.

E.6.3 Compliance verification

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

- evaluates a licensee's operations and activities,

- reviews, verifies and evaluates licensee supplied information,
- ensures that administrative controls are in place, and
- evaluates a licensee's remedial action and any actions taken to avoid future incidents.

Programs cited in the licence or previously assessed during the licence application review process are evaluated. The CNSC checks that a licensee's activities meet acceptance criteria derived from:

- legal requirements,
- the CNSC policies, standards, or guides that clarify how the Commission intends to apply the legal requirements,
- licensee supplied information that expressly states the licensees intentions to meet the legal requirements in performing the licensed activity, and
- the CNSC personnel's expert judgment, including knowledge of industry best practices.

The CNSC's personnel assess licensee programs and their implementation according to the following five ratings:

A. Exceeds requirements,
B. Meets requirements,
C. Below requirements,
D. Significantly below requirements, and
E. Unacceptable.

The following categories are used to summarize all assessment and inspection results, as well as group licensee programs and performance in several safety areas being evaluated for licensing purposes. A standard list of programs or topics has been developed for each type of facility, and may include:

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

Compliance verification results are used in licence renewals and mid-term reports.

<u>Regulatory Inspections</u>

Type II Inspections
Type II – or routine – inspections provide an overall perspective of the status of a facility in the area examined and note any obvious deficiencies or abnormalities. These may be planned or unscheduled inspections, but are usually conducted according to written check sheets, which allow an inspector to record his or her observations and recommendations for follow-up action. Check sheets are dated, signed and kept on file.

Type I Inspections
Type I evaluations are usually done according to inspection guides prepared for that specific occasion. The results are recorded and sent to the licensee for follow-up action, as necessary, and kept 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 scheduling conflicts between the licensee's contacts.

Type I 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. Personnel who conduct the audit are chosen for their expertise in the area being assessed. They could include specialists from head office, project officers on-site, 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 dates for completion.

Regulatory Reporting
The CNSC's personnel also assess the contents of submitted operating reports. Licensees are required to submit operating reports to the CNSC according to licence conditions. The frequency of these submissions varies by licensee, facility and risk level, but it generally ranges from quarterly to annually. The analysis of safety-significant events is another component in the safety performance evaluation of a facility. The objective of these analyses is not for the CNSC personnel to duplicate reviews done by licensees, but to ensure that licensees have adequate processes in place to take corrective actions when needed and integrate lessons learned from past events into day-to-day operation.

E.6.4 Compliance enforcement

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

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

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

E.7 Considerations taken into account in deciding whether or not to regulate nuclear substances as radioactive waste

Section E.3.1 indicates that the CNSC is authorized, under the NSCA, to regulate nuclear substances so as to protect human health and the environment. The CNSC Regulatory Policy P-290, *Managing Radioactive Waste*, defines radioactive waste as "any waste containing a nuclear substance", leaving no room for regulatory doubt, and promotes the following key principles with respect to radioactive waste:

- the generation of radioactive waste should be minimized to the extent practicable, and

- 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 section B.5.)

E.8 Established regulatory body

E.8.1 Funding of the CNSC

The CNSC is a departmental corporation, listed in Schedules II and V of the *Financial Administration Act.* The NSCA stipulates that the CNSC report to the Parliament of Canada through a member of the Privy Council for Canada who is designated by the Governor in Council. Currently, this designate is the Minister of Natural Resources Canada. The Commission requires the involvement and support of the Minister for special initiatives such as amendments to regulations and requests for funding.

The CNSC's operations are funded through annual appropriations from Parliament. Most costs incurred for the CNSC regulatory activities are recovered through licence fees, under the CNSC *Cost Recovery Fees Regulations*. The CNSC collects these fees and deposits them into the Consolidated Revenue Fund of the Government of Canada. The activities that are not cost-recoverable activities, such as cost-exempt licensees and fulfillment of international obligations, are funded by the federal government.

Recently, due to growth in the nuclear sector, the CNSC has experienced rapidly increasing demand for its licensing, licensee certification and pre-project power-plant design review activities. As a result, the regulatory body has necessarily explored alternate funding mechanisms to meet future resource requirements. In 2007–08, the CNSC received approval from Canada's Treasury Board for revenue spending authority commencing in 2008–09. This authority is being phased in over a two-year period, with full implementation of revenue spending authority for all cost-recoverable activities effective in 2009–10. This authority will enable the CNSC to address growth in the nuclear sector.

E.8.2 Maintaining competent personnel

Recruitment and retention of personnel continues to be a focus for the CNSC. Since the last reporting period, the organization has increased its staff by more than 30 percent. Between April 1, 2006 and March 31, 2008 alone, the CNSC hired 178 people. Even more growth is anticipated in the coming years due to growth in the regulated industry.

In support of this growth, the CNSC reviewed its recruitment and retention strategy to ensure stated goals are achievable and current. The revised strategy emphasizes knowledge management, raising the CNSC's profile through employer branding, human resources planning, and recruitment and development of new personnel.

Given the importance of employee development, the CNSC continues to encourage learning and development opportunities for managers and employees. The implementation of mandatory individual learning plans will ensure that employees prepare for future careers with the CNSC, while building the skills required for their current roles. In addition to the more than 100 in-house courses offered each year, the CNSC encourages employees to attend external training courses. The CNSC is placing particular emphasis on developing and implementing a comprehensive leadership program.

New employees and managers at the CNSC are further supported by a recently launched Orientation program, which is comprised of a comprehensive orientation manual, a half-day orientation session and an enhanced orientation Web site (due to launch in Fall 2008).

The CNSC also continues to contribute to the CANTEACH and University Network of Excellence in Nuclear Engineering (UNENE) programs. (See section F.3.2.)

<u>Aboriginal Consultation</u>
Consulting Canadians on matters of interest and concern to them is an important part of good governance, sound policy development and decision-making. In addition to good governance objectives, Canada has statutory, contractual and common law obligations to consult with Aboriginal groups. To this end, and as one of the many departments, agencies and other Government of Canadian entities that, collectively, comprise the federal *Crown*, the

CNSC is obligated to ensure that any regulatory activity that it undertakes, which may have an impact on established or potential Aboriginal rights, is informed by rigorous consultation with prospective rights holders.

The role of the CNSC in ensuring that this legal obligation is fulfilled may vary, depending on the nature of the project in question or the role of other federal entities etc. In some instances, the CNSC may be part of a federal Crown consultation *team*, in other instances it may be the *lead* or coordinator, and in yet other cases the CNSC may be the sole federal entity involved in consulting a group of Aboriginal peoples with respect to a particular project.

The CNSC must ensure that the legal duty to consult is met across the entire nuclear cycle and all aspects of nuclear safety in Canada. From mining and milling, to transportation of radioactive materials, the construction and operation of power reactors, and decommissioning and fuel waste management, the CNSC acknowledges that Aboriginal rights may potentially be impacted at any given stage in the cycle. The CNSC also recognizes that other federal departments, agencies, as well as provincial and territorial governments, as representatives of the Crown, have a role to play in most – if not all – of those stages, and thus sees itself as one of many organizations that, collectively, have an obligation to ensure that the legal duty to consult is met. Further information is available at: nuclearsafety.gc.ca/eng/ea/aboriginal/index.cfm

Management System

In 2005, the CNSC formally committed to establishing a corporate wide management system in accordance with the requirements and guidance set out in IAEA's Safety Standard *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety* (GS-R-1), draft standard *Management Systems for Regulatory Bodies* (DS-113) and accompanying safety guides. Furthermore, the CNSC established a Quality Council. The CNSC's Executive Vice President of Operations holds the position of Chief Quality Officer and heads the council. A new division for internal quality management was also formed.

The purpose of the management system is to define and apply a common set of practices, principles and processes across the entire organization. The management system will provide the CNSC with an overarching and uniform management structure, by:

- bringing together, in a coherent and consistent manner, all of the organization's business requirements,
- mapping out and managing processes as part of a larger integrated system to minimize duplication,
- defining roles, responsibilities and authorities,
- defining processes and procedures that relate to activities, as opposed to general functional roles, and
- serving as a consistent framework for continual and ongoing improvements.

In December 2007, the CNSC issued the Management System Manual as the top-tier document which describes the integrated management system to ensure consistent quality results. Ongoing efforts are focused on process development and documentation of the lower-tiered documents, including processes, procedures, forms and guides.

Integrated Regulatory Review Services (IRRS)

the CNSC established a project to host a mission from the IAEA's Integrated Regulatory Review Services (IRRS) focused on power plants. The CNSC sent a letter officially requesting the mission to the IAEA in November 2005. The project is being planned and executed in accordance with relevant IAEA documents and will follow the IAEA's modular IRRS approach.

As part of the CNSC's preparation for the IRRS mission, a self-assessment review team (SART) conducted an assessment in 2006, which outlined recommendations for improvements at the CNSC. A corrective action plan was drafted during the reporting period to respond to the SART's suggestions and establish an integrated plan to implement the following five corporate-wide improvement projects:

1. management system,
2. integrated planning and performance management,
3. regulatory compliance processes,
4. regulatory licensing processes, and
5. leadership development.

The licensing and compliance improvement initiatives aim to develop and implement integrated solutions, which will improve the effectiveness and efficiency of the CNSC activities and decisions, and clarify the roles, responsibilities, authorities, and accountabilities.

In 2006, the Integrated Improvement Initiatives Program was initiated as a way to enhance integration among all five of the aforementioned corporate wide improvement projects. The CNSC identified the management system as the lead initiative. Efforts throughout 2007 focused on process development in the areas of planning, licensing and compliance.

In 2007, following a review of IRRS missions in other countries, the CNSC chose to broaden the scope of the IRRS mission to include power plants, research reactors and other nuclear facilities and the regulation of nuclear substances. The IRRS mission is planned for May 2009.

E.9 Supporting the separation of roles

E.9.1 Separation of the CNSC and organizations that promote and utilize nuclear energy

The NSCA is a distinct and comprehensive legislation for the regulation of nuclear activities and the separation of functions of the regulatory body from organizations that promote or use nuclear energy. The CNSC’s mandate (see section E.3.1) focuses clearly on the health and safety of persons and the protection of the environment, and does not extend to economic matters.

Section 19 of the NSCA authorizes “the Governor in Council [to], by order, issue to the Commission directives of general application on broad policy matters with respect to the objects of the Commission.” However, any political directives given to agencies – such as the CNSC – must be of a general nature and cannot fetter the Commission Tribunal’s decision-making authority in specific cases. In addition, all directives must be published in the *Canada Gazette* and put before each House of Parliament.

E.9.2 Strategic communications

Part of the CNSC’s mandate is to disseminate information to all stakeholders. The CNSC has had ongoing, transparent discussions with the Canadian Nuclear Association (via a Regulatory Affairs Committee) since 2000 and with NPPs and other licensees (via the Cost Recovery Advisory Group (CRAG)) since 2002. The CNSC’s strategic communications plan was finalized during the reporting period.

The CNSC’s strategic communications plan involves a three-year phased approach. During 2006 and 2007, the CNSC focused its outreach activities on heightening public awareness and understanding about regulated nuclear activities and regulatory body’s role. In 2006, the CNSC made a special effort to engage diverse stakeholders, including municipal governments in the regions of major facilities, media, provincial officials, professional associations and non-governmental organizations (NGOs).

In late 2006, the CNSC established a Non-Governmental Organization Regulatory Affairs Committee to communicate and consult with NGOs on nuclear regulatory and policy matters. Co-chaired by a member of the NGO community, the Non-Governmental Organization Regulatory Affairs Committee is a forum for exchanging and clarifying information to promote common understanding of issues. It allows the CNSC to better respond to the information needs of the NGO community, while enabling NGO members to comment and advise the CNSC on broader issues related to nuclear regulation in Canada.

While a similar industry-based forum has existed since 2001, this Committee enables the CNSC to further expand its engagement with stakeholders. In addition to this forum, the CNSC also established links with an association of host communities of major nuclear facilities in early 2007.

The CNSC has held numerous hearings in host communities. To ensure the needs of future stakeholders are met, the CNSC is committed to proactively contacting communities likely to become involved in nuclear activities (such as mining and milling) in the next decade.

E.9.3 Values and ethics

The CNSC has a firmly entrenched values and ethics regime, which serves to strengthen and support value based governance, leadership and operational and individual ethical practice. Introduced in 2005, the Values and Ethics Strategy defines the organizational values on which the CNSC ethical practices are based. It includes provisions for the disclosure of wrongdoing in the workplace and the protection of employees from reprisal. To this already robust regime, the CNSC has now added the disclosure, reprisal protection and accountability elements of the *Public Servants Disclosure Protection Act*, which came into force in April 2007.

In 2008–09, the CNSC will receive the results of an evaluation of its Values and Ethics program and implement an Informal Conflict Management System (ICMS) within the organization. The evaluation recommendations will allow the CNSC to improve the efficacy of the Values and Ethics program, and the ICMS will provide personnel with many new dispute resolution options.

The evolution of the ethics regime at the CNSC creates an environment that supports exemplary practice and is resistant to forces and pressures that encourage inappropriate business conduct.

SECTION F – OTHER GENERAL SAFETY PROVISIONS

F.1 Scope of the section

This section addresses Articles 21 (Responsibility of the Licence Holder) to 26 (Decommissioning) of the Joint Convention. It provides information about the steps Canada takes to meet its obligations for general safety at the national and facility levels. This section also addresses requirements of several IAEA Standards. These include:

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

F.2 Responsibility of the licence holder

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 and financial resources to support the safe management of the spent fuel and radioactive waste management facility over its lifespan.

F.3 Human resources

Adequate human resources are defined as the employment of enough qualified staff to carry out all normal activities without undue stress or delay, including the supervision of work done by external contractors. Section 44(1)(*k*) of the NSCA provides the legislative basis for the qualification, training and examination of personnel. Sections 12(1)(*a*) and 12(1)(*b*) of the *General Nuclear Safety and Control Regulations* specify that the licensee must ensure the presence of a sufficient number of trained, qualified workers.

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

F.3.1 University Network of Excellence in Nuclear Engineering

The University Network of Excellence in Nuclear Engineering (UNENE) is an alliance of Canadian universities, nuclear power utilities, and research and regulatory agencies working to support and develop nuclear education, and research and development capability in Canadian universities. UNENE was established in July 2002. Its purpose is to assure a sustainable supply of qualified nuclear engineers and scientists that can meet the current and future needs of the national nuclear sector. It accomplishes this through university education and university-based education, and by encouraging young people to choose a career in the nuclear sector. More information is available online at unene.ca

The alliance consists of 10 universities and several industrial partners (CANDU Owners Group, OPG, Bruce Power, AECL, the CNSC and Nuclear Safety Solutions).

Funding has been committed towards the support of engineering programs, and education and research in nuclear engineering at the following universities:

- Queen’s University,
- University of Toronto,
- McMaster University,
- University of Waterloo,
- University of Western Ontario, and
- University of Ontario Institute of Technology

The funds will create six Research Chairs, and sponsor up to 100 students in Masters and PhD level programs. In addition, NWMO has committed funding to a Natural Sciences and Engineering Research Council (NSERC) research chair in nuclear fuel and waste containers research at the University of Western Ontario.

F.3.2 CANTEACH

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

F.3.3 OPG

OPG's Nuclear Waste Management Division currently comprises approximately 300 full-time employees. Staffing demand has increased over the past three years and is expected to continue increasing, primarily due to attrition from retirements. From 2005 to June, 2008, OPG recruited 36 positions (2005), 27 positions (2006), 72 positions (2007) and 41 positions (January to June, 2008). The 2007 increase in recruitment was primarily due to staffing of the new facilities at Darlington Waste Management Facility, combined with attrition at the other nuclear waste facilities. Staff for the skilled and semi-skilled trades has been recruited from within OPG, with an increasing emphasis on the external labour marketplace. Technical and engineering positions have been primarily filled from external sources, with a mixture of experienced candidates and approximately five new university graduates per year, hired through the University Graduate Training Program.

Nuclear Waste Management Division has introduced – or is in the process of introducing – the following recruitment and retention strategies:

- Succession Management: Assessment of leadership capabilities and succession replacement planning for all leadership positions,
- New Grad Trainee Program: A two-year rotational program with mentorship for university graduates in engineering, technical and business-related disciplines,
- Advance Hiring: Critical positions in the organization are identified in our succession-management program,
- Bench strength has been assessed with recommendations to advance, hire or develop new grads in advance of forecasted attrition,
- Development and Co-op Student Program: Each semester recruit two to four university or college students in technical and business streams for work terms. A number of these co-op students upon graduation are hired in the New Grad Training Program,
- Skilled Trade Apprenticeship: Ontario Power Generation organizes and maintains a skilled apprenticeship trades hiring and placement program. Nuclear Waste Management Division has access to this program on an as needed basis, and
- Semi-Skilled Labour: Direct hire from community impact areas.

With continued emphasis on succession management, workforce planning and staff development, the Nuclear Waste Management Division is positively positioned to meet its qualified staffing requirements for both the short and long-term.

F.3.4 Nuclear Waste Management Organization

In January 2005, NWMO was a small study group consisting of 12 individuals, with a mandate under the NFWA to provide recommendations to the Government of Canada on the long-term management of spent fuel. The NWMO initiated its study in 2002, and presented its report and recommended approach to the Minister in November 2005. In June 2007, APM, the approach recommended by the NWMO, was selected by the Government of Canada, and NWMO became responsible for implementing APM – subject to the necessary regulatory approvals.

In its new role, NWMO began to build a sustainable corporation with the necessary skills and capacity to manage Canada's spent fuel over the long term. In 2007, NWMO began to consolidate staff resources by hiring as permanent employees former NWMO contract staff as well as integrating into the organization many of the people who previously directed and managed Canada's technical research program for long-term spent fuel management. Ensuring NWMO viability also involved new permanent staff appointments in senior, intermediate, intern and support positions, with particular attention paid to succession planning.

In 2007, the new position of Vice President of Science and Technology was established. A manager of geosciences was hired along with a director of environment, a director of policy and planning and a manager of community relations. Three technical staff in geosciences, safety assessment and engineering also joined the organization. Two graduate trainees, one in engagement and communications and another in social research, were employed and administrative support was strengthened. Additional graduate trainees in the areas of engagement, social research and technology are being sought.

The organization recruited to fill several important functions that were formerly externally contracted. These included employing NWMO's own legal counsel to coordinate legal reviews and provide support for commercial contracts, protocol agreements, compliance requirements and labour-relations issues. A director of human resources was enlisted to manage recruitment, training and development, succession planning and labour relations issues. A director of communications was engaged to develop and implement a strategic approach to public communications.

For the NWMO, building an organization that is – and is seen to be – fully competent to carry out its mandate requires an ongoing effort. By the end of 2007, NWMO's staffing levels had increased to 27 full-time equivalents, from a core complement of 12 individuals a year earlier. This incremental strengthening and broadening of the organization's capabilities will continue as needs are identified in the coming years.

F.4 Financial resources

F.4.1 General

Canada generally applies the *polluter pays* principle – by which 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* (refer to Annex B). In 2002, under the NFWA, the owners of spent fuel were specifically required to establish segregated funds to fully finance long-term waste management activities.

F.4.2 Historic waste

In instances where remedial actions are required at uranium mine and mill tailings facilities, but where the owner no longer exists, the Government of Canada and provincial governments ensure that the sites are safely decommissioned. In Ontario (home of the former Elliot Lake uranium mining complex), the Government of Canada and the Province of Ontario entered into a Memorandum of Agreement in 1996 that outlined their respective roles in the management of *abandoned* uranium mine and mill tailings. Under the agreement, the costs associated with any necessary remediation at an abandoned site will be split between the two governments on a 50-50 basis. To date, these arrangements have not been necessary, as all Ontario sites have owners that are complying with their responsibilities.

In September 2006, the Government of Canada and the Province of Saskatchewan entered into a Memorandum of Agreement that defines roles and responsibilities for the remediation of certain cold war era uranium mine sites (principally the Gunnar mine and mill site in northern Saskatchewan.) These sites were operated from the 1950s until the early 1960s by private sector companies, which no longer exist. When the sites were closed, the regulatory framework in place was not sufficient to ensure appropriate waste treatment and containment, which has led to environmental impacts on local soils and lakes. On April 2, 2007, the Government of Canada and the Province of Saskatchewan announced the first phase of the clean-up. The total cost, which the Government of Canada and the Province of Saskatchewan will share, will be $24.6 million. A comprehensive environmental assessment of the project began on June 15, 2007.

F.4.3 Financial guarantees

Licensees of spent fuel and radioactive waste management facilities and uranium mines and mills must provide guarantees that adequate financial resources are available for decommissioning of these facilities and managing the resulting radioactive wastes, including spent fuel.

Section 24(5) of the NSCA provides the legislative basis for this requirement. Section 3(1)(l) of the GNSCR stipulates that “an application for a licence must contain a description of any proposed financial guarantee related to the activity for which a licence application is submitted.” Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities,* covers the provision of financial guarantees for decommissioning activities. Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*, provides guidance on the preparation of plans for the decommissioning of activities licensed by the CNSC. These guides can be viewed at nuclearsafety.gc.ca

Since the last reporting period, the CNSC personnel have continued to participate in the development of a CSA document on decommissioning nuclear facilities: CSA N294. This document is expected to be finalized in 2009. Additionally, the CNSC personnel are also participating in the development of an IAEA Safety Report comprising four volumes: safety assessment methodology, safety assessment for decommissioning of three test cases, graded approach to safety assessment for decommissioning, and a regulatory review to safety assessment for decommissioning. The safety report is scheduled for publication in 2008.

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

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

- 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. For example, during a licence renewal, the Preliminary Decommissioning Plan may be revised and the financial guarantee updated accordingly. 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.

Since the last reporting period, the CNSC personnel have been working on the development of a new comprehensive policy concerning financial guarantees. While all major licensees with Class I operating facilities and uranium mines and mills have financial guarantees in place, the CNSC personnel are currently reviewing the need to broaden the application of financial assurances to all facilities and other licensed activities not currently required to post financial guarantees.

International opinion (IAEA, NEA) has evolved substantively over the last several years in this area. The CNSC Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*, and draft Regulatory Policy P-319, *Financial Guarantees for Nuclear Facilities and Licensed Activities*, do not fully represent the current international opinion.

The CNSC’s personnel are considering the development of a revised policy and program for financial guarantees, to be developed in consultation with other government stakeholders, while also accounting for current international opinions. The CNSC’s personnel will then develop a series of recommendations for the Commission Tribunal’s consideration. If the Commission Tribunal accepts these recommendations, the CNSC’s personnel will implement the new policy.

F.5 Quality assurance

NSCA 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 their licences. 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, the overall QA program established by the power plant may be applied to the spent fuel or radioactive waste management facility. This requirement is referenced as part of a licence condition.

Review of QA principles and programs for uranium mines must comply with the QA expectations of the NSCA and UMMR. After a licence is granted, the licensee and other organizations involved must fulfill QA requirements to the satisfaction of the CNSC. Reviews conducted by the CNSC personnel concentrate on the licensee’s application of these standards and on its ability to:

- consistently define roles and responsibilities for the facility,
- implement the QA program in a structured manner,
- demonstrate control changes and program interactions, and
- self-assess and take corrective action.

F.5.1 QA program assessment

To assess licensee QA programs, the CNSC personnel examine the results from the licensees’ internal reviews and audits. They also perform detailed reviews of the documents that communicate the QA program requirements to licensee personnel. After the QA program is found to be acceptable, the CNSC 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 response and corrective action. The CNSC may decide an enforcement action is appropriate. Section E.6.4 provides further information on the CNSC Compliance Enforcement.

F.6 Operational radiation protection

F.6.1 Requirements for doses so they are consistent with ALARA

Operations at Canada's spent fuel and radioactive waste management facilities must be carried out to ensure that doses to workers, the public and the environment are as low as reasonably achievable, with economic and social factors taken into account (the ALARA principle). This approach is legislatively supported through the NSCA and the RPR. Doses are minimized 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.

In support of this requirement, Regulatory Guide G-129 rev 1, *Guidelines on How to Meet the Requirements to Keep All Exposures As Low As Reasonably Achievable*, was issued by the CNSC in October 2004.

F.6.2 Derived release limits

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

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

Doses received by members of the public through routine releases from nuclear facilities are very low – almost always too low to measure directly. Therefore, to ensure that the public dose limit is not exceeded, the RPR limits the amount of radioactive material released in effluents from nuclear facilities. These effluent limits are derived from the public dose limit, and are referred to as *derived release limits* or DRLs. The nuclear sector 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 site.

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 expected to receive the highest dose of radiation because of their age, diet, lifestyle and location.

F.6.3 Action levels

Licensees are required, through the RPR, 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. When an action level is reached, the following actions must be taken:

- notify the CNSC,
- investigate to establish the cause, and
- take action to restore the effectiveness of the radiation protection program.

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

F.6.4 Dosimetry

The CNSC requires every licensee to ascertain and record the magnitude of exposure to workers by direct measurement or monitoring, or, in cases where this is not possible, by estimation. If a nuclear energy worker has a reasonable probability of receiving an effective dose of greater than 5 mSv, the licensee is required to use a licensed dosimetry service. Dosimetry services are also licensed by the CNSC under the radiation protection regulations. Requirements for licensing are found in S-106 rev.1, *Technical and Quality Assurance Requirements for Dosimetry Services* (March 2006).

F.6.5 Preventing unplanned releases

The nuclear sector uses several means to reduce the risk of unplanned effluent releases of radioactive material into the environment: multiple barriers, reliable components and systems, competent staff, and the detection and correction of failures.

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 when materials are handled. Such operations are closely monitored by licensee staff, which 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 subject to stringent control, and is only done in the safest possible manner. 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 of an uncontrolled release into the environment, competent licensee staff is available for an initial mop-up exercise, preventing further spread of radioactive contaminants. If necessary, the stored waste may be retrieved and held more securely. Depending on the magnitude and seriousness of the release, emergency procedures and emergency preparedness (EP) plans may be activated.

F.6.6 Protection of the environment

Regulatory Policy P-223, *Protection of the Environment*, describes the philosophy, principles and fundamental factors which guide the Commission Tribunal as it regulates the production and use of nuclear energy, and the production, possession and use of nuclear substances, prescribed equipment and prescribed information. These are regulated in order 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 must be followed for every regulatory decision made by the Commission Tribunal or the CNSC personnel, and applies to all types of the CNSC licenses, including decommissioning.

Regulatory Standard S-296, *Developing Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills* (March 2006), sets out the environmental protection policies, programs and procedures that licensees shall implement at uranium mines and mills and Class I nuclear facilities – which include spent fuel and radioactive waste management facilities – when required by the applicable licence or other legally enforceable instrument.

The requirements of an Environmental Management System (EMS) include the following tasks:

- establish, implement and maintain an EMS that meets the requirements set by the Canadian Standards Association’s ISO 14001:2004, Environmental Management Systems – Requirements with Guidance for Use. Certification to ISO 14001 by an authorized registrar or other independent third party is not considered by the CNSC as meeting the requirements of this standard. The CNSC, in exercising its responsibilities as outlined in the NSCA, will evaluate all licensees’ programs in relation to the requirements of this standard,

- ensure that the scope of the EMS is consistent with the definitions of ‘environment’, ‘environmental effect’ and ‘pollution prevention’, as provided in the Glossary of S-296,

- conduct internal audits (clause 4.5.5 of ISO 14001:2004) at planned intervals so that all elements of the EMS are audited on at least a five-year cycle, and

- conduct a management review (clause 4.6 of ISO 14001:2004) annually.

The supporting Regulatory Guide G-296, *Developing Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*, was released in 2006, along with S-296. The purpose of this regulatory document is to help applicants seeking a licence for Class I nuclear facilities and uranium mines and mills (other than a licence to abandon) to develop and implement environmental protection policies, programs and procedures in accordance with the NSCA and its associated regulations. G-296 outlines the scope of an EMS, recognizing that the complexity of the EMS documentation should be appropriate for the nature and scale of the environmental effects that may result from licensed activities. ISO 14001, with a few additional the CNSC-specific requirements, is the basis for the CNSC Regulatory Standard S-296 and may be incorporated in a licence as a legal requirement. For all licences, the information provided in G-296, along with ISO 14001 and ISO 14004, can be used to develop an EMS that will meet the CNSC requirements for policies, programs and procedures in environmental protection.

The EMS should include – in a manner that is appropriate for the facility type and phase of licensing – the proposed measures to control the release of nuclear substances, hazardous substances, or both, into the environment, and the measures that will be taken to mitigate the effect.

In terms of releases, the EMS should be commensurate with overall regulatory requirements, the specific information provided on 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.

In terms of wastes, the EMS should be commensurate with overall regulatory requirements and the specific information provided on the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed. This includes waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method(s) for managing and disposing of that waste. For uranium mines and mills, there is a further requirement to address management 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 uncontaminated surface and ground water,
- the anticipated quantities, composition and characteristics of backfill, and
- the proposed waste management system.

As a further consideration, the EMS should address environmental emergency preparedness and response by dealing with the following issues:

- proposing measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, and

- proposing measures for the health and safety of persons.

Reporting requirements for certain emergency situations should also be included in the EMS. Lastly, additional elements relating to worker training or qualifications, and the environmental protection obligations of workers, should be included. Training programs should enable workers to meet their obligations with respect to environmental protection.

Monitoring and Measurement

Licensees should establish procedures to measure, monitor and evaluate environmental performance relative to the performance indicators and targets they have set to achieve their environmental objectives. Measurement and evaluation are the best way to verify whether the controls placed on contaminants are effective. For licensees to achieve their performance targets it is important that the overall monitoring process include continual feedback mechanisms. Such mechanisms enable licensees to take appropriate action when necessary. Monitoring should be conducted on a spatial and temporal scale, reflecting the environmental effects predicted in an environmental assessment.

Effluent monitoring should be the primary indicator of performance in terms of releases to air, surface waters, groundwater and soil. Effluent monitoring addresses both the nature and quantity of releases of nuclear and hazardous substances (including wastes). Monitoring schedules should be controlled administratively, to help prevent situations that might lead to unreasonable risk for the environment. Targets should be designed that will prompt investigations – and thus lead to preventive measures – when situations are abnormal.

As part of a Code of Practice for Uranium Mines and Mills, certain performance targets (action levels) must be developed to protect the environment. These should address how releases at the source are managed. All facilities require action levels for the radiation protection program. Although specific to radiation protection, Regulatory Guides G-218 *Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills,* and G-228 *Developing and Using Action Levels,* provide useful generic guidance on the principles underlying action levels. These principles, along with ALARA (as outlined in Regulatory Guide G-129 rev 1, *Guidelines on How to Meet the Requirements to Keep All Exposures As Low As Reasonably Achievable*) should be used to develop targets for environmental performance.

Class I nuclear facilities do not require a Code of Practice for environmental protection. However, licensees of Class I nuclear facilities should ensure their operations can control releases that are potentially harmful. The development of administrative controls typically requires modeling of environmental pathways, in order to derive release targets that can be interpreted in terms of levels in environmental media. These levels are chosen to protect the environment as a whole, with adequate safety margins. The *Canadian Environmental Quality Guidelines* provide practical guidance on levels that are thought to be sufficiently protective. Alternatively, levels can be derived from assessments performed under the CEA Act, the CEPA, or the NSCA.

Facilities that may potentially expose the public to releases are also expected to develop Derived Release Limits (DRLs), historically referred to as Derived Emission Limits (DELs). Facilities calculate DRLs through multimedia pathways modeling; DRLs represent estimates of releases that could result in doses to the public that equal the prescribed public limit (for effective dose of 1 mSv) or equivalent dose limits. If not referenced in the EMS as part of licensing documentation, DRLs may be incorporated separately as a licence condition.

Environmental Monitoring (CSA Revised Standard N288.4)
With the promulgation of the NSCA in 2000, protection of the environment (as opposed to the previous human-focused legislation) from both radionuclides and hazardous substances also became the responsibility of the CNSC. The present CSA document N-288.4, *Radiological Monitoring of the Environment*, issued in 1990, addresses only the monitoring of potential radiological contaminants in the environment through pathways for humans. Therefore, it was recognized that a revised environmental monitoring standard/guide is required. The CNSC personnel are working with the CSA to develop a revised version of N288.4 that will address radiological, conventional (i.e. hazardous substances) and physical stressors and pathways for both human and non-human biota. This document will be targeted to Class I nuclear facilities and uranium mines and mills and is expected to be completed by the next reporting period in 2011.

F.6.7 Canadian Nuclear Safety Commission activities

To verify compliance with the requirements of a licence and regulations, the CNSC personnel:

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

A detailed description of the Compliance Verification Program is provided in section E.6.3.

F.7 Nuclear emergency management

Nuclear emergency preparedness and response in Canada is a multi-jurisdictional responsibility, shared by all levels of government and the licensees. In emergency situations, licensees are responsible for protecting health, safety, security and the environment by preventing or mitigating the effects of accidental releases of nuclear or hazardous substances. Licensees must also respect Canada's international commitments on the peaceful use of nuclear energy. The provinces and territories have primary responsibility to implement measures for civil protection and off-site nuclear emergency preparedness and response; this includes designating municipalities to carry out nuclear emergency planning within their jurisdictions.

The Government of Canada is responsible, through the Federal Nuclear Emergency Plan (FNEP), for coordinating federal actions that support provinces and territories during a nuclear or radiological emergency. It must also respond to emergencies that have international implications. The FNEP outlines the federal government's role in such situations, the manner in which it must be organized, and its capability to respond to a nuclear emergency. Health Canada, as the lead department, is responsible for coordinating the federal nuclear emergency response of more than 14 departments and six federal agencies, including the CNSC. These organizations each have distinct roles and responsibilities, making a structured framework essential. The FNEP provides this structure.

The CNSC employed a collaborative approach in developing its Nuclear Emergency Management (NEM) policy and upgraded programs. NEM was developed in partnership with external stakeholders, and has included extensive consultations with licensees, the public and provincial, territorial, municipal and federal government organizations involved in emergency management.

The CNSC's NEM policy provides the foundation for all the CNSC emergency management activities. Specifically, it outlines responses consistent with the risks at hand, clarifies roles and responsibilities, and helps maintain current capacity while taking future requirements into consideration. In addition to developing the Policy *Nuclear Emergency Management* (P-325), it has also identified key elements of an improved nuclear emergency management program. Furthermore, it is developing emergency plans and procedures.

The CNSC Emergency Operations Centre (EOC) has recently been reorganized to increase its reliability and functionality and to enhance its back-up resources. It has conducted extensive training with its staff and with other Government of Canada departments on their roles, responsibilities, procedures and emergency response to radiological and nuclear related events. It has undertaken a wide variety of activities, from the installation of an emergency power generator at the CNSC headquarters (to maintain the CNSC's capacity in the event of a power outage) to reactivating a federal-provincial-territorial committee on radiological/nuclear emergencies.

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

The CNSC maintains its regulatory role and responsibilities by directly overseeing licensees' response actions. It also provides technical and advisory support to the provincial, territorial and federal authorities through the FNEP. These responsibilities encompass a wide range of contingency and response measures to prevent, correct or mitigate accidents, spills, abnormal situations and emergencies.

Ontario, where 20 of 22 of Canada's reactors and the largest nuclear waste management facility are located, named its first Commissioner of Emergency Management in 2004. The Commissioner's role is to:

- oversee Ontario's emergency planning and preparedness,
- monitor emergency situations in other jurisdictions to ensure the entire province is prepared for similar situations,
- work in partnership with the Government of Canada on the co-location of an emergency management centre,

- lead the development of regulations to implement emergency management across key government ministries, and
- assist in reviewing the current provincial *Emergency Management Act* and related legislation and regulations.

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

New Brunswick has one reactor, located near Point Lepreau. The New Brunswick Emergency Measures Organization (NB EMO) coordinates emergency preparedness for New Brunswick's provincial and municipal governments. NB EMO works at the provincial and municipal levels through district coordinators to ensure that the province and its communities have appropriate and tested emergency plans. In addition, New Brunswick has invested significantly in provincial communications infrastructure to improve connectivity and harmonization with federal and provincial intervening organizations during a nuclear emergency.

Saskatchewan has several uranium mines in the northern part of its territory. The Saskatchewan Emergency Management Organization (SaskEMO) is the provincial government's lead agency for emergency management. SaskEMO coordinates overall provincial emergency planning, training and response operations for the safety of residents and the protection of property and the environment, before, during and after an emergency. Corrections and Public Safety is responsible for *The Emergency Planning Act* (November 1, 1989). *The Emergency Planning Act* contains provisions for emergency planning, emergency powers and disaster relief. Corrections and Public Safety, through SaskEMO, is the provincial government's lead agency for emergency management. SaskEMO supports community preparedness by encouraging the formation of local government emergency measures organizations, assisting in the development of location emergency plans and providing on-site consultation to municipal officials during government-declared states of emergency. SaskEMO also supports provincial preparedness by maintaining the provincial government emergency plan and related contingencies, coordinating provincial government resources during a state of emergency, assisting government departments, Crown corporations and agencies with emergency planning, and coordinating with federal government emergency preparedness programs within Saskatchewan.

In Nova Scotia, many shipments containing radioactive substances enter and dock at the Port of Halifax. The *Emergency Measures Act* is Nova Scotia's emergency management and emergency-powers legislation. It establishes the rules for managing emergencies in Nova Scotia, and requires municipal governments to have emergency plans. The Nova Scotia Emergency Measures Organization (NS EMO) ensures the safety and security of residents of Nova Scotia, their property and environment by providing for a prompt and coordinated provincial and municipal response to an emergency. This is accomplished through cooperative and consultative planning before emergencies occur, and by coordinating the provision of provincial resources to assist with the response. NS EMO facilitates and coordinates communication and emergency planning efforts between the various levels of government.

F.7.1 The CNSC's assessment of licensees' emergency management programs

The CNSC's personnel input and audit the emergency plans submitted by licensees. Spent fuel and radioactive waste management facilities submit emergency plans as part of their licence application, which the CNSC personnel review, according to regulatory criteria and guidance documents.

F.7.2 Types of nuclear emergencies

With respect to nuclear accident mitigation, emergency planning includes both on-site and off-site consequences, as described below:

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

- off-site nuclear emergencies are events that occur outside licensed facilities, but may have originated from, or were associated with, a licensed facility or activity, and may even have originated from outside Canada. Events of this type will require intervention from provincial, territorial or municipal authorities operating outside of the licensed facility or activity and will likely require support from the licensee and the federal government (FNEP).

F.7.3 Federal government responsibilities

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

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

As much as possible, the Government of Canada's emergency planning, preparedness and response is based on the *all-hazards* approach. However, because of the inherent technical nature and complexity of nuclear emergencies, hazard-specific planning, preparedness and response arrangements are required. These special arrangements, which are one component of the larger federal emergency management framework (described in Part 1 of Annex D of the *National Support Planning Framework*) constitute the FNEP. The FNEP describes the federal government's preparedness for nuclear emergencies and how it would coordinate the federal response.

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

The Government of Canada is responsible for managing a nuclear civil liability regime that addresses civil liability and compensation for injury and damage arising from nuclear incidents. This regime is established under the NLA and the CNSC designates certain nuclear facilities as coming within its scope. Typically, these are facilities where there is a risk of criticality. An operator of such an installation is absolutely and exclusively liable for any civil damages caused by an incident at that installation, and carries mandatory insurance. In the event of a serious incident, the NLA provides special compensation measures that may be imposed by government to replace the normal court process. NRCan is the lead department for ensuring the process of compensation is well coordinated and administered in Canada.

F.7.4 International arrangements

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

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

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

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

F.8 Decommissioning

In accordance with Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*, the CNSC requires that Class I facilities and uranium mines and mills licensees keep decommissioning plans up to date throughout the lifecycle of a licensed activity. The CNSC also requires that licensees prepare a preliminary decommissioning plan and detailed decommissioning plan for approval.

The preliminary decommissioning plan must be filed with the regulatory body as early as possible in the lifecycle of the activity or facility. In the case of nuclear facilities, specific requirements for decommissioning planning are set out in the CNSC regulations for uranium mines and mills, and Class I and Class II nuclear facilities.

The preliminary plan documents the preferred decommissioning strategy and objectives at the end of decommissioning. The plan should be sufficiently detailed to assure that the proposed approach is technically and financially feasible. It must also be in the interests of health, safety, security and protection of the environment. The plan defines areas to be decommissioned and the general structure and sequence of the principal decommissioning work packages envisioned.

The applicable regulations and Regulatory Guide can be viewed on the CNSC Web site at: nuclearsafety.gc.ca

Decommissioning activities are listed in Annex 7. Decommissioning waste generated in the last reporting period is included in Section D.

F.8.1 Qualified staff and adequate financial resources

Section 24(5) of the NSCA legislates that licensees of nuclear facilities must guarantee that adequate financing and human resources will be available for the decommissioning of facilities and the management of resulting radioactive wastes, including spent fuel. Section 3(1)(l) of the GNSCR states that, “An application for a licence shall contain a description of any proposed financial guarantee relating to the activity to be licensed.” Section F.4.3 describes the financial guarantees applicable to the decommissioning process. 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 GNSCR specify that the licensee must ensure the presence of a sufficient number of trained qualified workers.

F.8.2 Operational radiation protection, discharges, unplanned and uncontrolled Releases

During decommissioning, the licensee is required to maintain a radiation protection program that takes under consideration the ALARA principle, derived release limits, dose limits and actions levels, measures to prevent or mitigate the effects of unplanned releases, and the protection of the environment.

F.8.3 Emergency preparedness

For nuclear emergency management, a plan is required during decommissioning. The plan is based on the risk associated with the facility at the time of decommissioning.

F.8.4 Records

As part of the decommissioning planning process, records information is reviewed. Relevant aspects are incorporated into the documentation required for formal approval of both preliminary and final decommissioning plans. A preliminary plan serves as the basis for the decommissioning financial assurance provided by the licensee. Regulatory agencies require that it be in place prior to the start of construction and operations. A detailed decommissioning plan must be developed while operations approach completion. This serves as the basis for environmental assessments and subsequent licensing of the decommissioning activities. The detailed plan must include a description of the records and information that will be permanently retained and of the reports that are to be submitted to regulatory agencies.

The licensee must retain specified records and information, typically through the corporate office, as the need for on-site staff diminishes. Reports submitted to regulatory agencies will be retained in accordance with the respective agencies' procedures.

For example, the *Class I Nuclear Facility Regulations* require that every licensee who operates a nuclear facility keep a record of the following:

- 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.

Also, every licensee who decommissions a Class I nuclear facility shall keep a record of the following:

- the progress achieved in meeting the schedule,
- the implementation and results of the decommissioning,
- the manner in which, and the location at which, any nuclear or hazardous waste is managed, stored, disposed of or transferred,
- 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
- the status of each worker's qualifications, re-qualifications and training.

These regulations can be viewed at the CNSC's Web site at: nuclearsafety.gc.ca

SECTION G – SAFETY OF SPENT FUEL MANAGEMENT

G.1 Scope of the section

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

In addition to describing facilities and their normal operation, this section discusses the steps and controls in place to prevent accidents with radiological consequences and to mitigate the consequences should such accidents occur. The information contained in this section demonstrates that the requirements of the following applicable IAEA Safety Standards have been addressed:

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

G.2 Nuclear power plants

In Canada, spent fuel is stored in wet and dry states at the locations where it is 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 – 6 to 10 years, depending on site-specific needs and organizational administrative controls – and when the associated heat generation has diminished, the spent fuel can be transferred to an on-site dry storage facility. These dry storage facilities are large, reinforced concrete cylinders or containers. Each nuclear generating station in Canada has enough storage space to store all the spent fuel produced during the operating life of the station. A 600MW CANDU nuclear reactor produces approximately 20 cubic metres of spent fuel per year.

G.3 CANDU fuel

All CANDU fuel bundles are fabricated from natural uranium oxide pellets, 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 percent to 95 percent full power reactor operation.

G.4 Research reactors

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

As of March 2008, there were eight operating research reactors in Canada. Five of these are SLOWPOKE-2 reactors, designed by AECL. Of the five, four are located at Canadian Universities: one in Ontario at the Royal Military College of Canada, one in Quebec at the École Polytechnique, one in Alberta at the University of Alberta and one in Nova Scotia at Dalhousie University. The remaining SLOWPOKE reactor operates in Saskatchewan, and is managed by the Saskatchewan Research Council.

Of the three remaining research reactors, one includes a 5 MW pool-type reactor at McMaster University, while the last two reactors, namely National Research Universal and Zero Energy Deuterium-2, are located at the AECL CRL. In the past, research reactors have typically used highly enriched uranium fuel (HEU) for the fuel cores, but within the last decade some of them have been converted to low-enriched uranium fuel (LEU). This conversion to an LEU operation is in line with the United States Department of Energy's Reduced Enrichment for Research Test Reactors Program. The program aims to convert all HEU research reactors to LEU fuel. The HEU fuel used in Canadian reactors comes from the United States.

G.4.1 Nuclear fuel waste from research reactors

Two of the five SLOWPOKE 2 reactors in Canada use LEU (below 20 percent U-235); all others use HEU. All SLOWPOKE 2 cores are preassembled and cannot be modified by the licensee. The cores last many years, with reactivity decreases in fuel compensated for by the addition of beryllium reflector shims. Once the decreased reactivity of the used fuel can no longer be compensated for by the addition of reflector shims (usually after 20 to 30 years, depending on usage) the complete core is removed and the spent fuel is either sent to AECL CRL for waste management storage or to the United States. The fuel may also be removed if the facility is decommissioning or is converting to an LEU core.

The waste and spent fuel for CRL reactors is stored on-site. The spent fuel from NRU is stored in fuel storage pools until it can be transferred to Waste Management Area 'B', which is described in Annex 4. The ZED-2 reactor is operated occasionally and is mainly used for prototype testing of fuel to determine fuel characteristics.

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

G.5 Medical isotope production fuel

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

G.6 Storage of spent fuel

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

- small quantities that are transported to research facilities for experimental or examination purposes, and which are stored at those facilities, and

- the fuel from the Nuclear Power Demonstration (NPD) reactor, which is stored at the nearby AECL CRL site.

All Canadian power reactors were constructed with on-site spent fuel storage bays or water pools. Spent fuel is stored in either storage bays or in dry storage facilities at the location where it was produced. The only exception is the spent fuel produced at the now-closed NPD nuclear facility. The spent fuel from this facility was transferred to the AECL CRL, where it was placed in a dry storage facility. Please refer to sections D.8 and D.9 for a map of the locations.

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 dry storage facilities in tile holes and in silos at the CRL and WL waste management facilities.

The engineered structures, canisters, MACSTOR and OPG dry storage containers were originally designed for a 50-year lifetime. The actual life of the structures could be much longer. These structures are vigorously monitored; in the event of a structure failure, the spent fuel can be retrieved and transferred to a new structure.

Dry storage facilities are licensed for a limited period. Licences issued by the regulatory body in Canada are generally valid for a five- to 10-year period. At the time of licence renewal, the CNSC examines the operational performance of the dry storage facility to determine whether it can continue to operate safely for another licensing term – again, typically for a five year period. This situation may continue until a long-term management facility becomes available.

G.7 Spent fuel management methods

The fuel cycle in Canada is a once through process (currently, there is no reprocessing or intent to reprocess spent fuel for recycling of its uranium and plutonium content). The development and selection of an approach for long-term management of spent fuel is discussed in section G.17.

G.7.1 Requirements for spent fuel storage

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

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

The 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, known as CSA N292.2-07, *Interim Dry Storage of Irradiated Fuel*. The Canadian nuclear sector uses this standard as a guide to facilitate the licensing process.

G.8 Safety of spent fuel and radioactive waste management

In Canada, spent fuel management and radioactive waste management and associated facilities are regulated in a similar fashion. Safety and licensing issues are regulated according to NSCA requirements and associated regulations.

G.8.1 General safety requirements

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

G.8.2 Canadian licensing process

The Canadian licensing process covers siting, construction, operation, decommissioning and abandonment. No phase may proceed without the required applications, documentation, assessments and approvals. A full description of Canada's comprehensive licensing system is provided in section E.4.

G.8.3 Protection and safety fundamentals

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

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

G.8.4 Generic performance requirements

There are three main generic performance requirements:

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

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

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

G.8.5 Generic design and operational principles

There are two main principles for generic design and operations:

- the use of multiple engineered barriers to ensure spent fuel and radioactive waste are adequately contained and isolated from humans and the environment during normal and abnormal conditions, and

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

G.8.6 Performance criteria

The performance criteria accepted by the CNSC are as follows:

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

G.8.7 Safety requirements

Spent fuel and radioactive waste management facilities must be operated in a safe manner that protects 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 include the following:

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

G.8.7.1 Nuclear criticality safety

Criticality safety requirements must address both normal and abnormal conditions. Criticality safety analyses must be performed when significant quantities of fissionable materials are stored or handled. Each analysis must clearly demonstrate that the storage and handling of the nuclear waste is safe, which means that an inadvertent criticality cannot occur under normal (or credible abnormal) conditions. The analysis of a facility must consider the off-site consequences of improbable or inadvertent criticality events and demonstrate that these consequences do not violate the public evacuation criteria established by international standards (*IAEA Safety Standards Series GS-R-2*) and national guidelines (*Canadian Guidelines for Intervention during a Nuclear Emergency*).

G.8.7.2 Facility design

The spent fuel storage and radioactive waste systems must be 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 that exceeds the regulatory limit.

At present, all spent fuel and radioactive waste management facilities operate at a small fraction of the public regulatory limit.

G.8.7.3 Physical security and safeguards

The CNSC monitors and assesses the effectiveness of nuclear facilities' and nuclear materials' physical security and provides advice and assistance to licensees about how to apply the NSR. The CNSC administers the agreement between Canada and the IAEA about the application of safeguards to nuclear activities in Canada. The purpose of this safeguards agreement is to verify that Canada is meeting its obligations under the non-proliferation treaty. The CNSC personnel coordinate the activities of IAEA inspectors, who are authorized to carry out safeguards inspections and other activities at nuclear facilities in Canada. The operators of spent fuel management facilities are required under section 5(h) of the *Class I Nuclear Facilities Regulations* to provide in their construction application measures to facilitate Canada's compliance with any applicable safeguards agreement.

G.8.7.4 Industrial safety

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

G.9 Protection of existing facilities

Canadian regulations ensured the safety of the spent fuel management facilities that existed when the Joint Convention entered into force, as all facilities were under a CNSC licence. Consequently, the operation of spent fuel management facilities must be conducted according to NSCA requirements, associated regulations and licence conditions.

Storage facilities for spent fuel and radioactive waste have been designed to ensure 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 exceed regulatory guidelines. All discharges from nuclear facilities must be in conformance with the NSCA, its associated regulations and, if applicable, conditions specified in the licence.

G.10 Protection in the siting of proposed facilities

As discussed in section E.3.2, 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.

The requirements for a licence to site a Class I nuclear facility are listed in section 4 of the *Class I Nuclear Facilities Regulations*. Other requirements are indicated in section 3 of the *General Nuclear Safety and Control Regulations* and section 3 of the *Class I Nuclear Facilities Regulations*.

G.10.1 Public information programs

It is a regulatory requirement for licence applicants and licensed operators of Class I nuclear facilities and uranium mines and mills to launch public information programs about their activities. The CNSC has issued a guide that provides general information about the regulations regarding public information programs. This document, entitled G-217, *Licensee Public Information Programs*, is available at the CNSC Web site, nuclearsafety.gc.ca

For example, at the Bruce site, OPG operates the Western Waste Management Facility (WWMF) which accommodates all of the low- and intermediate-level nuclear waste for all 20 OPG-owned nuclear units, including those leased to Bruce Power. In addition, the WWMF has spent fuel dry storage facilities being used for the interim management of spent fuel from the Bruce reactors. As described in section H.7.1.1, OPG operates an extensive public information program at the Bruce site. OPG also operates spent fuel dry storage facilities at the Darlington and Pickering Generating Stations. The public information programs at those sites are integrated with the Station Public Information programs and include many of the same tactics used at the Bruce site, such as brochures, newsletters, tours, media briefings and the Internet. The information centres at the Darlington and Pickering sites have also created displays on spent fuel dry storage.

G.10.2 International arrangements with neighbouring countries that could be affected

The Canadian regulatory regime does not obligate the proponents of domestic nuclear facilities that may affect the United States to consult with foreign jurisdictions or with the public about the proposed siting of such facilities.

Canada and the United States, however, are signatories to the *International Convention on Environmental Impact Assessment in a Transboundary Context* (Espoo, Finland 25 February 1991). When this Convention is ratified, 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),

- “ensure that affected Parties are notified” of the proposed installation,

- “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

- include in the notification “information on the proposed activity, including any available information on its possible transboundary impact.”

The Governments of Canada and the United States, 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. This includes measures to control the discharges of radioactive materials into the Great Lakes System. These obligations are contained within the *Great Lakes Water Quality Agreement* (1978), as amended by the protocol signed November 18, 1987.

Since the 1950s, the CNSC and the United States Nuclear Regulatory Commission have practiced 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 the exchange of certain technical information that “relates to the regulation of health, safety, security, safeguards, waste management and environmental protection aspects of the siting, construction, commissioning, operation and decommissioning of any designated nuclear facility” in Canada and the United States.

G.11 Design, construction and assessment of safety of facilities

After the granting of a siting authorization, the second formal licensing step for nuclear facilities is the construction licence.

The requirements for a licence to construct a Class I nuclear facility are listed in section 5 of the *Class I Nuclear Facilities Regulations*. Information listed in section 3 of the GNSCR and section 3 of the *Class I Nuclear Facilities Regulations* is also required. It includes items such as the proposed design (including systems and components), the QA program, the possible effects on the environment and the proposed measures to control releases to the environment, a waste management strategy and a preliminary decommissioning plan (refer to section F.8).

Prior to construction of a new spent fuel storage facility, an application to the CNSC for a licence would possibly require the CNSC to initiate an EA before making a decision. The CEA Act requires that early on in the project an integrated environmental assessment of the possible impacts on individuals, society and the environment – at all licensing stages – must be carried out. The CEA Act is further described in Annex 2.5. At the end of the environmental assessment process, if it has been determined that the project is not likely to cause significant adverse environmental effects licensing can proceed.

Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management* (see section B.6), assists licensees and applicants as they assess the long-term safety of storage and disposal of spent fuel and radioactive waste.

G.12 Operation of facilities

The third step in the licensing process is obtaining an operating licence.

Requirements to operate a Class I nuclear facility are listed in section 6 of the *Class I Nuclear Facilities Regulations*. Information listed in section 3 of the GNSCR and section 3 of the *Class I Nuclear Facilities Regulations* is also required. It includes such items as a safety analysis report, commissioning program, the measures to prevent or mitigate releases of nuclear substances and hazardous substances to the environment and a preliminary decommissioning plan.

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

- effluent and environmental monitoring programs,
- operating and maintenance procedures,
- commissioning programs,
- inspection and maintenance programs,
- 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.

G.13 Monitoring of spent fuel dry storage facilities

If a nuclear facility possesses dry storage facilities, it is required to have an Operational Monitoring Performance Assessment Program. The program is the means by which the performance of individual barriers – as well as the entire containment system – are 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 any unsafe condition or the degradation of structures, systems and components. A typical monitoring program for a spent fuel dry storage facility may include the following elements:

- gamma radiation monitoring,
- canister monitoring for leaks, tightness verification of the baskets and canister liners,
- effluent monitoring (including airborne emissions and liquid emissions), and
- an environmental monitoring program.

G.13.1 Gamma radiation monitoring experience

Routine gamma radiation surveys are performed using a handheld monitor at appropriate points inside the dry storage facility fence and on all sides of the dry storage containers, or by Thermoluminescent Dosimeter (TLD) mounted devices to monitor cumulative fields. Experience has demonstrated that gamma radiation at dry storage facilities is significantly less than predicted during the design phase.

G.13.2 Leak tightness verification experience

Leak tightness verification of the AECL-type fuel baskets and concrete canisters consists of connecting a pump to the liner cavity and re-circulating the air through filters. Excessive humidity indicates either a liner leak or water holdup in the canister from operations carried out before sealing. The presence of radioactivity indicates a basket leak. For the OPG-type dry storage containers, leak tightness is verified through helium leak testing before containers are placed in storage. Subsequent aging management activities provide assurance that the container condition and weld integrity are not compromised, and helium cannot leak out.

Experience indicates that the various dry storage structures and components currently used in Canada effectively contain the fission products in the fuel bundles.

G.13.3 Environmental monitoring experience

Every nuclear generating station, including AECL's research facilities, has an environmental monitoring program. Spent fuel dry storage facilities at these sites are addressed in the site environmental monitoring programs, which:

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

Experience shows that spent fuel dry storage facilities in Canada operate safely and within prescribed regulatory limits.

G.13.4 Effluent monitoring experience

G.13.4.1 AECL

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

- two air heaters,
- blowers with High Efficiency Particle Absolute (HEPA) filters,
- associated ductwork, and
- dampers.

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

G.13.4.2 OPG

OPG dry storage containers are wet-loaded in the fuel bay, decontaminated, drained and dried, and a 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 the liquids resulting from the draining and vacuum drying are returned to the fuel bay. At the dry storage facility, a special workshop houses the following dedicated systems for dry storage container processing:

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

Airborne contamination hazards may present a danger if any loose surface contamination on the dry storage container becomes airborne, or if there is leakage of the dry storage container internal gas (such gas may 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 backfilling with helium.

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

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

G.14 Disposal of spent fuel

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

G.15 New facilities

The only new spent fuel management facility is located at the Darlington Nuclear Generating Station. The facility was completed in 2007, and it is now operational. In October 2007, the regulatory body issued an operating licence to OPG for the Darlington Waste Management Facility. The current facility comprises a dry storage container processing building and a storage building, designed to store 500 containers. OPG has been granted regulatory approval to construct two additional storage buildings with storage capacity for an additional 1,000 dry storage containers.

Figure G.1 – Darlington Waste Management Facility

G.16 Proposed facilities

Spent fuel from the operation of research reactors at the AECL CRL is currently stored below ground in vertical cylindrical concrete structures called *tile holes*. These are situated in Waste Management Area B. The fuel initially loaded into these storage structures from 1963 to 1983 was research reactor prototype fuel, and included uranium metal fuel that has less corrosion resistance than modern day alloy fuels. While these fuels are safety stored, monitoring and inspection have shown that some of the fuel containers and fuels are corroding.

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

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

G.17 Long-term management of spent fuel

<u>Policy and Legislative Framework</u>
Since the early days of the CANDU program, several concepts for long-term management of spent 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 spent fuel waste management program was formally initiated by the Governments of Canada and Ontario. AECL was assigned responsibility to develop a concept for placing spent fuel in a deep underground repository within the plutonic rock of the Canadian Shield. Ontario Hydro (now Ontario Power Generation Inc.) was assigned responsibility to study and develop technology to store and transport spent fuel. It was also designated to provide technical assistance to AECL in the area of repository development. 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) for the deep geologic repository concept to a 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 report of the federal Environmental Assessment Panel was submitted to the Canadian government in 1998. It made recommendations to help the federal government reach a decision on the acceptability of the disposal concept and the steps to be taken to ensure the safe long-term management of spent fuel waste in Canada (CEA Agency 1998).

The federal government responded to the Environmental Assessment 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 the NWMO by the nuclear utilities. In 2002, the Canadian Parliament passed the NFWA, which indicates that the Governor-in-Council will select one approach for the long-term management of nuclear fuel waste from those examined by the NWMO. The NFWA includes the following:

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

- The waste management organization is to create an Advisory Council, which will reflect a broad range of scientific and technical disciplines. Its expertise should include public affairs, other social sciences as needed, and traditional Aboriginal knowledge. It will also include representatives of the local and regional governments and Aboriginal organizations that are affected by the selected approach because of their geographic location.

- The waste management organization is to submit, within three years of the NFWA coming into force, a study setting out proposed approaches for the management of nuclear fuel waste, and its final recommendation. The study must include approaches based on the following methods:
    - a modified AECL concept for deep geologic disposal in the Canadian Shield,
    - storage at nuclear reactor sites, and
    - centralized storage, either above or below ground.

Under the NFWA, the federal government was tasked with reviewing the study prepared by the waste management organization, selecting a long-term management option from those proposed and providing oversight during implementation. NRCan will oversee how NWMO implements the management approach and ensure compliance with the NFWA. The NWMO will report annually to the Minister of Natural Resources. Every third year – following the selection of an approach by the Governor-in-Council – this report will include a summary of activities and a strategic plan for the following five years.

Canada’s plan has now moved forward against this legislative framework.

Pursuant to the NFWA, the NWMO was established in 2002 by the nuclear energy corporations – OPG, HQ, and NB Power. Upon its establishment in 2002, the NWMO’s first mandate was to develop, in collaboration with Canadians, a management approach for the long-term care of Canada’s spent fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible. From 2002 to 2005, the NWMO studied various approaches to the long-term management of Canada’s spent fuel.

In 2005, the NWMO recommended the APM approach to the Minister of Natural Resources. APM includes a technical method based on an end point of centralized containment and isolation of the spent fuel in a deep geologic repository in a suitable rock formation. It provides for continuous monitoring of the spent fuel, and the potential to retrieve it for an extended time. There is provision for contingencies such as the optional step of shallow storage at the selected central site, if circumstances favour early centralization of the used fuel before the repository is ready.

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

On June 14, 2007, following a review of the NWMO’s study *Choosing the Way Forward*, the Government of Canada announced that it had selected the APM approach for the long-term management of spent fuel in Canada.

With this Government decision, NWMO assumed responsibility for implementing the APM approach. Governance and organization staffing have evolved to provide the oversight, skills and capabilities required to implement APM. The Advisory Council continues to provide advice as required by the NFWA and NWMO issues its reports annually to the Minister of NRCan. To support financing of the plan, waste owners continue to make regular deposits to the segregated trust funds established in 2002. In 2008, the NWMO submitted to the Minister of Natural Resources a funding formula and schedule for trust-fund deposits. Refer to section K.4 for further information on plans for the long-term management of spent fuel.

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

For information on the public consultation strategy refer to Section K.4

SECTION H – SAFETY OF RADIOACTIVE WASTE MANAGEMENT

H.1 Scope of the section

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

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

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

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

H.2 Radioactive waste in Canada

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

Certain types of radioactive waste, such as that from hospitals, universities and industry, contain 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 the acceptable levels authorized by the CNSC, it can be disposed of by conventional means (in local landfill or sewer systems).

With the notable exception of waste from nuclear power plants – which is contaminated with long-lived radioisotopes – radioactive waste is generally shipped directly or via a waste broker to the waste management facility operated by AECL at its CRL. The typical storage facilities at CRL include shielded above-ground storage buildings, concrete bunkers and concrete tile holes. In some cases, radioactive waste is shipped to United States waste treatment and disposal facilities. For information on the amount shipped to the United States, please refer to Annex 5.1.8.

Canadian methods for the management of radioactive waste are similar to those of other countries. Primary emphasis is placed on minimization, volume reduction, conditioning and long-term storage of the waste, since long-term management 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 reduced in volume by compaction or incineration prior to storage. All radioactive waste currently generated is stored in such a way that it can be retrieved when necessary. 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, the facilities for the handling radioactive waste must be licensed by the CNSC and conform to all pertinent regulations and licence conditions. The waste management objective throughout the industry – from mines to reactors – is the same, which is to control and limit the release of potentially harmful substances into the environment.

H.3 Characteristics of radioactive waste in Canada

H.3.1 Fuel manufacturing waste

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

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

- uncontaminated and contaminated zirconium dioxide,
- graphite crucibles used to cast billets,
- filters,
- scrap lumber,
- pallets,
- rags,
- paper,
- cardboard,
- rubber,
- plastic,
- oils, and
- solvents.

H.3.2 Electricity generation waste

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

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

H.3.3 Historic waste

Historic LLW in Canada refers to LLW that was managed in the past in a manner no longer considered acceptable, but for which the current owner cannot reasonably be held responsible, and for which the Government of Canada has accepted the long-term responsibility. In 1982, the Government of Canada established the Low-Level Radioactive Waste Management Office (LLRWMO) within AECL, as the federal agent for the clean-up and management of historic low-level radioactive waste in Canada. NRCan provides policy direction and funding to the LLRWMO. The LLRWMO has completed historic waste clean-ups across Canada and continues to monitor several sites with historic radium or uranium contamination. At some sites, materials have been placed in interim storage pending the development of a long-term management approach. Ongoing site monitoring, inspection and maintenance are conducted at these sites.

In keeping with the 1996 *Policy Framework for Radioactive Waste*, Canada has taken different approaches for the management of spent fuel, low- and intermediate-level radioactive waste and uranium mine and mill tailings. These different approaches reflect not only the different scientific and technical characteristics of the wastes, but also the economics and the geographic dimensions of Canada and the locations of the waste. Long-term strategies and solutions for historic LLW are evolving for the various regions of the country. The LLRWMO helps develop and implement the Government of Canada’s strategic approach to historic waste management by working with communities and federal stakeholders to develop solutions to safely and cost-effectively reduce liabilities and associated risks. These community-based solutions apply sound waste management and environmental principles in the best interests of Canadians.

H.3.4 Radioisotope production and use waste

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

H.3.5 Uranium mining and milling waste

Uranium mining and milling waste comprises three major waste streams: mill tailings, waste rock and wastewater.

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.

The method used to manage tailings from uranium mine operations varies from mine to mine. Much depends on where the mine is located. The quantity of tailings produced at any uranium mine is determined by the grade of the ore, as well as the size of the deposit. Canada’s operating mines (all in northern Saskatchewan) have high-grade ore deposits, in comparison to past mining operations in Canada; therefore, smaller volumes of tailings are being produced.

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

Tailings Management Facilities (TMFs) have evolved over the decades, from simple deposition into natural landforms and lakes to the construction of engineered surface storage facilities, complete with seepage collection systems to the current practice of placing the tailings in engineered mined-out open pits converted to TMFs. Tailings in modern facilities are covered with water (subaqueous deposition), to enhance radiation protection and avoid oxidization and winter freezing of the tailings.

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

Waste rock characteristics are highly variable. Some waste rock contains sufficient concentrations of sulphide to generate moderate levels of acidity. This can mobilize potential contaminants from secondary minerals. In Saskatchewan, some waste rock contains secondary arsenic and nickel minerals, often to the point where the long-term care and control of these non-radioactive contaminants – not the waste rock's radioactivity – drive the level of care needed to manage it.

The wastewater (effluent) generated from mining and milling processes is treated as required and the treated water discharged to the environment is monitored to ensure it meets regulatory standards prescribed by the provincial and federal Governments. These limits ensure that the impact on the environment is minimal.

H.3.6 Radioactive waste at research reactors

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

Liquid wastes from research reactors mostly consist of water that contains radioactive contamination. Typically, the water is cleaned up through a water purification system, which 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 AECL CRL. At the TRIUMF (accelerator), there is also a small amount of contaminated oil, produced annually from oil used in the vacuum pumps. All of this slightly contaminated oil (approximately 2 litres per year) is presently stored on-site. Waste management at the AECL CRL is described in detail in Annex 5.

H.4 Waste minimization

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

The Canadian nuclear sector actively promotes and practices waste minimization. For example, OPG policy is to minimize the production of radioactive waste at source by preventing materials from unnecessarily becoming radioactive. Waste minimization is also a key principle espoused in the Canadian industry standard CSA N292.3, *Management of Low- and Intermediate-Level Waste*. The Canadian nuclear sector 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.

Canadian licensees follow various forms of waste minimization, depending upon site and operational specifics. As an example, OPG is implementing a number of waste minimization activities. Specific initiatives include the following:

- establishment of a waste minimization culture at OPG,
- material exclusion – take as little material into zoned areas as possible, particularly packaging,
- use reusable equipment and materials as much as possible,
- segregation of waste into waste and recycling at collection points,

- use of washable protective equipment to replace disposable items, including rubber gloves, reusable booties, redesigned washable hoods, reusable bags, plastic wrapping and washable mops,
- minimization of material entering zoned areas,
- segregation of waste into *radioactive* and *likely clean* at many collection points for further monitoring and characterization of *likely clean* waste,
- additional waste characterization,
- use of industry best practices related to free release standards and segregation, and
- development of suitable metrics to monitor improvements.

AECL is also undertaking similar activities and has a project underway to design, construct and operate a facility to enhance its capability to effectively utilize free-release standards and segregation.

H.5 General safety requirements

The main objective in the regulation of either a spent fuel dry storage facility or a radioactive waste management facility is to ensure that they and their activities do not pose unreasonable risks to health, safety, security and the environment. Canada's comprehensive licensing system, described in detail in section E.4, does not differentiate between a spent fuel management facility and a radioactive waste management facility. The design, construction and operation of either facility must ensure the safety of human health and the environment.

H.5.1 Protection and safety fundamentals

The regulation of spent fuel and radioactive waste can be divided into generic performance requirements, generic design and operational principles and performance criteria. These criteria are described in sections G.8.4 to G.8.6.

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

H.5.2 Safety requirements

Safety requirements for the management of spent fuel and radioactive waste must provide for the protection of the environment and the health and safety of workers and the public. During normal operations, spent fuel and radioactive waste management facilities must be operated in a safe manner. System components that may require periodic maintenance must be readily accessible and designed to permit safe and efficient maintenance. The safety requirements are described in detail in section G.8.7.

H.6 Protection of existing facilities

The safety of radioactive waste management facilities that existed when 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, its 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. A list of facilities is included in section D.

H.6.1 Past practices

Legacy radioactive wastes at AECL sites date back to the Cold War and the birth of nuclear technologies in Canada. These include contaminated buildings that have been shut down, and contaminated lands that are managed by AECL on behalf of the Government of Canada. The liabilities include high-level waste, in particular used research reactor fuel and high-level liquid waste from the production of medical isotopes, and Cold War era fuel processing experiments. In 2006, the Government of Canada initiated the NLLP (as described in section K.5.2) to deal with the liabilities at AECL sites. A description of AECL waste management facilities is included in Annex 5.

In 1982, the Government of Canada established the LLRWMO within AECL as the federal agent for the clean-up and management of historic low-level radioactive waste in Canada. Canada's historic waste inventory consists largely of radium and uranium contaminated soils. The Government of Canada has accepted responsibility for the long-term management of this waste.

NRCan provides policy direction and funding to the LLRWMO, enabling it to carry out its work. The LLRWMO has completed historic waste clean-ups across Canada and continues to monitor several sites with historic radium or uranium contamination. The bulk of Canada's historic low-level radioactive waste is located in the southern Ontario communities of Port Hope and Clarington. In March 2001, the Government of Canada and the local municipalities partnered on community developed proposals to address the clean-up and long-term management of these wastes. This partnership launched the Port Hope Area Initiative (PHAI). The PHAI and other initiatives to deal with historic waste are described in section K.5.3.

As already shown in section F.4, when remedial actions are required at uranium mine and mill tailings facilities where the owner no longer exists, the Government of Canada and provincial governments ensure that the sites are safely decommissioned. In Ontario, home of the former Elliot Lake uranium mining complex, the Governments of Canada and Ontario entered into a Memorandum of Agreement in 1996 that outlined their respective roles in the management of abandoned uranium mine and mill tailings. In keeping with the *Policy Framework for Radioactive Waste*, best efforts are made to identify the uranium producer or property owner of a site. Where such an owner cannot be identified, the governments have agreed to share costs, including a 50/50 sharing of costs associated with any necessary remediation. To date, these arrangements have not been necessary, as all Ontario sites have owners that are complying with their responsibilities.

In a similar vein, the Governments of Canada and Saskatchewan entered into a Memorandum of Agreement that defines roles and responsibilities for the remediation of certain cold war era uranium mine sites, principally the Gunnar mine and mill site in northern Saskatchewan. On April 2, 2007, the Governments of Canada and Saskatchewan announced the first phase of the clean-up. The total cost, which the governments will share, will be $24.6 million. NRCan has advanced $1.13 million as its share of Phase 1. A comprehensive environmental assessment of the project began on June 15, 2007. In October 2007, the Government of Saskatchewan and EnCana Corporation entered into an agreement for the decommissioning and reclamation of the nearby Lorado uranium mill site. The Gunnar and Lorado mine sites are described in Annex 8.1.1.2.

H.7 Protection in the siting of proposed facilities

The *Class I Nuclear Facilities Regulations* stipulate a lifecycle 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 GNSCR, NSR, RPR, and NSRDR also have requirements that must be met.

The requirements for a licence to site a Class I radioactive waste management facility are listed in section 3 and 4 of the *Class I Nuclear Facilities Regulations*. Note that additional information is also required by section 3 of the GNSCR.

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

H.7.1 Public information programs

The CNSC's Regulatory Guide on public information programs is addressed in section G.10.1. Information on OPG's public information program for spent fuel is also addressed in section G.10.1. Information on OPG's existing public information program for its low- and intermediate-level waste storage (see section H.7.1.1) and an example of public information for a new uranium mine or mill (see section H.7.1.2) are included below.

H.7.1.1 Public information program for low- and intermediate-level nuclear waste storage

The following is an example of an existing public information program where spent fuel (see section 10.1) and radioactive waste are located. OPG operates an extensive public information program in the Municipality of Kincardine and surrounding communities where it has facilities to store low- and intermediate-level radioactive waste and spent fuel. For the last five years, OPG, in partnership with the host Municipality of Kincardine and surrounding communities, has worked to establish a Deep Geologic Repository for the long-term management of low- and intermediate-level nuclear waste. In support of current operations and this future project, OPG operates a multi-tactical information program designed to inform and engage the public in dialogue and discussion on nuclear waste issues. Tactics include the use of advertising, brochures, videos, tours, briefings for community leaders, media and politicians, open houses, transportation seminars for first responders, newsletters, direct mailings, radio open line shows, speaking engagements, exhibits at many community events, sponsorships and, to reach beyond the local communities, extensive use of the internet where reports, brochures, videos and newsletters can be obtained. OPG considers itself a member of the communities in which it operates. It strives to be open and transparent in all its operations.

H.7.1.2 Public information for a new uranium mine or mill

The CNSC is committed to operating with a high level of transparency. This includes engaging stakeholders, First Nations and other Aboriginal groups, such as the Environmental Quality Committee (EQC), through a variety of consultation processes, information sharing and communications.

An environmental assessment for a new uranium mine or mill – conducted either through a comprehensive study or through a panel review – provides significant opportunities for public participation. This includes encouraging the public to comment on draft Environmental Assessment Guidelines and the Comprehensive Study Report (CSR). Comprehensive studies and panel reviews also offer funding for people who wish to participate in the review. These funds are provided and administered by the CEA Agency. After the public hearing phase, the Commission Tribunal considers licence applications for new uranium mines as set out in the CNSC *Rules of Procedure*, available on the CNSC Web site at: nuclearsafety.gc.ca

Typically, public hearings for licensing applications take place over two hearing days within a 90-day period, with public intervener submissions taking place on the second hearing day. Public hearings give affected parties and members of the public an opportunity to be heard before the Commission Tribunal. Usually, the Record of Proceedings and Reasons for Decision are published for the public within six weeks of the hearing. Refer to section E.4.3 for information on the public hearing process.

In addition to the formal licensing process, the CNSC encourages licence applicants to consult with the public about their plans for new uranium mines and mills during the pre-application phase. For example, the CNSC licensees travel to northern Saskatchewan where they host public information sessions about the Saskatchewan uranium mines and mills. Along with other organization, the CNSC personnel participate in these sessions. This allows the CNSC personnel to learn more about the local communities and the outreach activities prepared by licensees.

H.8 Design, construction and assessment of facilities

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

Before the CNSC can make a decision about whether to grant a licence to a party that has applied to construct a Class I radioactive waste management facility, the CNSC may have to initiate an environmental assessment. The CEA Act requires that early on in the project an integrated Environmental Assessment of the possible impacts on individuals, society and the environment of all licensing stages must be carried out. The CEA Act is further described in Annex 2.5. At the end of the environmental assessment process, if the CNSC concludes that the project is not likely to cause significant adverse environmental effects, licensing can proceed.

Regulatory Guide G-320, *Assessing the Long-Term Safety of Radioactive Waste Management* (see section B.6 of the Report) helps licensees and applicants assess long-term safety of storage and disposal of radioactive waste.

H.9 Operation of facilities

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

As a requirement of a licence to operate, the licensee must also keep a record of:

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

H.9.1 Criticality safety

Criticality safety requirements must address both normal and abnormal conditions. Criticality safety analysis must be performed when significant quantities of fissionable materials are stored or handled. The analysis must clearly demonstrate that the storage and handling of the nuclear waste is safe and, therefore, an inadvertent criticality cannot occur under normal (or credible abnormal) conditions. The analysis must consider the off-site consequences for low-probability, high-consequence inadvertent criticality events and demonstrate that the consequences of such events do not violate the public evacuation criteria established by international Standards (*IAEA Safety Standards Series GS-R-2*) and national guidelines (*Canadian Guidelines for Intervention during a Nuclear Emergency*).

H.10 Institutional measures after closure

H.10.1 Introduction

Article 17 applies to institutional measures that must be taken after a disposal facility has been closed. Disposal means that the radioactive waste is disposed of in a manner where there is no intent to retrieve it and that surveillance and monitoring is not required. Canada does not currently have a disposal facility. Examples of institutional controls for proposed future radioactive waste repositories are discussed in sections H.10.2 (i) and (ii). Decommissioned tailings management facilities require long-term institutional controls. These will vary from minimal – after the closure of the current generation of in-pit TMFs, which were designed for future decommissioning – to ongoing monitoring and maintenance programs at older sites where tailings have been deposited in surface facilities. Section H.10.3 describes the institutional control program developed by the Province of Saskatchewan for decommissioned mine sites, including former uranium mining and milling sites situated on Crown lands in that province.

Regulatory Body Requirements

Any proposal for the siting, construction and operation of a disposal facility must satisfy the requirements of the NSCA and its associated regulations as well as the CEA Act. If a licence application is received for a disposal facility, current nuclear regulations in Canada require that the CNSC oversee the nuclear inventory there. This implies perpetual licensing from the CNSC, unless the risks are very minimal and oversight by another regulatory or governmental body allows the Commission Tribunal to exempt the site indefinitely from pursuing a CNSC licence. (This is determined on a case-by-case basis).

Several requirements are imposed by the NSCA and its associated regulations, including the following;

- A licence from the CNSC must be held by anyone wishing to possess and use nuclear substances.
- Persons and the environment must be protected from unreasonable risk arising from the production, possession and use of nuclear substances and the development, production and use of nuclear energy.
- A licensee must conform with international obligations to which Canada has agreed (such as the commitments in the Joint Convention Report).

Regulatory Guide-320, *Assessing the Long-Term Safety of Radioactive Waste Management*, helps licensees and applicants assess the long-term safety of storage and disposal of radioactive waste, including institutional controls (see section B.5). The Guide describes typical ways to assess the impacts that radioactive waste storage and disposal methods have on the environment and on the health and safety of people. It addresses topics that include the use of institutional controls.

After closure of a disposal facility, institutional controls may be a part of an abandonment licence application. Current Canadian regulations do not allow removal from licence control (abandonment) without an explicit exemption by the regulatory body. Such an exemption would require the licensee to present a safety case demonstrating long-term safety. The case would have to cite engineering design and barriers and/or other forms of institutional controls, including periodic site verification. The CNSC would examine on a case-by-case basis the proposed institutional controls for long-term safety, for cost, for consequences of failure of the institutional controls and for reliability of the institutional controls. The CNSC must be satisfied that the abandonment of the nuclear substance and the prescribed equipment or information does not pose an unreasonable risk to the environment or the health and safety of persons, or pose an unreasonable risk to national security or result in a failure to achieve conformity with measures of control and Canada's international obligations.

Pursuant to section 8 of the CNSC *Class I Nuclear Facilities Regulations*, an application for a licence to abandon a Class I nuclear facility that includes spent fuel management facilities shall contain the following information:

- the name and location of the land, buildings, structures, components and equipment that are to be abandoned,
- the proposed time and location of the abandonment,
- the proposed method of, and procedure for abandonment,
- 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,
- the results of the decommissioning, and
- the results of the environmental monitoring.

Records

According to the GNSCR, every person is required to keep a record by the NSCA and shall retain the record for the period specified in the regulations. No person shall dispose of a record, unless they are no longer required by the NSCA to keep the record, or unless they have notified the regulatory body of the date of disposal and the nature of the record at least 90 days before it is disposed.

In terms of an abandonment licence or an exemption from licensing, the records may also be required to be archived or stored indefinitely, under the oversight of another government or regulatory body.

H.10.2 Examples of the use of institutional controls for proposed spent fuel and radioactive waste repositories

The following are examples of Canadian initiatives for repositories:

(i) NWMO's Proposed Repository for the Long-Term Management of Spent Fuel

On November 3, 2005, the NWMO submitted to the Government of Canada a final study *Choosing a Way Forward – The Future Management of Canada's Used Nuclear Fuel* and a recommendation. The recommended approach, APM, includes centralized containment and isolation of spent fuel in a deep geologic repository in a suitable rock formation. In June 2007, the Government of Canada issued its decision, accepting the APM as Canada's Plan.

After a decision is made to close the deep repository, a provision will come into play for post-closure monitoring of the facility. The precise nature and duration of post-closure monitoring and any requirements to restrict public access to the area will be developed collaboratively during implementation and take advantage of modern technology. This is a decision to be made by a future society.

(ii) Ontario Power Generation's (OPG) Deep Geologic Repository (DGR) for Low- and Intermediate-Level Radioactive Waste

Regulatory approval processes following closure of this facility and dismantling of the surface facilities may require institutional controls to prevent the public from accessing the site for some period of time. For OPG's proposed DGR, it is expected that unrestricted access could be allowed eventually – with all activities permitted, except deep drilling (subject to any ongoing use of the site for nuclear activities). Restrictions could be put on zoning and land use. At the current stage of the DGR program, specific details of these and any additional activities have yet to be defined.

H.10.3 Example of the development of institutional control for decommissioned uranium mines and mills in Saskatchewan

An initiative is underway in the Province of Saskatchewan, entitled *Institutional Control Program – Post Closure Management of Decommissioned Mine/Mill Properties on Crown Land in Saskatchewan (draft),* under the auspices of the provincial Ministry of Energy and Resources (April 2008).

Since the last reporting period, Saskatchewan initiated the formal development of an institutional control framework for the long-term management of decommissioned mine and mill sites on provincial Crown land. The development of the framework was to ensure the health, safety and well-being of future generations, provide certainty and closure for the mining industry and recognize obligations by the province and national and international obligations for storage of radioactive materials. The Ministry of Energy and Resources has been assigned responsibility for the Institutional Control Registry. An interdepartmental Institutional Control Working Group (ICWG) of senior representatives from the Ministries of Environment, Energy and Resources, Northern Affairs, Justice, Finance and Executive Council developed a framework and consulted with stakeholders from the federal government, industry, Aboriginals and Northern residents, special interest groups and the general public.

In May 2006, the provincial legislature promulgated the *Reclaimed Industrial Sites Act* to implement and enforce a recognized need for institutional control. With the *Reclaimed Industrial Sites Act* in place, the ICWG proceeded with the development of the *Reclaimed Industrial Sites Regulations,* which were subsequently approved in March 2007. The *Reclaimed Industrial Sites Act* and *Reclaimed Industrial Sites Regulations* legislate the establishment of the Institutional Control Program (ICP). In the case of a former uranium mining or milling site, the ICP recognizes the jurisdictional authority of the NSCA as enforced by the CNSC.

The two primary components of the ICP are:

- the Institutional Control Registry and the Institutional Control Funds, and
- the Monitoring and Maintenance Fund and the Unforeseen Events Fund.

The Registry will maintain a formal record of closed sites, manage the funding and perform any required monitoring and maintenance work. Registry records will include the location and former operator, site description and historical records of activities, site maintenance, monitoring and inspection documentation and future allowable land use for the site. In the case of a decommissioned uranium mining or milling site, it will reference the related the CNSC documentation and decisions.

The Monitoring and Maintenance Fund will pay for long-term monitoring and maintenance. The Unforeseen Events Fund will pay for unforeseen future events. Examples of unforeseen events include damage resulting from floods, tornadoes or earthquakes. To reduce the province's risk when it accepts custodial responsibility for sites, and to offset the cost of future monitoring, maintenance and unforeseen events, dedicated site-specific funding will be established by the site holder. The funds will be managed by the province but are legislated and stand alone from provincial revenue.

The ICP completes the regulatory framework for the province, helping the province respond to industry's requirement for clarity in the investment climate and accepting responsibility for safety and environmental concerns. This helps create a sustainable mining industry and protects future generations.

The Ministry of Energy and Resources is responsible for the Institutional Control Registry. During a dialogue with the stakeholders a discussion paper was prepared to introduce the structure and operation of the Registry – and the requirements for a company applying to enter a site into the Registry. The discussion paper can be viewed at: http://ir.gov.sk.ca

H.11 Monitoring programs

Each radioactive waste management facility in Canada must have in place an approved monitoring program. The monitoring program for a waste management facility must detect unsafe conditions and degradation of structures, systems and components that could result in an unsafe condition. This is how the performance of the individual storage structures – and the entire waste storage system – is evaluated. It helps ensure standards will create a safe environment for humans, non-human biota and the physical environment. For more information on environmental monitoring programs, refer to section F.6.6. Radiological effluent discharge levels for radioactive waste management facilities are provided throughout Annexes 5-8.

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,
- an environmental monitoring program, which may include water quality, soil sampling, sediment sampling and fish sampling, and
- surface water and groundwater monitoring.

SECTION I – TRANSBOUNDARY MOVEMENT

I.1 Scope of the section

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

I.2 Introduction

The Canadian laws and regulations used to control imports and exports in accordance with Canada's bilateral and multilateral agreements are as follows:

- NSCA and the associated Nuclear Non-Proliferation Import and Export Control Regulations,
- CEPA 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.

I.3 Controlled substances

Licences issued by the CNSC stipulate limitations on licensees' ability to import and export the nuclear substances they possess.

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

The list consists of the following materials and radioisotopes, which are 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, which has been designated as surplus waste, may not require a specific licence to export. However, under current Canadian regulations, the licence must authorize export or import activities; otherwise, the licensee must obtain a formal authorization from the regulatory body to export or import.

I.4 Exporting state

The CNSC and ITC have adopted a one-door approach for applying for export authorizations required under the *Nuclear Non-Proliferation Import and Export Control Regulations* and the *Export and Import Permits Act* for substances listed in section I.3. The application for a permit is sent to ITC four to six weeks before the scheduled export to allow sufficient time to process, consult intra- and inter- departmentally, and issue the CNSC licence and the ITC export permit. The ITC provides a copy of the permit to the CNSC, which then extracts the data it needs to evaluate the proposed licence. It is important to note that both the permit and licence application evaluations are performed independently and in parallel with each other.

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

As a matter of policy, Canada establishes NCAs with any country to which nuclear substances, equipment and technology may be exported for nuclear use. This ensures that the materials will be used for peaceful, non-explosive purposes. The substances can still be exported to countries with which Canada does not have an NCA, as long as they are for non-nuclear use. Canada also imports substances from countries with which it may not currently have NCAs.

Typically, the shipping state is required to notify the importing state if the shipping state wishes to make the material subject to the NCA. Often, a notification of shipment is also expected by the importing state, so that it can make the necessary preparations. These notifications are typically done directly between governmental authorities via established information channels. In Canada, the CNSC is responsible for transmitting prior notifications.

I.5 State of destination

Possession licences issued by the CNSC specify the nuclear substance(s) that the licensee is authorized to hold. These possession licences also authorize certain types and maximum quantities of nuclear substances to be imported without further authorizations. When substances are imported (as described in section I.3), specific authorizations must be obtained. These authorizations verify that the applicant holds the necessary possession licences for receiving and properly handling the nuclear substances. If the applicant does not hold the necessary licence, the applicant would be notified of the requirements for holding the substance shown in the application.

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

All Canadian shippers and receivers of safeguarded nuclear material must report the transfers to the CNSC.

I.6 Destination south of latitude 60 degrees

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

SECTION J – DISUSED SEALED SOURCES

J.1 Scope of the section

This section addresses Article 28 (Disused Sealed Sources) of the Joint Convention, which requires that:

1. Each contracting body shall, in the framework of its national law, take appropriate steps to ensure that the possession, re-manufacturing or disposal of disused sealed sources is done safely.

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

J.2 Introduction

In Canada, the NSCA establishes requirements for the protection of health, safety, security and the environment, as well as the fulfillment of Canada's international obligations and commitments on the peaceful uses of nuclear energy. The CNSC is the regulatory authority responsible for controlling the export and import of risk-significant sealed sources in Canada, and is mandated by the NSCA to:

- regulate the development, production and use of nuclear energy in Canada,

- regulate the production, possession, use and transport of nuclear substances, along with the production, possession and use of prescribed equipment and information,

- implement measures that respect international control of the development, production, transport and use of nuclear energy and nuclear substances, including the non-proliferation of nuclear weapons and explosive devices, and

- disseminate scientific, technical and regulatory information that concerns the CNSC's activities and their effects on the environment and the health and safety of persons of the development, production, possession, transport and use of nuclear substances referred to above.

Radioactive nuclear substances, whether in sealed or unsealed source form, have many industrial, medical and educational applications. A wide variety of organizations, including universities, hospitals, research organizations, government departments are typical users of sealed sources.

Most sealed sources are small in size and their radioactivity may range from tens to billions of Becquerels (Bq). When a sealed source is no longer required, or has decayed beyond its useful life, it may be treated as radioactive waste and sent to a licensed waste management facility. If a source's radioactivity has decayed below its exemption quantity or its clearance level, it may be released from regulatory control, pursuant to section 5.1 of the NSRDR. Sources that remain within regulatory control must be managed in consideration of all existing regulations.

J.3 Regulatory framework

In accordance with section 26 of the NSCA and subject to regulations, no person shall possess, transfer, import, export, use, abandon, produce, or service a sealed source, except in accordance with a licence.

As defined in the NSRDR, 'sealed source' refers to a radioactive nuclear substance in a sealed capsule or bonded to a cover, where the capsule or cover is strong enough to prevent contact with or dispersion of the substance – under the conditions for which the capsule or cover was designed.

The NSRDR has recently been amended to include the latest international levels established in the 1996 edition of the IAEA *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of*

Radiation Sources. Exemption quantities are minimum threshold values below which regulatory control is not required. Nuclear substances in these quantities do not pose any significant risk to persons or the environment.

Individuals who wish to obtain a licence to import, export, use, abandon, produce or service a sealed source must provide the information required under section 3 of the NSRDR. For controlled nuclear substances or for the export or import of high risk, radioactive sealed sources as identified in the *IAEA Code of Conduct on the Safety and Security of Radioactive Sealed Sources*, separate licence requirements are provided in the *Nuclear Non-Proliferation Import and Export Control Regulations*. There are additional requirements for persons wishing to apply for a licence to transport nuclear substances. The requirements are prescribed by the *Packaging and Transport of Nuclear Substances Regulations*.

J.4 Sealed sources used in Canada

Through Canada's regulatory control program, the NSC must license activities involving sealed sources. Each licence specifies the isotope and the maximum quantity (in Bq) of each radioactive nuclear substance.

J.4.1 Disposal of sealed sources in Canada

There are no sealed source disposal facilities in Canada. A sealed source may only be transferred in accordance with the conditions of a licence or the written instructions issued by the CNSC. For long-term management, radioactive sealed sources may be returned to a manufacturer. They may then be disposed, sent to a licensed waste management facility, or transferred to a person authorized to possess the sealed sources. If a sealed source has decayed below its exemption quantity or its clearance levels – as identified in Schedule 1 and Schedule 2 of the regulations – it may also be released from regulatory control, pursuant to section 5.1 of the NSRDR.

Once a sealed source is no longer needed or wanted, it may be shipped directly or through licensed collection firms to AECL CRL for management or to be returned to its nation of origin.

J.4.2 The National Sealed Source Registry and Sealed Source Tracking System

In 2004, the CNSC formed a project team to develop the National Sealed Source Registry (NSSR) and the Sealed Source Tracking System (SSTS). The team worked throughout the following year to design and build the system. In 2005, the project team recommended to the Commission Tribunal that 278 licences be amended to require licensees to report the movements of their sealed sources.

On January 1, 2006, the CNSC implemented the SSTS and the NSSR. The NSSR was designed to hold information about radioactive sources in all categories for licensees. The SSTS was designed to enable the reporting of receipts, transfers, imports and exports of all high-risk radioactive sources (Category 1 and Category 2), within strict time limits. Each import, export, receipt and transfer is called a "transaction" for SSTS purposes. The SSTS tracks all high-risk radioactive sources throughout their complete lifecycle.

During its first year of operation, the CNSC conducted outreach activities to inform licensees about the regulatory changes concerning source-tracking. The CNSC also prepared demonstration CDs with "how-to" guides about the source tracking system. An information package – which consisted of a letter, a demonstration CD and security authorization codes – was sent to each the CNSC licensee whose licence had been amended. For the first half of 2006, all SSTS transactions were reported by mail, fax or email. In July 2006, the CNSC launched a secure Web site for reporting SSTS transactions, using the Government of Canada "E-pass" secure technology.

By the end of 2006, the SSTS had logged more than 30,000 transactions for Category 1 and Category 2 source imports, exports, transfers and receipts. The majority of these transactions represented bulk shipments, including imports and exports, by a single, large Canadian source manufacturer. In December 2006, the CNSC was tracking 1,638 Category 1 sources and 3,920 Category 2 sources in Canada.

In 2008, the NSSR will be expanded to include sources in Category 3, 4, and 5.

J.4.2.1 Import and export of radioactive sealed sources

The enhancement of Canada's export and import control program for risk-significant sealed sources is the result of the government's commitment to two key IAEA documents: the *Code of Conduct on the Safety and Security of Radioactive Sources* and the IAEA Guidance. Under the leadership of the IAEA, the Code and the IAEA Guidance were developed internationally to improve the safety and security of radioactive sources around the world. In support of the IAEA and its efforts to develop a global control regime, the Government of Canada committed to meet the provisions contained within the Code and implement an export and import control program as outlined in the IAEA Guidance.

Under the Code, the CNSC is the Canadian regulatory authority responsible for controlling the export and import of hazardous sealed sources. By implementing export and import control measures, the CNSC enhances national and international safety and security. These measures make sure that only authorized persons are recipients of risk-significant sealed sources. The CNSC's export and import control program is consistent with the Code and IAEA Guidance and aims to:

- achieve a high level of safety and security regarding risk-significant sealed sources,
- reduce the likelihood of accidental harmful exposure to risk-significant sealed sources or the malicious use of such sources to harm individuals, society and the environment, and
- mitigate or minimize the radiological consequences of any accident or malicious act involving risk-significant sealed sources.

Effective April 1, 2007, the CNSC amended all licences dealing with the export and import of high-risk sources. The amendment restricts the general export authorization included in the "possession and use" licence to require the licensee to apply for a separate export licence for risk-significant radioactive sources.

In considering an application to export risk-significant radioactive sources, the CNSC must satisfy itself that the importing state meets the expectations specified in paragraph 8(b) of the supplementary guidance, regarding Category 1 sealed sources, and paragraph 9(b), in respect to Category 2 sealed sources. Where such assurances cannot be obtained, the CNSC may consider authorizing the export under the requirements described in paragraphs 15 and 16 of the supplementary guidance.

In assessing an importing country's or facility's capabilities, the CNSC may also take into consideration some of the following concerns:

- whether the recipient facility has been engaged in clandestine or illegal procurement of radioactive sources,
- whether import or export authorizations for radioactive sources have been denied to the recipient facility,
- whether the recipient facility has diverted, for purposes inconsistent with the IAEA Code of Conduct, any previous import or export of radioactive sources, and
- the risk of diversion or malicious acts involving radioactive sources.

The CNSC has fully implemented the requirements of the IAEA Code and supplementary guidance in its enhanced export and import control program. Before it grants any export authorization of Category 1 radioactive sources, the CNSC ensures – through the use of special IAEA forms available to member states – that the importing state gives the CNSC its consent to import Category 1 sealed sources. Category 2 sealed sources do not need prior consent. In all cases, the CNSC's export licence requires that a prior shipment notification be issued to the CNSC, the importing country and the importing facility. Notification must be seven days before the intended date of shipment.

In support of the enhanced the CNSC export and import control program, Regulatory Guide RD-341, *Control of the Export and Import of Risk-Significant Sealed Sources*, has been published in draft form. The guide will be made available in the near future, to assist licensees in applying for an export licence.

Since the start of the program on April 1, 2007, the CNSC has received more than 350 applications to export Category 1 and Category 2 radioactive sealed sources to over 69 states.

J.4.3 Retention of records

NSRDR requires every licensee to keep a record for a period of three years of any transfer, receipt, disposal or abandonment of a nuclear substance. Requirements include:

- 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,
- when the nuclear substance is a sealed source, the model and serial number of the source, and
- when the nuclear substance is contained in a radiation device, the model and serial number of the device.

J.4.4 Safety of sealed sources

The requirement to licence sealed sources (pursuant to the NSRDR) ensures that throughout its lifecycle of, a sealed source is possessed, transferred, imported, exported, used, abandoned, produced or serviced in accordance with regulatory requirements.

J.5 Sealed sources in the international community

The re-entry of disused, previously exported sealed sources is permitted either by an import licence (in respect to controlled nuclear substances) or in accordance with a general import authorization on possession and use licence issued by the CNSC.

SECTION K – PLANNED ACTIVITIES

K.1 Scope of the section

This section provides a summary of key activities and programs mentioned throughout this report, including planned next steps. Where appropriate, these include measures of international co-operation.

K.2 Introduction

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

- improving regulatory framework,
- updating, revising and developing new regulatory documents that provide guidance to licensees,
- developing long-term management options for spent fuel and radioactive waste, and
- addressing historic and legacy issues.

K.3 Regulatory framework initiatives

In September 2007, the CNSC personnel presented a new approach for regulatory framework to the Commission Tribunal. The CNSC is continually making improvements to the framework, to make it more robust and more responsive to current and emerging needs. For example,

- international standards (IAEA, ISO) are being adapted or adopted as appropriate,

- external consultations are being aligned with the Treasury Board of Canada's *Guidelines for Effective Regulatory Consultations*, and

- an online consultation form was launched to encourage people to participate in the development of regulatory documents.

For future regulatory documents, emphasis will be put on setting requirements for regulations and licence conditions and to provide guidance in regulatory documents. This initiative will result in documents being developed more efficiently while spanning a wider regulatory subject matter.

An analysis over gaps or oversights is being prepared for regulations and related documents to help develop long range plans for the framework. The Regulatory Policy Committee is providing strategic level direction to coordinate the identification, development and implementation of the framework.

Planned initiatives for regulatory documents include Regulatory Policy P-319, *Policy Financial Guarantees for Nuclear Facilities and Licensed Activities,* and Regulatory Guide G-306, *Financial Guarantees for Decommissioning of Licensed Activities*. For information on these two regulatory documents, please refer to section F.4.3.

Future planned initiatives for regulatory documents, specific to spent fuel and radioactive waste, include reviewing P-290, *Managing Radioactive Waste,* and G-320, *Assessing the Long-Term Safety of Radioactive Waste Management*, to ensure their continued relevancy for licensees. The CNSC also may consider revising G-219, *Decommission Planning for Licensed Activities*, published in 2000, to ensure it remains relevant to licenses.

K.4 Long-term management of spent fuel

K.4.1 Assessment of options for long-term management of spent fuel (2002–05)

From 2002 to 2005, the NWMO studied approaches for long-term management of Canada's spent nuclear fuel.

NWMO began by analysing management options that have been considered internationally. Following this review and screening, NWMO selected as the basis for its initial assessment the three methods specified in the NFWA: deep geologic disposal in the Canadian Shield, storage at nuclear reactor sites and centralized, above- or below-ground storage. From the insights gained through the NWMO analysis and public consultation, the NWMO proposed a fourth option, Adaptive Phase Management (APM). NWMO believes APM would best meet the objectives and expectations of Canadians.

The management options were subject to multiple assessment processes. The NWMO developed an assessment framework for evaluating the options according to citizen values, ethical principles and eight objectives:

- fairness,
- public health and safety,
- worker health and safety,
- community well-being,
- security,
- environmental integrity,
- economic viability, and
- adaptability.

The analysis included ethical and social considerations. A preliminary assessment of the three options in the NFWA examined the strengths and limitations of each approach, through an application of multi-attribute utility analysis. Extensive comparative analysis of the costs, benefits and risks of the three options in the NFWA and the NWMO's fourth option provided quantitative and qualitative assessments. The assessment processes were supported by multi-disciplinary research contributions, workshops, and submissions from Canadians, guidance on values and ethical principles from citizens, Aboriginal traditional knowledge and the NWMO's Roundtable on Ethics.

The NWMO developed its recommendation, APM, following the input of technical specialists, the public and Aboriginal People. NWMO engaged Canadians in a wide ranging dialogue on the values, principles and objectives they believe are required of a nuclear waste management approach, in order for the approach to be socially acceptable, environmentally responsible, technically sound and economically feasible. In studying these options, the NWMO held 120 public consultations and numerous full-day dialogues on values, covering a cross-section of the population in every province and territory. Approximately 18,000 citizens contributed to the study. More than 60,000 people expressed their interest by visiting the NWMO Web site. The final study report, *Choosing a Way Forward*, which contains the detailed recommendation and NWMO's supporting assessment findings and research, is available for download at nwmo.ca.

K.4.2 Adaptive Phased Management: NWMO proposal to government (2005)

In November 2005, the NWMO submitted its study and recommended the APM approach to the Minister of Natural Resources.

APM is composed of:

1. a technical method that:

    a) is based on centralized containment and isolation of the spent fuel in a deep geologic repository of suitable rock formations, such as the crystalline rock of the Canadian Shield or formations such as sedimentary rock,

b) is flexible in the pace and manner of implementation, through a phased decision-making process that will be supported by a program of continuous learning, research and development,

c) provides for an interim step in the implementation process, in the form of shallow underground storage of spent fuel at the central site, prior to final placement in a deep repository,

d) monitors of the spent fuel to support data collection and confirmation of the safety and performance of the repository, and

e) is able to retrieve the spent fuel over a long period, until such time as a future society makes a determination on the final closure and the appropriate form and duration of post-closure monitoring.

and

2. a management approach, whose key characteristics include:

a) responsiveness to advances in technology, natural and social science research, Aboriginal traditional knowledge and societal values and expectations,

b) sustained engagement of people and communities while making and implementing decisions,

c) financial stability, through funding by the nuclear energy corporations (currently OPG, HQ and NB Power) and AECL, according to a financial formula required by the NFWA,

d) site selection, focused on provinces that currently benefit from the nuclear fuel cycle: Saskatchewan, Ontario, Quebec and New Brunswick, although communities in other regions will also be considered, and

e) selecting a site which preferably has a willing community to host the central facilities. The site must meet the scientific and technical criteria to ensure that multiple engineered and natural barriers will protect human beings, other life forms and the biosphere.

APM was designed to build upon the advantages of each of the other three approaches and in order to provide safety and fairness to this and future generations.

In proposing an APM, the NWMO tried to provide a risk-management approach that is comprised of deliberate stages and periodic decision points. The APM:

- commits this generation of Canadians to take the first steps to manage the spent fuel we have created,
- includes a design and process that ensures that the APM meets rigorous safety and security standards,
- features a step-by-step decision-making process that will provide the flexibility to adapt to experience and societal change,
- provides genuine choice by taking a financially conservative approach and by allowing capacity to be transferred from one generation to the next,
- promotes continuous learning – improvements in operations and design can be made to enhance performance and reduce uncertainties,
- provides a viable, safe and secure long-term storage capability, with the potential for retrieving waste, which can be exercised until future generations have confidence to close the facility, and
- is rooted in values and ethics and engages citizens, allowing for societal judgments as to whether there is sufficient certainty to proceed with each step.

K.4.3 Government decision (June 2007)

Following a government-wide review, the Government of Canada announced on June 14, 2007, that it had selected the APM approach for the long-term management of spent fuel, as proposed by the NWMO.

When the Government of Canada accepted this management approach, NWMO assumed responsibility for implementing the APM method.

K.4.4 Implementing the long-term management plan (2007–08 activities)

In 2007 to 2008, NWMO grew into a broader implementing agency and began its initial implementation activities in seven key areas of its initial five-year plan. These activities included:

- developing relationships with interested organizations, individuals and Aboriginal peoples, and seeking their views on how APM should be implemented,
- advancing the social research program and incorporating the ongoing Canadian technical research program (this program involves the specialist consulting community, 11 universities and four international partnerships),
- completing a proposed funding formula to pay for the long-term management of spent fuel (in its 2007 Annual Report, the NWMO submitted this funding formula for approval by the Minister of Natural Resources. APM is estimated to cost $24.4 billion (2002). Consistent with the NFWA, nuclear energy producers began contributing to trust funds in 2002, in order to ensure that money will be available for implementing the long-term nuclear waste management program. NWMO will be proposing continued schedules of trust fund deposits),
- continuing to assess how changing circumstances might affect NWMO’s plans, including the prospects for new nuclear power plants, additional fuel volumes and different fuel types,
- enhancing the governance structure in several ways, including development of revised by-laws and members agreement, new appointments to the Board of Directors and Advisory Council, establishment of an independent technical review group, and the formalization partnerships with the Aboriginal Working Group Niigani and the Canadian Association of Nuclear Host Communities, who will provide advice and guidance,
- strengthening NWMO’s organizational capacity by incorporating additional technical and social research, public engagement, legal and human resources expertise which includes establishing an intern program, and
- advancing research into processes for selecting a repository site; convening initial dialogues with interested organizations and individuals concerning the design of a process for selecting a site. Site selection will not begin until the selection process is discussed and confirmed. It is likely that a number of years will elapse before a suitable site within an informed and willing host community is found.

K.5 Long-term management of low- and intermediate-level radioactive waste

All Canadian low- and intermediate-level radioactive waste is currently in safe storage. Canada’s two major low- and intermediate-level radioactive waste owners, OPG and AECL (which are responsible for about 98 percent of the waste), have initiatives underway to develop and implement long-term solutions. Furthermore, the federal government’s PHAI involves the clean-up and long-term management of historic LLW in Port Hope, Ontario.

Ongoing initiatives to address the long-term management of low- and intermediate-level radioactive waste in Canada are described in the following sections.

K.5.1 Proposed low- and intermediate-level waste deep geologic repository at OPG's Western Management Facility

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

The Municipality of Kincardine currently hosts OPG's Western Waste Management Facility (WWMF), which is the centralized storage site for low- and intermediate-level radioactive waste (L&ILW) arising from the operation of the 20 OPG-owned reactors in Ontario. OPG has safely managed L&ILW for the Pickering, Darlington and Bruce reactors at the Bruce site for over 30 years. Currently, an estimated 77,000 cubic metres of L&ILW is in interim storage. Throughout the life of the facility, emissions have been less than one percent of the regulatory limit.

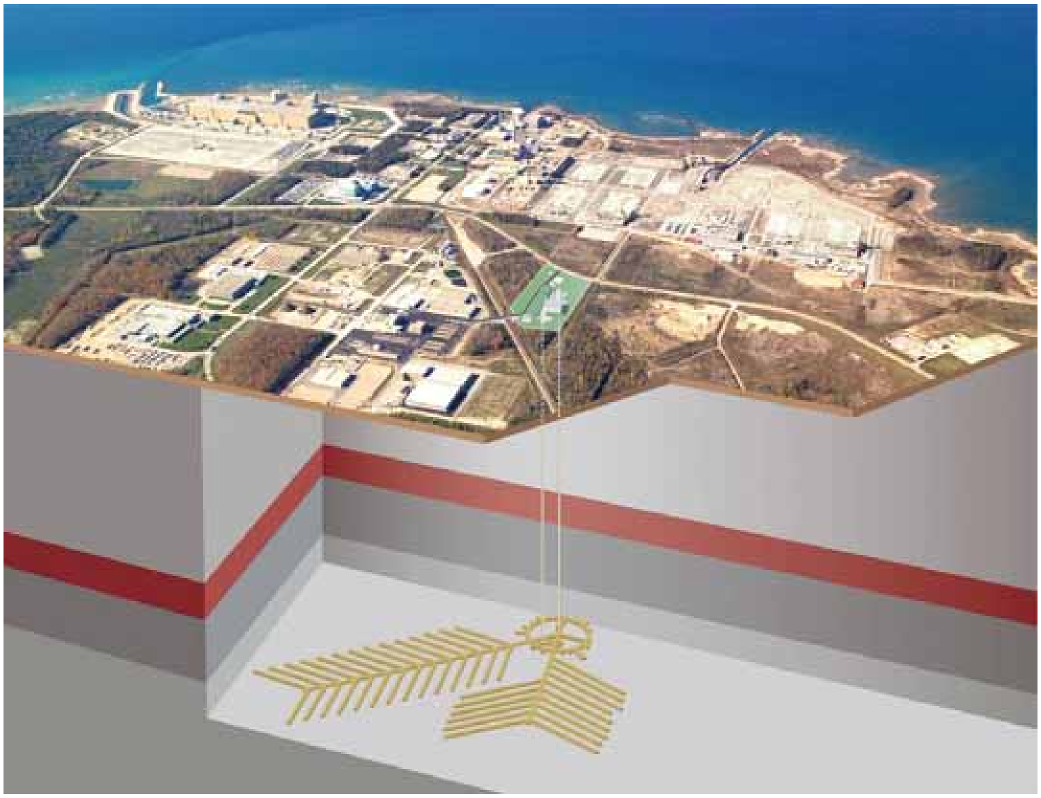


Figure K.1 – Artist's concept of the Deep Geologic Repository

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

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

Three options were studied: enhanced processing and storage, covered above-ground concrete vault and deep geologic repository. A geotechnical feasibility study, a preliminary safety assessment, a social and economic assessment, a community attitude survey, interviews with local residents, businesses and tourists and an environmental review led to the creation of the IAS. Another component of the Independent Assessment Study was a public consultation program, conducted in Kincardine and surrounding municipalities.

The IAS concluded that each of the options was feasible. The options could be constructed to meet international and Canadian safety standards with a high margin of safety, would not have significant residual environmental effects and would not have a negative effect on tourism. The geology of the Bruce site was considered ideal for the DGR option. The study report can be accessed at opg.com/dgr

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

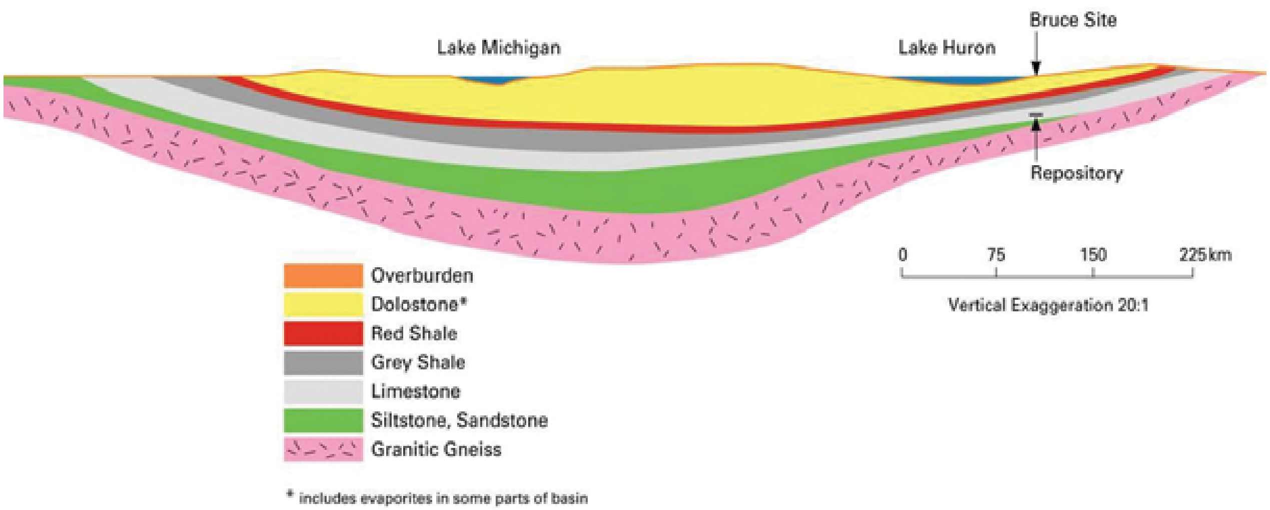


Figure K.2 – Michigan Basin geology

Following the Council resolution, Kincardine and OPG began to negotiate terms for a hosting agreement. Hosting agreements have been implemented in a number of jurisdictions in Canada and internationally by communities that support the location of a long-term waste management facility. The model for this agreement was the Port Hope agreement, which was negotiated between the federal government and the local Municipalities in the Port Hope area. It provided for the clean-up and long-term management of approximately two million cubic metres of historic radioactive and specified industrial wastes currently existing in the communities.

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

From mid-October 2004 to mid-January 2005, OPG assisted Kincardine to undertake a public dialogue on the DGR proposal. In particular, an independent consultant completed a community consultation to determine the level of community support. Each residence in Kincardine was contacted by telephone during the first three weeks of January 2005. The telephone calls were supplemented by a mail-out, as required. The results of the poll were announced at the Kincardine Council Meeting on February 16, 2005 and are as follows:

- 60 percent *in favour*,
- 22 percent *against*,
- 13 percent *neutral*, and
- 5 percent *don't know/refused to answer*.

Seventy-two percent of eligible residents participated in the telephone poll.

In December 2005, OPG submitted a letter of intent to construct the DGR to the CNSC, thus initiating the environmental assessment (EA) process. The EA process is now underway and coincides with further geo-scientific investigations, conceptual design work and safety analyses.

Two deep boreholes were drilled at the site in 2007 and further boreholes are planned for 2008 and 2009. These boreholes have confirmed the expected stratigraphy at the site. More than 200 metres of low-permeability shale form a protective cap over the low-permeability limestone formation where the repository will be constructed. Hydraulic conductivity measurements, in both the limestone and shale formations, have shown values of 10^{-11} m/s and below. These values indicate that any solute movement away from the repository will be diffusion-controlled.

The DGR concept is composed of horizontally excavated emplacement rooms, which will be arranged in two panels with access provided via two vertical, concrete-lined shafts. The proposed depth of the repository is 680 metres below ground.

The environmental impact assessment is scheduled to be submitted in 2011. EA approval and a Site preparation and construction licence are expected to be received in 2012. The earliest in-service date is expected in 2018.

K.5.2 Nuclear Legacy Liabilities Program (NLLP)

The nuclear legacy liabilities have resulted from 60 years of nuclear research and development carried out on behalf of Canada by the National Research Council (1944 to 1952) and AECL (1952 to present). These liabilities are largely located at AECL research sites and consist of shutdown research buildings (including several prototype and research reactors), a wide variety of buried and stored wastes, and contaminated lands. The shutdown buildings and contaminated lands need to be safely decommissioned, to meet federal regulatory requirements, and long-term solutions need to be developed and implemented for the wastes. More than half of the liabilities are the result of Cold War activities during the 1940s, 50s and early-60s. The remaining liabilities stem from R&D for medical isotopes, nuclear-reactor technology and national science programs.

About 70 percent of the liabilities are located at AECL's CRL in Ontario and a further 20 percent are located at AECL's shutdown Whiteshell Laboratories, in Manitoba. The remaining 10 percent relate largely to three shutdown prototype reactors in Ontario and Quebec, which were crucial to the developmental stage of Canada's CANDU reactor technology. The inventory of legacy waste includes spent fuel, high-, intermediate- and low-level solid and liquid radioactive waste, and wastes from site clean-up work across Canada.

In 2006, the Government of Canada adopted a new long-term strategy to deal with the nuclear legacy liabilities. The overall objective of the strategy is to safely and cost-effectively reduce the liabilities and associated risks. In the best interests of Canadians, the strategy is based on sound waste management and environmental principles. The estimated cost to implement the strategy over 70 years is about $7 billion.

The development of the strategy took into account two fundamental assumptions:

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

The implementation of the strategy at CRL will need to be coordinated with ongoing site operations. It will need to deal with operational facilities and other infrastructure over time, as they are shutdown and taken out of service. Waste characterization, processing, conditioning, treatment, packaging and storage, as well as long-term waste management facilities, will have to be designed and constructed before the licensee will be able to deal effectively with much of the waste. These facilities will be designed and sized to provide for the management of waste generated by AECL's ongoing research and development activities.

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

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

These three elements continue necessary care and maintenance activities to maintain the liabilities in a safe state until future phases of the program can address the sites. Further developments and refinements of the strategy will involve public consultations.

A Memorandum of Understanding between NRCan and AECL sets the direction for implementing the five-year plan. NRCan is responsible for policy direction and oversight, including control of funding. AECL is responsible for carrying out the work. A Joint NRCan-AECL Oversight Committee, chaired by NRCan, makes decisions on the planning, delivery, reporting and administration of the five-year plan. To represent the interests of the Government, NRCan:

- provides policy direction and oversight,
- ensures value for money, transparency and accountability, and
- provides for public consultations to inform the further development of the long-term strategy;

while AECL:

- implements the work,
- ensures regulatory compliance, safety and effectiveness,
- identifies priorities and develops annual plans,
- reports on approved activities, and
- holds and administers licences, facilities, land, materials and other asset responsibilities related to the nuclear-legacy liabilities.

K.5.2.1 Long-term strategy to decommission Chalk River Laboratories

AECL submitted to the CNSC a long-term strategy (70 years) for the decommissioning and site restoration of its CRL, which includes the construction of the infrastructure required to characterize, treat, store and manage over the long-term of all of AECL’s low- and intermediate-level radioactive waste. The CNSC accepted this strategy, and implementation began in 2006.

Over the past two decades, AECL undertook a modest program of removing redundant, unoccupied buildings, as the funding allowed. At the time of initiating the NLLP, twenty buildings were in various stages of decommissioning. Work is in progress to transfer an additional 27 buildings from active use to decommissioning. The transition will take place over the five-year start-up phase of the NLLP program, when AECL implements its site renewal program to move staff and equipment to newer facilities.

Within the past two years, two major buildings were demolished: the former plant hospital and a 12,000 m^2 radioisotope laboratory building that had been in use since the late 1940s. Demolition can produce a large amount of construction materials as waste. Building and equipment surveys, as well as the treatment of some materials to remove the contamination, resulted in the designation of significant quantities of waste as being likely clean and cleared for recycling, reuse or disposal in local landfills. These activities helped to minimize the quantity of waste requiring long-term management within the radioactive waste management areas on-site.

A key accomplishment of the program has been the construction and commissioning of the Waste Analysis Facility (WAF). The WAF is playing a major role in the effective disposal of building decommissioning and remediation materials. The WAF is a large warehouse-like structure, designed to receive the wide variety of decommissioning wastes designated in the field to be *likely clean* and to provide final confirmation that the waste meets free-release criteria and is safe to leave AECL property.

Another component of the program is to reduce risks associated with environmental contamination of CRL lands. Recent field activities and analyses have allowed completion of the following:

- *Disposal of legacy liquid isotope production wastes:* This activity involved the disposal of ~ 2,000 separate containers of mixed liquid wastes (oils and solvents with radioactive contamination) that were being stored on the surface of one of the waste management sites. Approximately 70,000 litres were analyzed, re-bulked and shipped off-site for incineration in the United States.

- *Remediation of the Glass Block Test Sites:* Fifty-two glass blocks were recovered from two experimental sites and transferred to secured storage in CRL's Waste Management Areas. These blocks were part of an experiment that dated back to 1958 to study fission product leeching rates into the water table from vitrified fuel reprocessing waste.

- *Removal of the Field Scale Lysimeter Test Facility:* This was an underground installation used to research radioactive contamination migration through different buffer materials that had been applied to buried waste packages. The lysimeter waste packages were removed, analyzed and shipped off-site for disposal.

- *Recovery of NRX fuel rods from Waste Management Area A:* Thirty-three irradiated NRX fuel rods and pieces, buried in wooden crates following the NRX accident in 1952, were recovered. The fuel was repackaged in fuel cans and moved to modern tile holes for storage.

- *Remediation of the Solvent Bunkers:* These 40-year-old concrete bunkers, located in one of CRL's waste management areas, housed 30 drums containing mixed contaminated waste solutions generated from tank rinses. To date, 24 drums have been fully assessed and disposed off-site.

The groundwater monitoring program conducted on the CRL site has also been enhanced over the past two years. There has been an increase from 100 to 160 boreholes. The program now samples for non-radiological, as well as radiological, contaminants. The enhanced program, in conjunction with other existing environmental monitoring programs on-site, will result in improved identification of contaminant plumes and aid in the development of more effective remediation strategies. The monitoring of environmental performance will also ensure that the detailed strategy for remediating the affected areas of the CRL is carried out by addressing the riskiest areas first. Any changes in performance are reflected in periodically updated priorities within the long-term strategy.

The shoreline and riverbed sediments downstream of the CRL site are being sampled and analyzed as part of an expanded monitoring program. This information is being used to develop strategies to minimize any potential ecological impact on the Ottawa River that might result from earlier operations on the site.

Finally, several studies are being initiated to better define the waste processing, treatment and long-term management facilities necessary to deal with the wide variety of legacy waste types that exist at all AECL sites. These studies will help define the shielded facility requirements for waste handling, the volume reduction and waste immobilization techniques, the extent to which buried wastes can be managed in place over the long-term, and the options for the long-term management of the wastes that need to be recovered and treated. Of note is the initiation of a feasibility study. The study will evaluate the potential suitability of the CRL site geology for a deep repository, to serve the long-term management of AECL's inventory of low- and intermediate-level solid radioactive waste. In support of this study, the existing geologic information has been compiled, a monitoring network for micro-seismic activity has been installed, and the first of five planned boreholes have been drilled. These activities have been undertaken to obtain new data on fractures and groundwater salinity using depth (to 900 metres) and other geochemical data in order to assess the local geology.

K.5.2.2 AECL Liquid Waste Transfer and Storage (LWTS) Project

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

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

The LWTS objectives are as follows:

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

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

The project authorities are preparing the submission package to the CNSC for a licence to construct the waste storage system.

K.5.3 Management of historic waste

In 1982, the Government of Canada established the LLRWMO within AECL to be the federal agent for the clean-up and management of historic LLW in Canada. NRCan provides policy direction and funding to the LLRWMO to carry out its work. Over the course of its existence, the LLRWMO has completed historic waste clean-ups across Canada and continues to monitor several sites with historic radium or uranium contamination.

K.5.3.1 Port Hope Area Initiative

The bulk of Canada's historic LLW is located in the southern Ontario communities of Port Hope and Clarington. These wastes and contaminated soils amount to roughly 2 million cubic metres. They originate from the operations of a radium and uranium refinery in the Municipality of Port Hope, dating back to the 1930s. While recognizing that there are no urgent risks from a health or environmental standpoint, the Government of Canada determined that intervention measures are required in order to implement more appropriate long-term management measures for these materials.

In March 2001, the Government of Canada and the local municipalities entered into an agreement on community-developed proposals to address the clean-up and long-term management of these wastes, thereby launching the PHAI. The $260 million initiative, which began in 2001, includes an EA and regulatory review phase, an implementation phase and a long-term monitoring phase, as well as a property value protection program. The LLRWMO is the proponent for the PHAI on behalf of the Government of Canada.

The PHAI will result in the long-term management of these historic wastes in two above-ground mounds that will be constructed in the local communities. The initiative includes two projects – the Port Hope Project and the Port Granby Project. Both PHAI projects are currently in phase one (environmental assessment and regulatory review), which is expected to be completed in 2010.

The Port Hope Project entails the clean-up of the urban area and 14 major sites, as well as the consolidation of all of the wastes (approximately 2 million cubic metres) in the Municipality of Port Hope at one long-term waste management facility (WMF). This facility is to be located at the present site of the existing Welcome WMF. The

Government of Canada, through its responsible authorities – NRCan, the CNSC and Fisheries and Oceans Canada – has accepted the LLRWMO produced EA Study Report and has issued a screening report that concludes the project is not likely to result in significant adverse environmental effects. The LLRWMO is currently completing the requirements to obtain a CNSC licence for the Port Hope Project. The programs – delivering Interim Waste Management, Property Value Protection and community consultation – are ongoing.

The Port Granby Project involves the relocation of the existing Port Granby wastes (approximately 0.5 million cubic metres) to a new above-ground, long-term WMF. The WMF is to be located at a nearby site, north of the current site and away from the Lake Ontario shoreline. An EA Study Report was submitted to the Responsible Authorities (RA) in July 2007. Since then, Fisheries and Oceans Canada has withdrawn as an RA because it has determined that the project as described (relocate waste to new site) is not likely to cause a harmful alteration, disruption or destruction (HADD) of fish habitat. The original community proposed concept – to manage the waste at its current shoreline site – was likely to result in harm to the fish habitat. The LLRWMO is now working to complete an addendum to the Port Granby EA Study Report in advance of the EA screening process and decision (NRCan and the CNSC). The CNSC licensing process for the long-term waste management facility would follow.

Ongoing stakeholder consultation remains a priority, as municipal support is required for successful completion of the planning phase. In March 2007, the RAs completed the environmental screening of the Port Hope Project. The Municipality of Port Hope gave its consent to continue to the review stage. The Municipality of Clarington will also be asked to consent to the Port Granby project environmental assessment screening report before licensing may proceed for the Port Granby facility. Clean-up, waste facility construction and waste emplacement will take place in the following years, after which the facilities will continue to be monitored and maintained for the long-term.

Figure K.3 – Visualization of proposed Waste Management Facility, Port Hope Project

K.5.3.2 Other historic waste initiatives

Most of the remaining historic waste to be dealt with in Canada is located along the Northern Transportation Route between Port Radium, Northwest Territories and Fort McMurray, Alberta. The waste has resulted from the past transport of radium and uranium bearing ore and concentrates from the Port Radium Mine to the barge-to-rail transfer point at Fort McMurray.

In 2003, the Government of Canada completed a clean-up of contaminated sites in Fort McMurray, and the resulting contaminated soils are safely managed in a long-term, above-ground engineered containment mound, adjacent to the local municipal landfill.

Recovered materials from previous remediations are being managed under institutional control at Fort Smith, Fort Fitzgerald and Tulita. They are monitored and maintained by the LLRWMO on behalf of the Government of Canada. Some materials have also been packaged and transferred to long-term management facilities. Since the last reporting period, the LLRWMO has repackaged approximately 867 cubic metres of contaminated soil from the Tulita mound into bags. The bagged materials are being managed at the site of the old cell under a CNSC licence. The LLRWMO is currently pursuing a plan that would see these wastes transported to a disposal facility by October 2008.

The sites that still have to be remediated – including Sawmill Bay, Bennett Landing, Bell Rock and Fort Fitzgerald – are regularly inspected and monitored by the CNSC and the LLRWMO. All these sites are exempted from the CNSC licensing and have been placed under institutional control. Strategies are currently being developed for the clean-up of these remaining sites. They are estimated to consist of about 10,000 cubic metres of contaminated soils.

K.6 Other contaminated lands

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

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

1. inactive uranium mine and mill tailings management areas,
2. contaminated land sites, which have resulted from past practices in the radium and uranium industries,
3. landfills permitted by the Crown, and
4. devices containing radium-luminescent compounds.

K.6.1 Inactive uranium mine and mill tailings management areas

At the time the NSCA came into force, there were 19 tailings management sites resulting from the former operation of uranium mines in Canada that needed to be brought under regulatory control: 14 in Ontario, three in Saskatchewan, and two in the Northwest Territories. Of these, 17 are now licensed and licence applications (or letters of intent) have been received for the two other sites (Gunnar and Lorado).

K.6.2 Contaminated land resulting from past practices in the uranium and radium industries under institutional control

K.6.2.1 Consolidated cells

Since the last reporting period, one of the consolidated cells was issued a CNSC licence. The Lakeshore Road Storage Mound was licensed by the CNSC on January 1, 2006. A CNSC licence is held by the Toronto Regional Conservation Authority (TRCA).

In addition, the historic waste from the cell in Tulita has been repackaged, and the repackaged materials are currently being managed at the site of the old cell, under a CNSC licence. The LLRWMO is currently planning to transport these wastes to a disposal facility by October 2008.

The other three sites where historic wastes have been consolidated and placed under institutional control are located in Fort McMurray, Alberta, Fort Smith, Northwest Territories, and the Passmore Mound site, in Toronto, Ontario. These mounds are monitored and maintained by the Government of Canada, which has accepted responsibility for the long-term management of historic waste when there is not another responsible owner. There is no time limit established for institutional controls of consolidated historic waste sites in Canada. The reliance on institutional controls in the management of these historic wastes is determined on a case-by-case basis. For some historic waste sites, institutional controls are expected to remain in place over the long-term. For other sites they are considered to be temporary measures pending the implementation of appropriate long-term waste management solutions.

K.6.2.2 Port Hope contaminated sites

Canada's historic LLW, located in the southern Ontario communities of Port Hope and Clarington, is discussed in section K.5.3.2.1.

K.6.2.3 Northern transportation route

The status of the historic LLW along the Northern Transportation Route is discussed under section K.5.3.2.

K.6.2.4 Toronto area contaminated sites

Seven historic radium contaminated sites in the Toronto area are exempted from the CNSC licensing. These sites have been placed under institutional controls, to help ensure public and environmental safety. This includes private properties with radium-contaminated soil, building materials and approximately 10,000 cubic metres of mildly contaminated soil. The soil is held in an interim storage mound at Passmore Avenue, in Scarborough, and the Ontario Realty Corporation (ORC) has characterized the former scrap yard and metal yard. The Passmore mound and other properties in the Greater Toronto Area are monitored, inspected and remediated by the LLRWMO.

K.6.2.5 Deloro Mine Site

A contaminated land site in Eastern Ontario, the Deloro Mine Site, is undergoing an Environmental Assessment (EA) process and will be remediated under a CNSC licence. The proponent, the Ontario Ministry of Environment (OMOE), is leading the development of an EA Study Report, as required by the environmental study guidelines approved by the Commission Tribunal on September 26, 2003. From the project schedule provided by the OMOE, it is anticipated the EA Screening Report will be presented at a Commission Tribunal hearing in February 2009.

K.6.3 Landfills

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

K.6.4 Devices containing radium luminous compounds

Canada has implemented a comprehensive risk-informed strategy for the regulatory control of radium luminescent devices, which is also supported by a public information program. The regulatory body continues to provide outreach material and information to stakeholders and members of the public regarding the regulatory regime. Advice includes the mitigation of radiological risks associated with the possession of such devices.

K.6.5 Other CLEAN program activities

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

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

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

ANNEX 1 – FEDERAL STRUCTURE

1.0 Introduction

Canada is a confederation of 10 provinces and three territories, administered by a federal government. The provinces are self-governing in the areas of legislative power assigned to them by the Canadian Constitution, as 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 the country. 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. It declared certain works and undertakings to be for the general advantage of Canada, and therefore subject to federal legislative control. Such works and undertakings are constructed for the following purposes:

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

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

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

Under the Canadian Constitution, provincial laws may also apply in these areas when 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 redundant regulations by seeking cooperative arrangements between the federal and provincial departments and agencies that have responsibilities or expertise in these areas.

Although these cooperative arrangements have been successful in achieving industry compliance, they need 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 regulatory body to perform any of the nuclear-related activities otherwise prohibited by the NSCA. In addition, the NSCA provides authority for the regulatory body and the Governor-in-Council to incorporate provincial laws by reference and to delegate powers to the provinces in areas better regulated by them, or where licensees would otherwise be subject to overlapping regulatory provisions. The major federal government organizations involved in the Canadian nuclear sector are as follows.

1.1 Natural Resources Canada

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

- Canadian uranium exploration and development,
- environmental protection,
- production and supply capability,
- foreign ownership,
- domestic and international markets,
- exports,

- international trade, and
- end uses.

The Government of Canada, through NRCan, is responsible for ensuring that the long-term management 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 long-term waste management and other facilities required for their wastes.

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

NRCan is responsible for policy direction and oversight, including control of funding, for the Government of Canada's NLLP. This program deals with legacy waste and contamination at AECL research sites. AECL carries out the work under the program to ensure compliance with regulatory requirements and that health, safety and the environment are protected. NRCan also provides policy direction and funding to the LLRWMO. The LLRWMO is Canada's agent for the management of historic waste.

1.2 Canadian Nuclear Safety Commission

The CNSC is Canada's nuclear regulatory body, created by the Governor-in-Council under the NSCA. The CNSC reports to the Canadian Parliament through the Minister of Natural Resources. It is not part of the Department of Natural Resources; however, the Minister of Natural Resources can seek information from the CNSC on its activities. Under the NSCA, the Governor-in-Council may issue directives to the Commission Tribunal of general application on broad policy matters. The Governor-in-Council cannot give direction to the Commission Tribunal on specific licensing matters.

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

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

The CNSC's mission is to "regulate the use of nuclear energy and materials to protect health, safety, security, and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy." In pursuing its mission, the CNSC is working to become one of the best nuclear regulators in the world. The CNSC values quality, integrity, competence, dedication and respect of others.

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

1.3 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 (including the Advanced CANDU Reactor - ACR™), Multipurpose Applied Physics Lattice Experimental (MAPLE) research reactors, and Modular Air-Cooled Storage (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 works nationally and internationally with Canadian private sector businesses. It is responsible for the operations of the Chalk River Laboratories, the Whiteshell Laboratories, and the decommissioning of shutdown facilities on those sites and at three prototype reactor sites. AECL provides a national service for the storage of nuclear waste at the CRL site, excluding waste from operating nuclear reactors.

1.4 Low-level Radioactive Waste Management Office

The LLRWMO was established by the Government of Canada to carry out the relevant federal responsibilities for historic low-level radioactive waste management in Canada. The LLRWMO operates under a Memorandum of Understanding between NRCan and AECL. While the LLRWMO receives its funding and policy direction from NRCan, it organizationally established as a separate division of AECL within the Decommissioning and Waste Management Organization of AECL. While the mandate of the LLRWMO is fairly broad, its function is to manage historic wastes. In particular, the LLRWMO is the proponent for the Port Hope Area Initiative. The LLRWMO also provides public information on radioactive wastes.

1.5 Canadian Environmental Assessment Agency

The Canadian Environmental Assessment Agency (CEA Agency) is charged with the administration of the *Canadian Environmental Assessment Act* (CEA Act, see Annex 2). The CEA Act 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 CEA Act ensures that the environmental effects of projects are considered as early as possible in a project's planning stages. One of the CEA Act's goals is to provide public participation opportunities in the EA process.

1.6 Foreign Affairs and International Trade Canada

Foreign Affairs and International Trade Canada (DFAIT) is charged with promoting nuclear cooperation and safety both bilaterally and multilaterally. DFAIT also implements 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, so as to verify that treaty obligations and commitments are being honored. DFAIT is responsible for the implementation of the *Chemical Weapons Convention* and the *Comprehensive Nuclear-Test-Ban Treaty*. In addition, DFAIT oversees foreign policy, including global security issues and is a required interlocutor for dealings with other governments.

1.7 Health Canada

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

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

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

1.8 Environment Canada

Environment Canada's mandate is to:

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

Environment Canada administers the *Canadian Environmental Protection Act* (CEPA).

1.9 Transport Canada

Transport Canada's mission is to develop and administer policies, regulations and services for a national transportation system that is safe and secure, efficient, affordable, integrated and environmentally friendly. Transport Canada sets policies, regulations and standards to protect the safety, security and efficiency of Canada's rail, marine, road and air transportation systems. This oversight includes the transportation of dangerous goods, such as nuclear substances and ensuring that related developments can be sustained.

ANNEX 2 – CANADIAN LEGISLATIVE SYSTEM AND INSTITUTIONAL FRAMEWORK

2.0 Introduction

Five pieces of legislation currently govern the nuclear sector 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* (CEA Act). The NSCA is the main legislation dealing with safety considerations.

2.1 Nuclear Safety and Control Act

The NSCA was passed by Parliament on March 20, 1997. This was the first major overhaul of Canada's nuclear regulatory 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 which covers the nuclear sector regulatory developments. 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 Tribunal (the tribunal which makes licensing decisions) and the CNSC personnel, who makes recommendations to the Commission Tribunal, exercise delegated licensing and authorization powers and assess licensee compliance with the NSCA, its 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,

- possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information,
- mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance,
- produce or service prescribed equipment,
- operate a dosimetry service for the purposes of this Act,
- prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility, or
- 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, which had to be developed before the NSCA could be fully 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*.

The CNSC is the governmental authority responsible for implementing the requirements of the Canada/IAEA safeguards agreement, pursuant to Article III of the Nuclear Non-Proliferation Treaty. In this capacity, the CNSC acts as Canada's State System of Accounting and Control of nuclear materials (SSAC). Most of the nuclear materials and facilities that are identified in this report, in accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, are also subject to the terms and conditions of the Canada/IAEA safeguards agreement.

2.2 Nuclear Energy Act

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

- undertake or cause to be undertaken research and investigations with respect to nuclear energy,
- with the approval of the Governor-in-Council, utilize, cause to be utilized and prepare for the utilization of nuclear energy,
- 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
- with the approval of the Governor-in-Council, license 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 licenses, discoveries, inventions, improvements and patent rights."

2.3 Nuclear Fuel Waste Act

Three provincial nuclear utilities, Ontario Power Generation (OPG), Hydro-Québec and New Brunswick Power, own 98 percent of the nuclear fuel waste in Canada. Most of the remainder is owned by AECL. Following a decade-long environmental assessment for a deep geologic disposal concept for spent fuel, which ended in 1998, it became clear that the Government of Canada needed to put in place a process to ensure that a long-term management approach for Canada's spent fuel would be developed and implemented. Given the relatively small volume of spent fuel in Canada, it was determined that a national solution would be in the best interest of Canadians.

On November 15, 2002, the Government brought into force the NWFA, which made the owners of spent fuel clearly responsible for the development of long-term waste management approaches. The document required waste owners to establish a waste management organization as a separate legal entity to manage the full range of long-term spent fuel management activities. It also required waste owners to establish trust funds with independent third-party trust companies, so as to finance their long-term waste management responsibilities. Through the waste management organization, the owners were required to prepare and submit a study to the Government of Canada of proposed approaches for the long-term management of the waste, along with a recommendation on which of the proposed approaches should be adopted. The NFWA required this analysis to include feedback from comprehensive public consultations that included Aboriginal peoples and be evaluated in terms of social and ethical considerations.

Under the NFWA, the federal government is responsible for reviewing the study prepared by the waste management organization, selecting a long-term management option from those proposed and providing oversight during its implementation.

As required by the NFWA, the waste owners established the NWMO and the trust funds necessary to finance the implementation of long-term waste management activities. Following extensive studies and public consultation, the NWMO submitted its study of options to the Government of Canada on November 3, 2005. The NWMO presented four options, including those listed in the NFWA:

- long-term storage at the reactor sites,
- central shallow or below ground storage,
- deep geologic disposal, and
- a fourth option called the Adaptive Phased Management (APM) approach, which combines the three previous options within a flexible, adaptive management decision-making process.

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

The NWMO is required to implement the Government's decision according to the NFWA, using funds provided by the waste owners.

The NFWA is administered by NRCan's Nuclear Fuel Waste Bureau (nfwbureau.gc.ca).

2.4 Nuclear Liability Act

The *Nuclear Liability Act* (NLA) establishes the legal regime that would apply in the event of a Canadian nuclear incident resulting in civil damages. The NLA is administered by the CNSC, while NRCan has responsibility for policy direction. The NLA can be viewed at laws.justice.gc.ca

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 and also provides for the establishment of a Nuclear Damage Claims Commission, in the event of a serious nuclear incident. This commission would deal with claims for compensation when the federal government deems that a special tribunal is necessary; for example, if claims are likely to exceed $75 million.

On October 26, 2007, the Minister of Natural Resources introduced in Parliament Bill C-5, "an Act respecting civil liability and compensation for damage in case of a nuclear incident". The proposed legislation updates and modernizes the current NLA (1976). Bill C-5's features include increased liability of nuclear operators ($650 million versus the current $75 million), a mechanism for periodic updating of the operator's liability, a longer limitation period for submitting compensation claims for bodily injury (30 years versus the current 10 years), the clarification of a number of key concepts and definitions, and greater definition of compensation procedures. As of June 2008, Bill C-5 had completed the Second Reading – Report Stage in the House of Commons.

At present, Canada is not a member of any of the international nuclear civil liability conventions; however, it has a reciprocity arrangement governing nuclear civil liability with the United States.

2.5 Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act* (CEA Act) sets out responsibilities and procedures on projects for which the federal government holds decision-making authority – whether as a proponent, land administrator, source of funding, or regulator. The CEA Act can be viewed on-line at laws.justice.gc.ca.

The majority of federal projects requiring an Environmental Assessment (EA) undergo either a screening or a comprehensive study. Both can be considered self-directed EAs, in the sense that the responsible authority determines the scope of the EA and the scope of the factors to be considered in the process. The responsible authority is directly involved and responsible for managing the EA process and for ensuring that an EA report is prepared. The responsible authority is the federal decision-maker, carrying responsibility under the CEA Act. As such, the CNSC is a responsible authority for any projects that it regulates. NRCan is the responsible authority for projects that it funds.

In practice, the project proponent may be delegated to conduct technical studies for the EA, the implementation 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 CEA Act, and for deciding on the course of action to ensure that the project follows the screening or comprehensive study procedures.

The CEA Act requires the EA of a proposed project to evaluate the possible impacts of all licensing stages before any irrevocable decisions are made. The CEA Act has four 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, and

4. to ensure that there will be an opportunity for public participation in the Environmental Assessment process, as appropriate.

ANNEX 3 – CANADIAN NUCLEAR SAFETY COMMISSION AND THE REGULATORY PROCESS

3.0 Introduction

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

3.1 Nuclear Safety and Control Act (NSCA)

A description of this NSCA is provided in Annex 2.

3.2 Canadian Nuclear Safety Commission (the CNSC)

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

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

3.3 The CNSC in the government structure

In accordance with the Canadian system of parliamentary government, the decision to introduce government legislation such as the NSCA into Parliament is made by the federal cabinet, on the advice and recommendation of the appropriate minister. The NSCA established the CNSC as a departmental corporation, named in Schedule II of the Government of Canada *Financial Administration Act*. The CNSC reports to the Parliament of Canada through a member of the Queen's Privy Council for Canada, designated by the Governor in Council as the minister for purposes of the Act. Currently, this designate is the Minister of Natural Resources. The CNSC is a departmental corporation, an independent agency and is not part of any government department.

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

The CNSC's personnel 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. Further information is provided in Annex 1.1.

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

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

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

The 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 according to the same standards as required from privately owned companies or operations.

3.4 Organizational structure

The task of the CNSC is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC consists of a president, the federally-appointed members of the Commission Tribunal, and approximately 730 staff members (as of the end of March 2008.) The organization's general structure is defined by the NSCA. The CNSC consists of two components:

- the Commission Tribunal – which refers to the agency's tribunal component, and
- the CNSC – which refers to the organization and its staff in general.

The Commission Tribunal

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

The Commission Tribunal's key roles are to:

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

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

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

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

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

The CNSC

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

The CNSC's personnel support the Commission Tribunal by:

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

In addition, the CNSC personnel prepare recommendations on licensing decisions, present them to the Commission Tribunal for consideration during public hearings and subsequently administer the Commission Tribunal's decisions. Where so designated, the CNSC's personnel also render licensing decisions.

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

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

1) Regulatory Operations Branch is responsible for regulation of the development, production and use of nuclear energy. It is also responsible for the production, possession, transport and use of nuclear substances and radiation devices in accordance with the requirements of the NSCA and its associated regulations. The Regulatory Operations Branch is comprised of the Directorate of Power Reactor Regulation, the Directorate of Nuclear Cycle and Facilities Regulation, the Directorate of Nuclear Substance Regulation, the Directorate of Regulatory Improvement and Major Projects Management. These four directorates are responsible for licensees in matters of licensing, compliance and enforcement.

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

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

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

The CNSC's Research and Support program

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

3.5 Regulatory philosophy and activities

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

- Persons and organizations subject to the NSCA and its 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 its associated regulations, to assure that they are properly discharging their obligations.

The CNSC establishes a strategic framework, which encompasses the following outcome areas:

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

The following activities are to achieve the above outcomes:

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

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

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

3.6 Regulatory framework

The CNSC's mandate, regulatory responsibilities and powers are set out in:

- The *Nuclear Safety and Control Act* (NSCA),
- The *Safeguards Agreement and Additional Protocol* between Canada and the IAEA, and
- Canada's bilateral and multilateral nuclear cooperation agreements.

The CNSC also conducts environmental assessments under the CEA Act and administers the NLA.

To carry out these responsibilities, the CNSC uses the following regulatory tools:

- regulations,
- licences, with licence conditions, and

- regulatory documents that provide guidance to the CNSC licensees on meeting criteria set out in the regulations.

In line with the *Cabinet Directive on Streamlining Regulation*, the CNSC took steps to enhance stakeholder consultation by holding information sessions on key regulatory documents, posting public comments related to key documents on its Web site and initiating an online public input form. Also in line with this directive, the CNSC is continuing to adopt or adapt national and international standards in regulatory documents.

3.6.1 The CNSC's regulatory documents

Regulatory documents support the CNSC's regulatory framework by expanding on expectations set out in the NSCA, its associated Regulations and legal instruments such as licences and orders. These documents provide instruction, assistance and information to the licensees.

Additional information on the CNSC's regulatory documents program is available on the CNSC Web site, at nuclearsafety.gc.ca.

Table A – Regulatory documents published by the CNSC

Document Number	Document Title	Date of Publication
Current Reporting Period		
RD-360	*Life Extension of Nuclear Power Plants*	February 2008
RD-310	*Safety Analysis for Nuclear Power Plants*	February 2008
RD-204	*Certification of Persons Working at Nuclear Power Plants*	February 2008
G-323	*Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement*	August 2007
S-210	*Maintenance Programs for Nuclear Power Plants*	July 2007
G-320	*Assessing the Long-Term Safety of Radioactive Waste Management*	December 2006
G-313	*Radiation Safety Training Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment*	July 2006
G-144	*Trip Parameter Acceptance Criteria for the Safety Analysis of CANDU Nuclear Power Plants*	May 2006
G-306	*Severe Accident Management Programs for Nuclear Reactors*	May 2006
P-325	*Nuclear Emergency Management*	May 2006
S-106 rev 1	*Technical and Quality Assurance Requirements for Dosimetry Services*	May 2006
S-296	*Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*	March 2006
G-296	*Developing Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*	March 2006
S-98 rev 1	*Reliability Programs for Nuclear Power Plants*	July 2005
S-294	*Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*	April 2005

Document Number	Document Title	Date of Publication
P-299	*Regulatory Fundamentals*	April 2005
Earlier Publications		
S-260	*Making Changes to Dose-Related Information Filed with the National Dose Registry*	October 2004
G-129 rev 1	*Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)"*	October 2004
P-290	*Managing Radioactive Waste*	July 2004
G-229	*Certification of Exposure Device Operators*	March 2004
G-217	*Licensee Public Information Programs*	January 2004
G-205	*Entry to Protected and Inner Areas*	November 2003
G-218	*Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills*	November 2003
G-4	*Measuring Airborne Radon Progeny at Uranium Mines and Mills*	June 2003
G-91	*Ascertaining and Recording Radiation Doses to Individuals*	June 2003
G-278	*Human Factors Verification and Validation Plans*	June 2003
G-276	*Human Factors Engineering Program Plans*	June 2003
G-221	*A Guide to Ventilation Requirements for Uranium Mines and Mills*	June 2003
G-147	*Radiobioassay Protocols for Responding to Abnormal Intakes of Radionuclides*	June 2003
G-273	*Making, Reviewing and Receiving Orders under the Nuclear Safety and Control Act*	May 2003
G-274	*Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities*	March 2003
G-208	*Transportation Security Plans for Category I, II or III Nuclear Material*	March 2003
S-99	*Reporting Requirements for Operating Nuclear Power Plants*	March 2003
G-225	*Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*	August 2001
P-211	*Compliance*	May 2001
G-228	*Developing and Using Action Levels*	March 2001
P-223	*Protection of the Environment*	February 2001
P-242	*Considering Cost-benefit Information*	October 2000
P-119	*Policy on Human Factors*	October 2000
G-149	*Computer Programs Used in Design and Safety Analyses of Nuclear Power Plants and Research Reactors*	October 2000
G-219	*Decommissioning Planning for Licensed Activities*	June 2000
G-206	*Financial Guarantees for the Decommissioning of Licensed Activities*	June 2000

Document Number	Document Title	Date of Publication
G-121	*Radiation Safety in Educational, Medical and Research Institutions*	May 2000
S-106	*Technical and Quality Assurance Standards for Dosimetry Services in Canada*	March 1998
R-117	*Requirements for Gamma Radiation Survey Meter Calibration*	January 1995
R-116	*Requirements for Leak Testing Selected Sealed Radiation Sources*	January 1995
R-52 rev 1	*Design Guide for Basic and Intermediate Level Radioisotope Laboratories*	June 1991
R-9	*Requirements for Emergency Core Cooling Systems for CANDU Nuclear Power Plants*	February 1991
R-8	*Requirements for Shutdown Systems for CANDU Nuclear Power Plants*	February 1991
R-7	*Requirements for Containment Systems for CANDU Nuclear Power Plants*	February 1991
R-85	*Radiation Protection Requisites for the Exemption of Certain Radioactive Materials from Further Licensing Upon Transferral for Disposal*	August 1989
R-105	*The Determination of Radiation Doses from the Intake of Tritium Gas*	October 1988
R-89	*The Preparation of Reports of a Significant Event at a Uranium Processing or Uranium Handling Facility*	August 1988
R-77	*Overpressure Protection Requirements for Primary Heat Transport Systems in CANDU Power Reactors Fitted with Two Shutdown Systems*	October 1987
R-72	*Geologic Considerations in Siting a Repository for Underground Disposal of High-Level Radioactive Waste*	September 1987
R-100	*The Determination of Effective Doses from the Intake of Tritiated Water*	August 1987
R-26	*Preparation of a Quarterly Health Physics Compliance Report for a Uranium Fuel Fabrication Plant*	September 1985
R-71	*Deep Geologic Disposal of Nuclear Fuel Waste: Background Information and Regulatory Requirements Regarding the Concept Assessment Phase*	January 1985
R-27	*Preparation of an Annual Compliance Report for a Uranium Fuel Fabrication Plant*	October 1984
R-25	*Preparation of a Quarterly Report on the Operation of a Uranium Refinery or Uranium Chemical Conversion Facility*	July 1984
R-58	*Bioassay Requirements for I-125 and I-131 in Medical, Teaching and Research Institutions*	September 1983
R-10	*The Use of Two Shutdown Systems in Reactors*	January 1977

The draft regulatory documents listed in Table B have been issued for external stakeholder comment. The comment period is now closed and these drafts are under revision, incorporating the comments received during consultation.

Table B – Draft regulatory documents

Document Number	Document Title	Issued for Public Consultation
Current Reporting Period		
RD-58	*Thyroid Screening Programs for Volatile Radioiodine* (formerly G-58)	October 2005
RD-337	*Design Requirements for New Nuclear Power Plants*	October 2007
RD-346	*Site Evaluation for New Nuclear Power Plants*	October 2007
RD-353	*Testing the Implementation of Emergency Measures* (formerly G-353)	April 2007
RD-314	*Implementation of Radiation Protection Programs by Consignors, Carriers, and Consignees of Nuclear Substances* (formerly G-314)	March 2004
RD-341	*Control of the Export and Import of Risk-Significant Sealed Sources* (formerly G-341)	February 2007
RD-363	*Nuclear Security Officer Medical, Physical, and Psychological Fitness* (formerly S-340)	February 2007
RD-336	*the CNSC Safeguards and Nuclear Non- Proliferation Reporting Requirements* (formerly S-336)	September 2006
RD-308	*Safety Analysis for Non-Power Reactors* (formerly S-308)	September 2006
RD-338	*Physical Security Requirements for Sealed Sources during Transport* (formerly S-338)	November 2006

3.7 Licensing process

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

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, renewal or amendment may trigger other legislation and regulations. For example, an EA under the CEA Act may be a prerequisite to proceeding with a licence application. The CEA Act may require an EA of a project to analyze potential environmental impacts and their severity, possible mitigation measures and any residual impacts. Both the physical and socio-economic environments must be considered in the EA. The range of stakeholder consultations is determined by the severity of the potential environmental impacts.

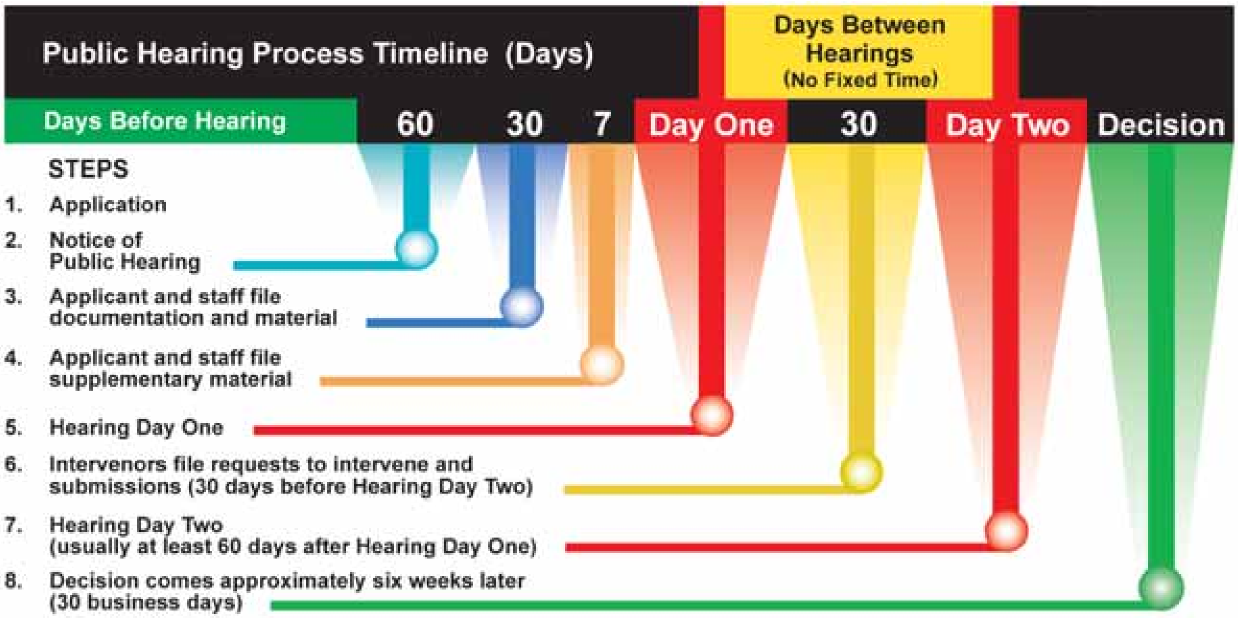
In addition, the CNSC also licenses the import and export of controlled nuclear substances, equipment, information and nuclear related dual-use items. Proposed imports and exports are evaluated by the CNSC personnel to ensure compliance with Canada's nuclear non-proliferation and export policies, international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

3.8 Licensing hearings

The NSCA establishes a legislative requirement for the Commission Tribunal to hold public hearings, with respect to exercising its power to license. NSCA also requires 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* set 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 the CNSC's interactions with internal and external stakeholders.

The Commission 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 the CNSC personnel recommendations. The second day is reserved to entertain interventions and is typically held 60 days after the first day to permit stakeholders time to review the application and recommendations.

See the following public hearing process chart for timelines:



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

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

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

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

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

3.9 Compliance

Administering licensing decisions of the tribunal entails a planned and continuous oversight. Whether based on- or off-site, the CNSC personnel work on a daily basis to carry out regular inspections, audits and reviews to provide a comprehensive overall and day-to-day picture of operations. This process ensures that the operations are safe and in compliance with the licence, as described in section E.6.1.

3.9.1 The CNSC Compliance Program

Confirmation of compliance with licences is managed within the CNSC Compliance Program (CCP). CCP is a formal compliance verification program that includes promotion, verification and enforcement. These elements of the program are described in Section E.6.1.

3.10 Cooperative undertakings

The CNSC works cooperatively with a number of other national and international organizations. At the national level, the CNSC’s mandate is clearly outlined by the NSCA, which specifies that nuclear regulatory activities are a federal responsibility. However, there are areas where other federal and provincial departments have legislated parallel or complementary responsibilities. They include security, emergency preparedness and mining.

In order to fulfill Canada’s international obligations, the CNSC collaborates with various agencies (such as its counterparts in other countries and Foreign Affairs and International Trade Canada) to ensure that nuclear cooperation is conducted consistently with international agreements, and especially with the non-proliferation regime.

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

3.11 The CNSC Outreach Program

The CNSC recognizes open, transparent and timely communications as being central to the work and management of Canada’s nuclear regulatory regime. 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 the CNSC policies, programs, services and initiatives.

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

The CNSC’s Outreach Program:

- provides the context and framework for outreach activities,
- provides tools and materials for existing and new activities,
- sets targeted, measurable outcomes,
- tracks and continuously seeks to improve the CNSC’s performance in doing outreach,

- identifies opportunities for new activities, and
- provides the structure and necessary resources to support additional the CNSC personnel to carry out related activities.

The CNSC uses outreach to communicate scientific, technical and regulatory information to stakeholders concerning the activities of the CNSC and the effects of the uses of nuclear energy and materials on health, security and the environment.

3.11.1.1 Framework for the CNSC's Outreach Program

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

3.11.1.2 Stakeholders

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

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

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

3.11.1.3 Definition of outreach

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

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

Outreach activity
An outreach activity is an activity that conveys information to or receives information from stakeholders (communication), or actively solicits input from stakeholders (consultation). For the purposes of the CNSC, outreach activities do not include mandated licensing and compliance activities but include:

- meetings with municipal officials and community groups,
- interactions with the public,
- public hearings of the tribunal, particularly when they are held in a local community,
- meetings with licensees on non-licence specific issues (e.g., quarterly meetings with CAN and CRAG meetings),
- presentations by the president and executives at various seminars and meetings of stakeholders,
- benchmarking and other exercises with other regulators,
- participation in international and national conferences and events,
- proactive media relations events, and
- consultations on environmental assessments.

Since the last reporting period, the CNSC's personnel have conducted approximately 119 outreach activities. It is possible that some activities have gone unreported. For example, the CNSC personnel met with the mayor of Elliot

Lake to provide a presentation on Cluff Lake decommissioning and the CNSC outreach initiatives from an Aboriginal perspective. In addition, the CNSC's personnel participate in bimonthly teleconferences with stakeholders interested in the long-term management of uranium mine and mill tailings, and inactive uranium mine sites. Finally, the CNSC's personnel hosted a member from the Brazilian Nuclear Energy Commission (CNEN) for two weeks to learn about the regulatory process for radioactive wastes and decommissioning. The mission was sponsored by the IAEA.

ANNEX 4 – SPENT FUEL STORAGE TECHNOLOGIES IN CANADA

4.1 Wet storage technology

Spent fuel discharged from a nuclear reactor is stored initially in wet bays or water pools. The wet bays, together with the cooling and purification systems, provide containment of the spent fuel and associated radioactivity and provide 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 that is approximately two metres thick. Inner walls and floors are lined with a watertight liner, consisting of stainless steel, a fiberglass reinforced epoxy compound, or a combination of the two. The bay structure is seismically qualified, so that the structures and bay components maintain their structural form and support function both during and following a design basis event. Other structural design considerations include load factors and load combinations (including thermal loads) for which upper and lower temperature limits have been established.

Figure 4.1 – Pool storage at Pickering NGS

4.1.1 Bay liners

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

4.1.2 Storage in wet bays

A number of designs are used to hold spent fuel for storage in wet bays. 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. Baskets, trays and modules are stacked vertically in the bays using seismically qualified stacking frames.

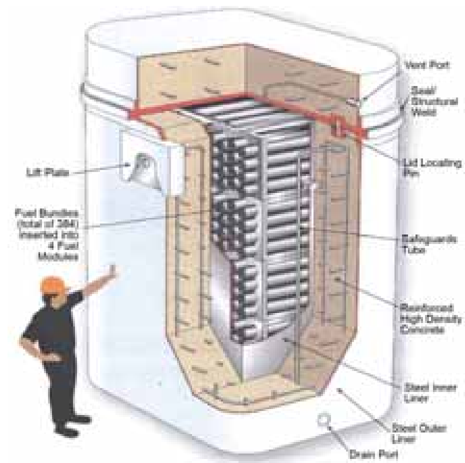


Figure 4.2 – OPG Dry Storage Container

4.1.3 Water pool chemical control

In all storage bays, water is circulated through cooling and purification circuits. A combination of ion exchange columns, filters and surface skimmers is used to control water purity within design limits. A typical purification system also includes resin traps, sample points and instrumentation to indicate when filters and ion exchange columns are exhausted, as well as 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, de-mineralized water is used.

4.2 Experiences with wet storage

Early operating experiences at both the AECL research reactor spent fuel bays (which have been in operation since 1947) and at the NPD and Douglas Point reactors have provided a basis for the successful operation of the spent fuel bays in this current generation of power reactors. Those experiences, along with the development of high-density storage containers, inter-bay fuel transfers and remote handling mechanisms, have contributed to the establishment of current safe storage techniques.

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

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

Procedures for locating and repairing the potential leaks were included into operations when Pickering NGS-A was returned to service after an extended shutdown. Techniques have been developed for underwater repairing by using an underwater-curing epoxy. Extensive repairs were completed in 2002/2003 at various locations in the Pickering NGS-A Primary Bay.

4.3 Dry storage technology

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

- AECL Concrete Canister,
- AECL Modular Air-Cooled Storage System (MACSTOR™), and
- OPG Dry Storage Container.

4.3.1 AECL Concrete Canisters

The AECL Concrete Canister Fuel Storage Program was developed at the Whiteshell Laboratories in the early 1970s, to demonstrate that dry storage for irradiated reactor fuel was a feasible alternative to water pool storage. Owing to the success of the demonstration program, concrete canisters were used to store Whiteshell Reactor-1 used fuel. Thanks to 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 can hold 54 bundles (used for fuel from Douglas Point, Gentilly-1 and Nuclear Power Development) and one can hold 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.

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

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

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

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

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

Three barriers (defence-in-depth) ensure the containment of the radioactive products:

- the fuel sheath,
- the fuel basket, and
- the internal liner.

4.3.2 AECL MACSTOR™ module

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

A typical MACSTOR™ module, such as the one used in Gentilly-2, is 8.1 metres wide, 21.6 metres long and 7.5 metres high. It stores 20 watertight galvanized carbon steel cylinders, arranged vertically in two rows of 10. Each cylinder holds 10 baskets of 60 spent fuel bundles, for a total of 12,000 bundles per module. Each cylinder is secured to the top slab of the module, and two sampling pipes, which extend to the outside of the MACSTOR™ module, are provided at its base. These pipes allow confirmation of the integrity of confinement.

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

To enhance cooling, the storage cylinders of the MACSTOR™ module are in direct contact with the air circulating in the module. All the surfaces of the storage cylinders are hot galvanized to protect the storage cylinders from ambient air.

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

Figure 4.3 – MACSTOR™ at Gentilly-2

4.3.3 Ontario Power Generation dry storage containers

OPG currently operates three spent fuel dry storage facilities – the Pickering Waste Management Facility (PWMF), the Western Waste Management Facility (WWMF) and the Darlington Waste Management Facility.

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

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

Figure 4.4 – DSC storage at the Western Waste Management Facility

4.4 Experiences with dry storage

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

The experience achieved at licensed dry storage facilities, which have 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, the general public and the environment. Dry storage containers have been used successfully and safely at the PWMF since 1996. The safety performance of the facility has been excellent over the entire period. Dose rates have remained below regulatory limits. Collective occupational radiation exposures have been less than predicted, by at least 30 percent. Emissions from the processing area have remained below regulatory limits. The PWMF operates contamination-free, and there have been no effluent releases resulting from dry storage.

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

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

4.5 Spent fuel storage facilities

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

4.5.1 Pickering Nuclear Generating Station

Pickering hosts two NGSs (Pickering NGS-A and NGS-B). Both stations consist of four CANDU Pressurized Heavy Water reactors. Pickering NGS-A commenced operation in 1971 and continued to operate safely until 1997, when it was placed in voluntary lay-up, as part of what was then Ontario Hydro’s nuclear improvement program. In September 2003, Unit 4 was returned to commercial operation. Unit 1 was returned to commercial operation in November 2005, while Units 2 and 3 remain in a safe shutdown state.

Pickering NGS-B commenced operation in 1982 and continues to operate today. OPG has begun a Pickering B Refurbishment Study to determine the feasibility of refurbishing the units at Pickering B in order to extend their operating lives until 2050-2060.

The spent fuel waste generated at both Pickering NGS-A and Pickering NGS-B is stored in the irradiated fuel bays for a minimum of 10 years before the spent fuel is transferred to the PWMF.

4.5.2 Pickering Waste Management Facility – Used Fuel Dry Storage

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

The used fuel dry storage area of the PWMF is comprised of a dry storage container processing building and two storage buildings. The Pickering spent fuel dry storage system is designed to transfer spent fuel from wet storage in the Pickering A and B irradiated fuel bays into a dual-purpose (storage and transport) concrete dry storage container designed by OPG. Prior to transfer to the PWMF, each loaded dry storage container is drained, its cavity is vacuum dried, and the container surface is monitored for loose contamination. If necessary, decontamination is carried out.

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

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

The PWMF can store up to 650 dry storage containers or 249,600 fuel bundles in the two existing storage buildings. An application to expand the facility – to include two additional storage buildings for storing a further 1,000 dry storage containers – has been approved for construction. While the two storage buildings will be constructed within the Pickering nuclear site – but some distance from the PWMF – the buildings will be part of the PWMF licence. Construction of storage building 3 has started. The two buildings will be operated within an established protected area.

In 2007, the PWMF (spent fuel dry storage area and re-tube components storage area combined) reported releases of less than 0.001 GBq to air and 0.12 GBq to water. It is important to note, however, that activity released from the PWMF is included in the total releases reported for the Pickering NGS.

Figure 4.5 – PWMF I and PWMF II area

4.5.3 Bruce Nuclear Generating Stations A and B

The Municipality of Kincardine, Ontario hosts the Bruce nuclear site, which contains two NGSs (Bruce NGS-A and NGS-B). Bruce NGS-A consists of four CANDU Pressurized Heavy Water reactors. Currently, only Units 3 and 4 are in operation; Units 1 and 2 are being refurbished.

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

4.5.4 Western Waste Management Facility – Used Fuel Dry Storage

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

The WWMF can process three to four dry storage containers per week. OPG is authorized to store up to 750,000 spent fuel bundles, or approximately 2,000 dry storage containers, at the facility.

In 2007, the WWMF (used fuel dry storage area and L&ILW storage area combined) released 13,400 GBq to air and 80.8 GBq to water. The activity released from the WWMF is typically less than one percent of the total activity released from the BNPD site.

4.5.5 Darlington Nuclear Generating Station

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

4.5.6 Darlington Waste Management Facility

The Darlington Waste Management Facility (DWMF) is located at the Darlington NGS site. It provides safe storage for the Darlington NGS used fuel until this fuel is transported to an alternative long-term spent fuel storage or disposal facility.

The current DWMF is made up of a processing building and storage building that can house up to 500 dry storage containers. The facility, however, is designed to provide a storage capacity for up to 575,000 fuel bundles produced at the Darlington NGS after two additional storage buildings are constructed in future. The spent fuel is stored in dual-purpose concrete dry storage containers, identical to those currently in use at the PWMF and WWMF. The processing of dry storage containers is also identical to the operations at the PWMF and the WWMF.

Figure 4.6 – Darlington NGS, with Darlington Waste Management Facility in the foreground

4.5.7 Gentilly-2 Nuclear Generating Station

The Gentilly-2 Nuclear Generating Station, which is operated by Hydro-Québec, houses a CANDU pressurized heavy water reactor. The station went into service in 1982, and began commercial operation in 1983.

The spent fuel generated here is first stored in a pool in irradiated fuel bays. After a period of cooling in the storage bays, the spent fuel is transferred to the dry storage facility. The transfer of the spent fuel into baskets is done directly in the pool. The loaded baskets are then transferred to a shielded workstation, in which the contents are dried and the basket lids are welded on. Once the work on the baskets has been completed, the baskets are transported to Hydro-Québec's spent fuel dry storage facility.

4.5.8 Hydro-Québec Used Fuel Dry Storage Facility

In operation since 1995, the Gentilly-2 Used Fuel Dry Storage Facility provides additional storage capacity in CANSTOR modules, which is an AECL-designed technology MACSTOR™. This facility has been authorized to build a total of 20 CANSTOR modules, with a total storage capacity of 240,000 spent fuel bundles. By the end of 2007, seven CANSTOR modules had been built and were in service. The eventual number of these modules will depend on a decision made concerning the refurbishment of the reactor.

Currently, the storage baskets are transferred on an as-needed basis, with transfers normally held between April and December each year. Approximately 4,500 spent fuel bundles are transferred to storage each year. At all times, the licensee makes sure that dose rates at the fence line of these facilities stays within the authorized limit of 2.5 μSv/h.

Figure 4.7 – Gentilly-2 Used Fuel Dry Storage Facility (bottom right)

4.5.9 Point Lepreau Nuclear Generating Station

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

4.5.10 Point Lepreau Used Fuel Dry Storage Facility

In operation since 1990, the Point Lepreau spent fuel dry storage facility provides additional storage capacity for the Point Lepreau NGS in above-ground concrete canisters. The facility is authorized to construct 300 canisters, for a total of 180,000 spent fuel bundles. By the end of 2007, the facility had constructed 180 canisters. Approximately 5,000 spent fuel bundles are transferred to dry storage each year, depending on the power output of the Point Lepreau nuclear reactor.

Samples of surface run-off from the spent fuel dry storage facility – as collected and analyzed in 2007 – have shown that tritium concentrations varied between 19 and 405 Bq/L. The average dose for the year at the spent fuel storage facility perimeter fence was 927.5 μSv, which is equivalent to an average dose rate of 0.11 μSv/h.

The Point Lepreau Generating Station is currently preparing for a major refurbishment outage, starting in April 2008. This work will enable the station to operate for another 25 to 30 years. To handle the spent fuel resulting from the extended operational life of the station, land was prepared to permit the construction of up to 300 additional canisters, depending on upcoming needs.

Figure 4.8 – Point Lepreau Used Fuel Dry Storage Area

4.5.11 Douglas Point Used Fuel Dry Storage Facility

The AECL Douglas Point Used Fuel Dry Storage Facility is located at the Bruce NGS. 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 in late 1987. The concrete canisters are currently in storage-with-surveillance mode. The Dry Fuel Storage Canister Air Sampling program showed gross beta activity levels were less than 1.0 Bq/canister in 2007.

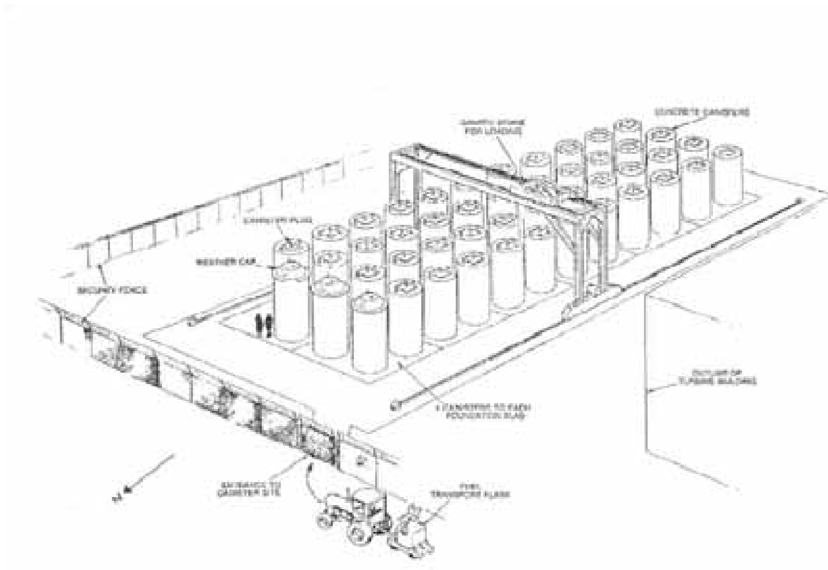


Figure 4.9 – Douglas Point Used Fuel Dry Storage Facility

4.5.12 Gentilly-1 Used Fuel Dry Storage Facility

The AECL Gentilly-1 Nuclear Power Station became operational in May 1972. It attained full-power for two short periods in 1972 and was then operated intermittently for a total of 183 effective full-power days until 1978. In 1984, AECL began a two-year decommissioning program, during which a total of 3,213 spent fuel bundles were transferred to concrete canisters. The concrete canisters are currently in storage-with-surveillance mode. The Dry Fuel Storage Canister Air Sampling program showed gross beta activity levels were 0.37 Bq for each canister in 2007.

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

The Waste Management Area G at AECL CRL is a used fuel dry storage area and contains concrete canisters as described in section 4.3.1. NPD was a demonstration reactor operated by Ontario Hydro (now OPG) from 1962 until 1987, at which time it was decommissioned. As part of the decommissioning program, the spent fuel was transferred to concrete canisters located at the AECL CRL used fuel dry storage area. At this site, AECL has stored 68 full and partial spent fuel bundles from Bruce, Pickering and Douglas Point, as well as 4,853 fuel bundles from the NPD reactor, in 12 dry storage concrete canisters. The concrete canisters are currently in storage-with-surveillance mode.

Two concrete canisters were constructed on the existing concrete support pad to store calcined waste from the processing of radioisotopes separated in the New Processing Facility at CRL. The final purpose of the canisters, however, may be changed after the recent cancellation of the Dedicated Isotope Facility.

4.5.14 Whiteshell Laboratories (WL) Used Fuel Storage Facility

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

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

Because of the success of the demonstration program, concrete canisters have been used to store all remaining WR-1 spent fuel. In addition, a number of spent fuel bundles from CANDU stations are stored in the WL facility after undergoing Post-Irradiation Examinations in the WL shielded facilities. The facility provides storage for 2,268 irradiated fuel bundles from both the WR-1 operation and CANDU reactor origin. Some spent fuel, resulting from operations prior to the 1975 canister development program, is buried in standpipes in the WMA. (Further details on the Whiteshell decommissioning program can be found in Annex 7.1.)

Figure 4.10 – Whiteshell Laboratories Used Fuel Storage Facility

4.5.15 NRU Research Reactor

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

Initial storage of the spent fuel rods is in water filled bays located within the NRU. After an appropriate time to allow for radioactive decay and cooling, the spent fuel is generally transferred to tile holes at Waste Management Area 'B' at CRL. The tile holes are also used to store the spent fuel from the NRX Reactor, which was shutdown in 1992.

4.5.16 McMaster Nuclear Reactor

The McMaster Nuclear Reactor (MNR) is a pool-type reactor, with a core of enriched uranium fuel moderated and cooled by light water. The reactor was upgraded to operate at powers up to five MW. MNR has recently been converted to LEU, some of which comes from France. All MNR used fuel (HEU and LEU), irrespective of its origin, is sent to Savannah River in the United States.

The MNR is the only Canadian medium-flux reactor in a university environment. The MNR's neutrons are used in nuclear physics, biology, chemistry, earth sciences, medicine and nuclear medicine. All the spent fuel generated at the McMaster Nuclear Reactor is stored in a water environment.

ANNEX 5 – RADIOACTIVE WASTE MANAGEMENT FACILITIES

5.1 Radioactive waste management methods

All radioactive wastes produced in Canada are placed into storage with surveillance, pending the establishment of long-term waste management facilities. At existing waste management facilities, the following various storage structures are currently in use:

- in-ground burial,
- low-level storage buildings,
- modular above-ground storage buildings,
- Quonset huts,
- tile holes,
- in-ground containers, and
- concrete bunkers.

5.1.1 Pickering Waste Management Facility – Re-tube components storage

The Pickering Waste Management Facility consists of the used fuel dry storage area (see Annex 4.5.10) and a storage area, called the re-tube components storage area (RCSA), which stores reactor core component waste from re-tube activities at the Pickering NGS-A. The RCSA is located within the protected area of the Pickering NGSs, and is operating in storage-with-surveillance mode, meaning that it is closed to new waste, unless it receives prior written approval from the regulatory body.

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

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

Figure 5.1 – PWMF with RCSA (left) and Spent Fuel Dry Storage Area (right)

5.1.2 Western Waste Management Facility – Low- and intermediate-level waste storage

The Western Waste Management Facility (WWMF) is owned and operated by OPG at the BNPD site in Kincardine, Ontario. The WWMF consists of two distinct areas:

- a low- and intermediate-level radioactive waste storage area, and
- a spent fuel dry storage area. (Refer to Annex 4.5.4.)

The low- and intermediate-level radioactive waste storage area provides safe handling, treatment and storage of radioactive materials produced at NGSs (Pickering A and B, Darlington, Bruce A and B) and other facilities currently or previously operated by OPG or its predecessor Ontario Hydro. The low- and intermediate-level radioactive waste storage area consists of various components, such as the waste volume reduction building (WVRB) and the transportation package maintenance building. The storage structures used in this facility include low-level storage buildings, refurbishment waste storage buildings, quadricells, in-ground containers, trenches and tile holes.

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

- **Radioactive waste incinerator area** – which contains the radioactive waste incinerator, shredder, associated equipment and an active drainage sump.

- **Compaction area** – which contains a box compactor and two maintenance shops for repairs, equipment storage, welding and equipment maintenance activities.

- **Material handling, storage and sorting area** – which provides for material movement, sorting and temporary storage of incoming and processed wastes. Access to the incinerator and compaction areas is included.

- **Control room** – which houses the main work control centre. All low- and intermediate-waste storage area systems and services alarms are monitored in this room.

- **Truck bays** – to establish a weather protected area for the receipt and unloading of wastes.

- **Ventilation equipment areas –** which contain air intake filters, intake fans, heating coils, air exhaust filters and exhaust fans. Radioactive airborne effluent monitors, for the building ventilation and radioactive incinerator exhaust, are also located in this area.

- **Electrical and storage rooms –** providing storage for electrical equipment, records and non-waste products.

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

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

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

Two refurbishment waste storage buildings have been constructed within the developed part of the low- and intermediate-level waste storage area. These buildings store the waste that arises from the refurbishment of Bruce NGS-A Units 1 and 2. One of these building contains the re-tube components in specially designed concrete and steel boxes, and the other houses the steam generators. The construction schedule for the future refurbishment waste storage structures will be based on need and, therefore, on the refurbishment plans developed for the nuclear generating stations by the power reactor licensee.

In 2007, the WWMF (spent fuel dry storage area and the low- and intermediate-level waste storage area combined) released 1.34E+13 Bq of tritium, 4.7E+04 Bq particulate beta/gamma, 7.02E+04 Bq I-131 and 4.67E+09 Bq C-14 to air. These emissions constitute a total of 0.04 percent of the derived release limit. Releases to water were 8.08E+10 Bq tritium and 3.13E+07 Bq gross beta – a total of 0.0009 percent of the derived release limit.

Figure 5.2 – Western Waste Management Facility

5.1.3 Radioactive Waste Operations Site 1

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

The facility, which has been operated in storage-with-surveillance mode since the mid-1970s, is closed to new wastes. OPG monitors and maintains the site and structures, and no new waste can be added without the prior written approval of the regulatory body.

5.1.4 Hydro-Québec Waste Management Facility

The Hydro-Québec Waste Management Facility consists of the used fuel dry storage area and the low-level radioactive waste management area (WMA). The low-level radioactive WMA provides for the safe storage of radioactive materials produced at the Gentilly-2 NGS. The low-level radioactive WMA consists of several types of reinforced concrete bunkers.

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

The low-level radioactive WMA receives approximately 25 cubic metres of radioactive waste per year. Samples of surface run-off from the radioactive WMA, collected and analyzed in 2007, have shown that the tritium concentrations varied between 280 Bq/L and 1,500 Bq/L. The average dose rate for 2007 at the radioactive WMA perimeter fence was 0.07 µSv/h.

In 2007, the CNSC approved Hydro-Québec's request to build additional waste management structures. The new Solid Radioactive Waste Management Facility (SRWMF) will be developed in four phases. This new facility will provide additional concrete bunkers to store low- and intermediate-level radioactive waste and filters. Construction of Phase 1 commenced in the spring of 2007, and is expected to become operational in summer 2008. The proposal to refurbish the reactor – if carried through – would require the construction of the remaining three phases of the SRWMF.

Two new types of concrete structures would be added to the SRWMF, if the refurbishment of the reactor were allowed to proceed. These structures are re-tube waste canisters (for the high-activity refurbishment waste) and used resin storage enclosures. The SRWMF continues to be under regulatory review. This project received a favourable CEA Act decision in December 2006.

Figure 5.3 – Gentilly-2 Installations de gestions des déchets radioactifs solides (IGDRS) Waste Facility

5.1.5 Point Lepreau Waste Management Facility

The Point Lepreau Solid Radioactive Waste Management Facility (SRWMF) includes a Phase I Area for the safe storage of radioactive materials produced at the Point Lepreau NGS, and a Phase II Area for the storage of spent fuel (described in Annex 4.5.10). Phase III was completed in 2007 to accommodate the reactor refurbishment waste.

The Phase I Area contains the following storage structures:

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

- **Quadricell:** The quadricell structures are designed to contain intermediate activity level waste, such as spent ion exchange resins and filters from reactor systems, and activated system components. Currently, there are approximately 144 cubic metres of quadricell storage, for a total 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 systems. These structures are contained within one of the vaults mentioned above.

The Phase I Area received approximately 1.9 cubic metres of radioactive waste per month in 2007.

Samples of surface run-off from the Phase I Area, collected and analyzed in 2007, have shown that tritium concentrations varied between 41 and 2,199 Bq/L. The average dose for the year at the Phase I Area perimeter fence was 907.5 µSv, which translates to an average dose rate of 0.10 µSv/h.

The Phase III Area contains the following storage structures:

- **Vaults:** These concrete structures are used to store the bulk of low-level waste from the refurbishment of the reactor. There are approximately 890 cubic metres of storage in the two vault structures.

- **Retube Canisters:** These concrete structures are used to store intermediate-level waste from the refurbishment of the PLGS reactor (primarily reactor components). There are approximately 165 cubic metres of storage in the five structures.

The average dose per year at the Phase III Area perimeter fence was 892.8 µSv, which translates into an average dose rate of 0.10 µSv/h. Note that, in 2007, this facility had no radioactive material stored in it, and the dose values represent the background dose rate.

Figure 5.4 – Point Lepreau re-tube waste canisters

5.1.6 Radioactive waste management at decommissioned reactor sites

The Douglas Point, Gentilly-1 and NPD reactors are shutdown, partially decommissioned and in the storage-with-surveillance phase. As these facilities contain radioactive materials, including radioactive wastes from decommissioning activities, they are presently licensed as waste management facilities. The storage-with-surveillance phase is currently envisaged to be 30 years or longer. A major factor influencing the length of the phase is the availability of long-term waste management facilities. (Annex 7 provides further information on the decommissioning activities at each of these sites.)

5.1.6.1 Douglas Point Waste Management Facility

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

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

- induced radioactivity in reactor components and the biological shield,
- radioactive corrosion products and fission products deposited on the drained heat transport and moderator surfaces,
- ion exchange resin from both the heat transport and moderator systems stored in underground tanks,
- contaminated soil stored in the service building,
- drums of contaminated steel from fuel storage trays, and
- intermediate-level waste stored in the fuel transfer tunnel leading from the reactor building to the receiving bay.

In 2007, DPWMF released 1.10E+11 Bq of tritium from the HEPA-filtered ventilation system for the reactor building during 1,036 hours of operation. Total liquid tritium release was 4.83+E10 Bq from the facility and the total beta/gamma release was 1.3343E+08 Bq.

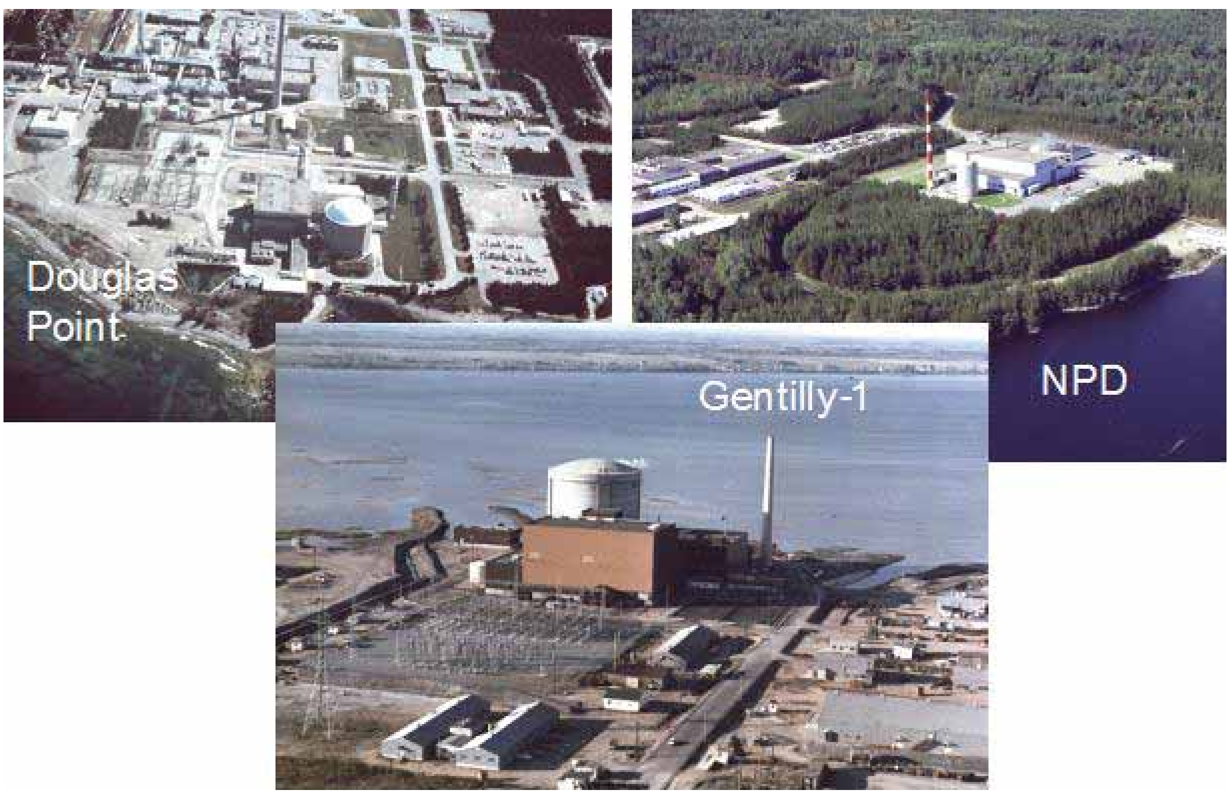


Figure 5.5 – Douglas Point, NPD and Gentilly-1 facilities

5.1.6.2 Gentilly-1 Waste Management Facility

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

The G1WMF consists of specified areas within the turbine and service buildings, the whole reactor building, the resin storage area and the spent fuel storage canister room.

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

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

There are no airborne releases from the G1WMF. In 2007, 7.4321E+04 Bq of activity beta/gamma were released from the facility liquid sump to the Hydro-Québec Power Reactor Active Liquid Discharge System.

5.1.6.3 Nuclear Power Demonstration Waste Management Facility

Located in Rolphton, Ontario, the AECL Nuclear Power Demonstration Waste Management Facility (NPDWMF) contains the decommissioned NPD Nuclear Generating Station. The station operated from 1962 until 1987, when Ontario Hydro (now OPG), with assistance from AECL, decommissioned it to a static state interim storage condition. After the static state was achieved, Ontario Hydro turned over control of the NPDWMF to AECL in September of 1988. Since then, various non-nuclear ancillary facilities, such as the administration wing, training centre, pump house and two large warehouses, were demolished and the refuse was removed from the site for reuse, recycling or waste. The fuel bundles were transferred to the CRL waste management area.

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

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

In 2007, the airborne emissions were 6.91E + 10 Bq for tritium and 2.60E + 04Bq for gross beta, while liquid effluent releases were 1.27E + 11Bq for tritium and 2.73E + 06Bq for gross beta.

5.1.7 AECL Nuclear Research and Test Establishment Facilities

AECL currently has two research facilities in Canada – one at the AECL CRL in Ontario, which is operational, and the other at the AECL WL in Manitoba, which is currently undergoing decommissioning. (Annex 7 provides further information on decommissioning activities.) The radioactive wastes produced at these two sites are stored in waste management facilities at each site.

5.1.7.1 Chalk River Laboratories

The Chalk River Laboratories (CRL) site is located in Renfrew County, Ontario on the shore of the Ottawa River, 160 kilometres northwest of Ottawa. The site, which has a total area of about 4,000 hectares, is situated within the boundaries of the Corporation of the Town of Deep River. The Ottawa River, which flows northwest to southeast, forms the northeasterly boundary of the site, the Petawawa Military Reserve abuts the CRL property to the southeast, and the Village of Chalk River, in the Municipality of Laurentian Hills, lies immediately to the southwest of the site.

The CRL site was established in the mid-1940s, and has a history of various nuclear operations and facilities, primarily related to research. Most of the nuclear and associated support facilities and buildings on the site are located within a relatively small industrial plant site area, adjacent to the Ottawa River near the southeast end of the property. Various waste management areas for radioactive and non-radioactive wastes are located within the CRL property, along the southwest to northeast corridor. The CRL WMAs provides some fee-based waste management for institutions such as universities, hospitals and industrial users, which have no other means to manage their wastes.

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 include a variety of contaminated wastes with 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.

- **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, wastes from radioisotope laboratories and workshops, and other materials such as contaminated soil, are in this category.

Liquid wastes, such as scintillation cocktails, radiological contaminated lubricating oils and polychlorinated biphenyl (PCB)-contaminated waste and isotope production wastes are also handled by the CRL waste management operations. Approximately 15 to 20 cubic metres of these types of waste are received into the WMAs per year – including wastes received from off-site waste generators – and are disposed of using commercial disposal services.

In addition, active aqueous wastes generated at the CRL site are treated at the Waste Treatment Centre (WTC). After treatment through a liquid waste evaporator, the treated effluent is released to the process sewer, which eventually discharges to the Ottawa River.

5.1.7.1.1 Waste Management Area A

The first emplacement of radioactive waste at the CRL site took place in 1946, into what is now referred to as waste management area (WMA) A. These emplacements took the form of direct disposal of solids and liquids into excavated sand trenches. The scale of operations was modest and unrecorded until 1952, when the clean-up from the NRX accident generated large quantities of radioactive waste (which included the NRX Calandria) that had to be managed quickly and safely. At this time, approximately 4,500 cubic metres of aqueous waste, containing 330 TBq (9,000 Ci) of mixed fission products, was poured into excavated trenches. This action was followed by smaller dispersals (6.3 TBq and 34 TBq of mixed fission products) in 1954 and 1955, respectively. The active liquid disposal tank received bottled liquids and, based on recorded observations, it is assumed the bottles were intentionally broken at the time of emplacement. The active liquid disposal tank was estimated to have received about 3.7×10^{13} Bq of Sr-90 and about 100 grams of plutonium. Waste is no longer accepted for emplacement in WMA A.

WMA A is on the western flank of a sand ridge. Three aquifers have been identified in the vicinity of WMA A: a lower sand, middle sand and upper sand. Groundwater flow is initially to the south. As the aquifer sands thicken, the flow direction bends to the south-southeast. The wastes are believed to be above the water table in WMA A, but infiltration has transported contaminants into the groundwater, which creates a contaminated plume with an area extent of 38,000 m^2. Groundwater monitoring data collected to date have encountered total beta, gross alpha and strontium-90 (Sr-90) in some of the sample wells. The groundwater plume is subject to periodic investigations to monitor migration of the plume and identify any deviations from expected conditions. Routine groundwater monitoring around the perimeter of WMA A (i.e., near the source of the plume) indicates stable or improving conditions, in that the contamination levels in the groundwater around the perimeter are generally either remaining at similar concentrations or gradually declining with time.

5.1.7.1.2 Waste Management Area B

Waste management area B was established in 1953 to succeed WMA A as the site for solid waste management. The site is located on a sand-covered upland, approximately 750 metres west of WMA A. Early waste storage practices for LLW were the same as those used in WMA A – namely, emplacement in unlined trenches and capped with sandy fill, in what is now the northern portion of the site. Additionally, numerous special burials of components and materials, such as the NRX calandria, occurred.

Asphalt-lined and capped trenches were used for solid ILW from 1955 to 1959, when they were superseded by concrete bunkers constructed below grade but above the water table in the site's sand. The use of sand trenches in WMA B for LLRW was discontinued in 1963 in favour of concrete bunkers and WMA C.

Concrete structures were used to store solid waste packages that did not meet sand trench acceptance criteria, but did not require a significant amount of shielding either. Early concrete bunkers were rectangular in shape. These were superseded in 1977 by cylindrical structures, which are still used.

Cylindrical bunkers are formed by using removable forms with corrugated reinforced concrete walls on a concrete pad. The maximum volume of a cylindrical concrete bunker is 110 cubic metres, but typical volumes of stored waste average about 60 cubic metres.

HLW are also stored in WMA B, in engineered facilities known as tile holes. Tile holes are used to store radioactive material that requires more shielding than can be provided in concrete bunkers. Stored materials include irradiated fuel, hot cell waste, experimental fuel bundles, unusable radioisotopes, spent resin columns, active exhaust system filters and fission product waste from the molybdenum-99 production process.

There are several groundwater contaminant plumes extending from WMA B. One plume, on the east side, contains organic compounds (e.g., 1,1,1-trichloroethane, chloroform, trichloroethylene) that emanate from the unlined sand trenches at the north end of the site. Referred to as the solvent plume, this plume is subject to periodic investigations to monitor contaminant migration and identify any deviations from expected conditions. Routine groundwater monitoring around the northeast perimeter of WMA B (i.e., near the source of the plume) indicates stable conditions, in that the contamination levels in the ground waters at the perimeter remain at similar concentrations over time.

The second plume emanates from the northwest corner of the WMA, and is dominated by strontium-90. The source of this plume is the western section of the unlined sand trenches. Routine groundwater monitoring around the northwest perimeter of WMA B (i.e., near the source of the plume) indicates improving conditions, in that the contamination levels in the groundwater at the perimeter decrease over time. The effects of this contaminant migration are mitigated by a plume treatment system known as the Spring B Treatment Plant. This automated treatment facility removes strontium-90 from surface water and groundwater, where the plume flow path discharges to the biosphere in a series of springs. This treatment system removes a significant fraction of the strontium-90 activity in the influent. In 2007, the Spring B Treatment Plant treated 2.4 million litres of groundwater, removing 2.9 GBq of strontium and reducing input concentrations from 1,232 Bq/L (avg.) to 4.1 Bq/L (avg.).

Tritium is another contaminant observed in the groundwater at WMA B. Routine groundwater monitoring around the WMA indicates that the tritium contamination levels remain stable over time. A number of different types of waste storage structures within WMA B are considered the source of this contamination.

Figure 5.7 – Waste Management Area B at the CRL

5.1.7.1.3 Waste Management Area C

Waste management area C was established in 1963 to receive low-level wastes with hazardous lifetimes less than 150 years, and wastes that could not be confirmed to be uncontaminated. Early operations consisted of emplacements in parallel trenches, separated by intervening wedge-shaped stripes of undisturbed sand. In 1982, this system was changed to a Continuous Trench method, to make more efficient use of the available space. In 1983, some of the original parallel trenches were covered with an impermeable membrane of high-density polyethylene.

The WMA C extension was constructed adjacent to the south end of WMA C in 1993, and began accepting wastes in 1995. As the continuous trench and/or its extension is backfilled and landscaped, material from the suspect soil stockpile was used for grading purposes to ensure that the surface of WMA C is suitable for travel by heavy equipment. Material placed in the soil stockpile satisfied specific acceptance criteria.

Besides the sand trench waste, inactive acid, solvent and organic liquid waste were also placed in specific sections of the trenches or in special pits located along the western edge of the area – although this practice is no longer followed. Contaminated sewage sludge was also emplaced in the sand trenches until late 2004.

Additions to WMA C waste inventory, including sewage sludge, are now restricted to interim above-ground storage of sealed containers. A new bulk material landfill for sewage sludge is being designed, and will be located near WMA C. Detailed work plans to remove readily available materials stored on the surface are in preparation.

Groundwater monitoring data at WMA C indicates that a plume is emanating from this area. The primary contaminant is tritium, although organic compounds are also observed at elevated concentrations in some boreholes. Routine groundwater monitoring around the WMA indicates that the tritium contamination levels remain stable over time.

5.1.7.1.4 Waste Management Area D

WMA D was established in 1976, to store obsolete or surplus equipment and components that are known or suspected to be contaminated but do not require enclosure (pipes, vessels, heat exchangers, etc.). It also stores closed marine containers holding drums of contaminated oils and liquid scintillation cocktails. These latter items pose more of a short-term chemical hazard than a radiological hazard.

Mixed and hazardous wastes are now routinely disposed of using commercial disposal facilities designed for this purpose. The site consists of a fenced compound, which encloses a gravel-surfaced area in which the components are placed. If the components have surface contamination, they must be packaged appropriately for the package to be free of surface contamination. The LLRWMO maintains two buildings for the storage of slightly contaminated material from non-AECL sites. All storage in WMA D is above ground. No burials are authorized in this area.

5.1.7.1.5 Waste Management Area E

WMA E is an area that received suspect and slightly contaminated soils and building materials, and other bulk soils and building debris from approximately 1977 to 1984. The waste materials were used to construct a roadway to a site intended to become a waste management area for suspect contaminated materials. This site was to be used in place of WMA C for this type of waste. The plan for the creation of this site was terminated, however, when concerns were raised about the location.

5.1.7.1.6 Waste Management Area F

A new area was established in 1976 to accommodate contaminated soils and slags from Port Hope, Albion Hills and Ottawa – all located in Ontario. This site was designated WMA F. The stored materials are known to contain low levels of radium-226, uranium and arsenic. Emplacement was completed in 1979, and the site is now considered closed, although it is subject to monitoring and surveillance to assess possible migration of radioactive and chemical contaminants.

5.1.7.1.7 Waste Management Area G

WMA G was established in 1988 to store the entire inventory of irradiated fuel from the NPD prototype CANDU power reactor in above-ground concrete canisters. Two additional concrete canisters were constructed on the existing concrete support pad to store calcinated waste, which will be created by the processing of radioisotopes separated in the new processing facility at CRL. Their final purpose, however, may be changed after the recent cancellation of the dedicated isotope facility.

5.1.7.1.8 Waste Management Area H

WMA H began operating in 2002, and is the location for the modular above-ground storage (MAGS) structures and the shielded above-ground storage (SMAGS) structures. Dry low-level wastes are packaged and, in some instances, compacted in steel containers prior to storage in MAGS and, on depletion of MAGS, in SMAGS. The first of six SMAGS structures have been completed, and a licence amendment has been issued by the CNSC to allow operation. An additional five SMAGS structures will be built at intervals of three to four years. These structures will provide storage capacity for the next 20 to 30 years.

Figure 5.8 – MAGS structure in Waste Management Area H

5.1.7.1.9 Liquid dispersal area

Development of the liquid dispersal area commenced in 1953 when the first of several infiltration pits was established to receive active liquids via pipeline from the NRX rod bays. The pits are located on a small dune, in an area bounded on the east and south by wetlands, and by WMA A to the west.

Reactor Pit #1 was a natural closed depression used between 1953 and 1956 for radioactive aqueous solutions. Dispersals included an estimated 74 TBq of strontium-90, along with a wide variety of other fission products, and approximately 100 grams of plutonium (or other alpha emitters expressed as plutonium). Between 1956 and 1998, the pit was backfilled with solid materials that included contaminated equipment and vehicles previously stored in WMA A, plus potentially contaminated soils from excavations in the active area.

Reactor Pit #2 was established in 1956 to succeed Reactor Pit #1. A pipeline was used for transfers of NRX rod bay water. Samples of water from the holding tank were analyzed for soluble and total alpha, soluble and total beta particles, strontium-90, tritium, cesium-137 and uranium.

The chemical pit was also established in 1956 to receive radioactive aqueous wastes from active laboratories on-site (other than the reactors). Its construction is similar to that of Reactor Pit #2 – namely, an excavation backfilled with gravel and supplied by a pipeline.

The last facility in the liquid dispersal area is the Laundry Pit, which was installed in 1956. As its name implies, the Laundry Pit was used for wastewater from the active area laundry and the decontamination centre but was only employed for that purpose for a year. The recorded inventory is 100 GBq of mixed fission products and 0.1 g plutonium-239.

The liquid dispersal area has not been used since 2000, and there are no plans for future use of this area. There are two groundwater plumes emanating from the liquid dispersal area, as would be expected for dispersal facilities. One plume from the reactor pits contains tritium as the only nuclide released in significant quantities. Routine groundwater monitoring around the reactor pits shows that the tritium contamination levels have significantly reduced since dispersal operations were halted. This groundwater monitoring shows the presence of other radiological contaminants, but at low concentrations that are declining over time.

The second plume emanates from the chemical pit, with the contaminant of primary concern being strontium-90. Routine groundwater monitoring around the chemical pit indicates improving conditions – in that the contamination levels in the groundwater is decreasing. The effects of this contaminant migration are mitigated by a plume treatment system known as the chemical pit treatment plant. This pump and treat treatment facility removes strontium-90 from groundwater collected from four collection wells that are spaced across the width of the plume near the pit. This treatment system removes a significant fraction of the strontium-90 activity in the influent. In 2007, the chemical pit treatment plant treated 3.1 million litres of groundwater, removing 2.5 GBq of strontium-90 and reducing input concentrations from 792 Bq/L (avg.) to 5.9 Bq/L (avg.).

5.1.7.1.10 Acid, chemical and solvent pits

A series of three small pits are located north of WMA C, and are collectively known as the acid, chemical and solvent pits. Constructed in 1982 and in operation until 1987, the pits were individually used for inactive chemical, acid and solvent wastes. The acid pit received about 11,000 litres of liquid wastes (hydrochloric, sulphuric and nitric acids) and a small amount of solid wastes (potassium carbonate powder, acid batteries and citric acid). The solvent pit received approximately 5,000 litres of mixed solvents, oils, varsol and acetone, while the chemical ACS pit received smaller volumes of wastes.

5.1.7.1.11 Waste Tank Farm

The Waste Tank Farm contains seven underground stainless steel tanks that store high-level radioactive waste. The first series of three tanks contain rod storage ion exchange regeneration solutions. One of the three tanks is empty and provides a transfer destination for the contents of either of the other two tanks should they develop a leak.

The second series of four tanks contains acid concentrate, mainly resulting from fuel reprocessing between 1949 and 1956. The last transfer of solutions to any of the storage tanks at the waste tank farm occurred in 1968; no additions have taken place since then. One of the four tanks is empty, and serves as a backup in the event that one of the other tanks leaks.

5.1.7.1.12 Ammonium nitrate decomposition plant

The ammonium nitrate plant was built in 1953, and was used to decompose the ammonium nitrate in liquid wastes from the fuel processing plant. The plant was shut down in 1954 following several leak events (releases) and was subsequently dismantled with much of the equipment being buried *in situ*.

As would be expected for this type of facility, a contaminant plume emanates from the nitrate plant compound, with the contaminant of primary concern being strontium-90. Routine groundwater monitoring at the perimeter of the compound indicates stable conditions – in that contamination levels in the groundwater remain stable over time.

The effects of this contaminant migration are mitigated by a plume treatment system, known as the wall and curtain treatment system, which operates passively using a clinoptilite zone installed in the ground next to an impermeable barrier that extends across the plume flow path. This passive treatment system removes a significant fraction of the strontium-90 activity in the influent. In 2007, the system treated 14.6 million litres of groundwater, preventing the discharge of 5.4 GBq of strontium-90 and reducing input concentrations from 366 Bq/L (avg.) to 1.2 Bq/L (avg.). Since 1998, the treatment system has prevented the discharge of 4.1E+10 Bq of Sr-90.

5.1.7.1.13 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 kilograms of thorium nitrate, 4,600 kilograms of ammonium nitrate, 10 grams of uranium-233, and 1.85 E+11 Bq each of strontium-90, cesium-137 and cerium-144. The pit was filled with lime to neutralize the acid and precipitate the thorium, and was then covered with soil.

5.1.7.1.14 Glass block experiments

In 1958, a set of 25 hemispheres of glass (two kilograms each) of mixed fission products was buried below the water table, as part of a program to investigate methods for converting high-level radioactive liquid solutions into a solid. 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. The glass blocks have now been recovered and transferred to secure storage in the waste management areas.

5.1.7.1.15 Bulk storage area

The bulk storage area was used prior to 1973 to store large pieces of equipment from the control area. Significant clean up efforts are now underway in this 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 such as dispersal of intermediate-level liquid waste and sand trench disposal of intermediate solid and liquid wastes. The releases have contaminated on site land, groundwater and surface water, and also resulted in off-site releases of contaminants to the Ottawa River.

The contaminant concentrations in off-site water bodies, however, are well below the standards set for both drinking water and the protection of aquatic life. DRLs have been established for airborne and liquid effluents released from the CRL site. CRL has developed administrative levels set at a fraction of the DRL and close to the normal operating levels. These administrative levels are used to provide timely warning that a higher than expected release has occurred and that the situation will be investigated promptly.

5.1.7.1.16 CRL Waste Treatment Centre (WTC)

The waste treatment centre (WTC) treats solid and liquid wastes from Chalk River Laboratories facilities, which are contaminated or suspected of being contaminated by radioactivity. The WTC also treats radioactive waste received by CRL from off site waste generators.

Solid wastes are baled (after compacting, if possible) and transferred for storage in concrete bunkers in WMA B. The number of 0.4 cubic metres bales produced per year ranges from 200 and 300. The solid waste generated internally by the WTC is in addition to those quantities, and includes disposable clothing, paper and cleaning materials, which are compacted where possible, baled and stored in WMA B bunkers. Slightly contaminated and suspected wastes of WTC waste are also sent for storage in WMA H.

Liquid waste is treated in variable amounts per year, ranging from 2,000 and 6,000 cubic metres. These wastes consist of decontamination centre waste, chemical active drain system waste, reactor active drains waste and new processing facility/MAPLE reactor waste. Treatment facilities include a liquid waste evaporator (LWE), which concentrates the waste, and a liquid waste immobilization system, which immobilizes the concentrate in bitumen, later drummed and stored in WMA B.

Atmospheric releases of radionuclides from the WTC occur via roof vents. Monitoring of the roof vents includes particulate gross alpha activity, particulate gross beta activity, tritium oxide and I-131. Treated liquid effluent from the WTC is discharged to the process sewer after sampling for gross alpha, gross beta and tritium oxide. The liquid effluent is also regularly monitored for suspended solids, total phosphorus, nitrates, pH, conductivity, organic carbon, chemical oxygen demand, solvent extractable, metals, volatile organics and semi-volatiles.

5.1.7.2 Whiteshell Laboratories

The Whiteshell Laboratories facility is a nuclear research and test establishment located in Manitoba on the east bank of the Winnipeg River, about 100 kilometres northeast of Winnipeg. Comprised a number of nuclear and non-nuclear facilities and activities, the major facilities on-site include the Whiteshell Reactor-1 (WR-1), the shielded facilities, research laboratories, liquid and solid radioactive waste management areas and facilities, including the concrete canister storage complex for the dry storage of research reactor fuel. WL is currently undergoing decommissioning. (Annex 7.1 provides further information on these decommissioning activities.)

The one Waste Management Area (WMA) is located approximately 1.5 kilometres northeast of the main WL site (2.7 kilometres by road). The area is approximately 148 by 312 metres, representing 4.6 hectares. WMA, which has been in operation since 1963, provides storage for low- and intermediate- level radioactive wastes. The following facilities are located within the WMA:

- an organic incinerator,
- LLW storage bunkers,
- LLW unlined earth trenches,
- ILW in-ground concrete bunkers,
- ILW storage bunkers,
- HLW/ILW in-ground concrete standpipes, and
- liquid waste storage tanks.

The Concrete Canister Storage Facility, described in Annex 4.5.14, is located next to the WMA.

The WL site is near the northeast boundary of the plains area of Manitoba. The WMA site is located about 10 metres above the normal Winnipeg River level, and is well above any recorded flood levels (river levels are also controlled by nearby hydroelectric dams.) The Winnipeg River flows through an area underlain by granite and granitic gneisses of the Precambrian Shield. The area is the transitional zone between the coniferous forest of the Canadian Shield and the aspen parklands of the prairies.

The WMA soil cover consists of 5.5 metres of highly plastic medium-brown clays above 4.6 metres of light-brown medium-plastic clay. The upper clay exhibits pronounced volume changes depending on moisture content, and is susceptible to frost heave. Both clays are very impermeable. A stable glacial till deposit underlies the entire area at a depth of approximately 10.5 metres. The glacial till is compact and has a high bearing strength. The granitic Lac du Bonnet batholith lies below the till at a depth of approximately 12 metres.

Hydrologically, the WMA is located in a groundwater discharge zone, which means that the groundwater flow is predominantly upward from the underground aquifer to the surface. The depth of WMA excavations is limited to ensure that the impermeable clay layers are not penetrated.

The incineration facility is used to incinerate waste laboratory solvents, and was formerly used to incinerate the organic coolant waste arising from the operation, shutdown and clean-up of the WR-1 reactor.

From 1963 to 1985, LLW was buried in unlined trenches approximately 6 metres wide by 4 metres deep, and with lengths up to 60 metres. Trenches were covered with at least 1.5 metres of excavated material after they were filled. There are 25 filled trenches located in the WMA. Trench storage of LLW was discontinued in 1985 in favour of engineered above-ground LLW storage bunkers. The LLW bunkers are constructed of concrete, with overall dimensions of 26.4 metres long by 6.6 metres wide by 5.2 metres high, with a wall thickness of 0.3 metres, which comes to a total of 805 cubic metres of storage space each. Future WMA plans are to construct shielded, modular above-ground storage (SMAGS) structures (discussed in section 5.1.7.1.8) for the storage of future decommissioning LLW wastes.

In-ground, or partially in-ground, bunkers are used to store ILW wastes. Possessing a variety of dimensions, these bunkers are constructed of reinforced concrete, with a wall thickness of 0.25 metres. In-ground, concrete standpipes (similar to the CRL tile holes described in section 5.1.7.1.2) were used at WL from 1963 to the mid-1970s (when the use of above-ground concrete canisters commenced) to provide storage for HLW/ILW packages. The standpipes are constructed of reinforced concrete, 0.2 metres thick, with a 0.3-metre integral base lined with galvanized steel pipes. A removable concrete shielding plug, about 0.9 metres thick, provides access.

5.1.8 Monserco Limited

Monserco Limited, in operation since 1978, operates a radioactive waste processing facility in Brampton, Ontario. In this facility, radioactive wastes (typically from hospitals, universities, research institutes and industrial firms) are sorted and packaged. Wastes may be processed on site by minimization techniques, and by delay and decay. Monserco also ships low-level contaminated waste, or slightly contaminated metals, directly to the United States for incineration or recycling. Monserco shipped approximately 66,000 kilograms of low-level radioactive waste and metals to the United States in the last year.

The company in the United States may return the material to Monserco unchanged if the company decides it cannot be processed. The resultant ash from incineration is accepted for disposal to licensed facilities within the United States. Levels of radionuclides monitored from the exhaust stack have always been less than specified investigation levels.

The service also includes the handling of spent sealed sources and used liquid scintillation vials and cocktails. Sealed sources and depleted uranium are shipped to AECL’s CRL radioactive waste facility for management. Monserco 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.

5.1.9 Cameco Blind River Refinery/Port Hope Conversion Facility/Port Hope Fuel Fabrication Facility waste and by-product management

Conserving resources and recycling of waste materials is an important part of operations – for both environmental and economic reasons. At the Cameco Blind River Refinery, nitrogen oxide air emissions are recovered and converted to nitric acid for reuse. At the Port Hope Conversion Facility, ongoing recycling programs include in-plant recovery of hydrofluoric acid from air emissions for recycle, and the creation and sale of an ammonium nitrate by-product for use as commercial fertilizer. At the Port Hope Fuel Fabrication Facility, scrap generated from fuel pellet manufacture is recovered.

There are several process streams in the refining and conversion processes that result in materials that contain economically attractive quantities of natural uranium. These recyclable products are suitable for use as alternate feed for uranium mills and are sent on for further processing to recover their uranium content.

The Blind River and Port Hope waste management programs collect, clean, monitor and, if necessary, cut to acceptable sizes all scrap material to the extent practicable before releasing it to commercial recycling agencies. Material that cannot be recycled, or does not meet strict release guidelines, is either compacted or incinerated to reduce volume, then drummed for storage on-site or, in some instances, processed further and combined with the uranium-bearing recyclable products noted above. The stored non-recyclable material that cannot be cleaned is primarily insulation, sand, soil and some scrap metal. These materials will remain in storage until a future recycle or disposal routes are identified.

Cameco is the licensee for two large historic waste management facilities in the Port Hope area: the Welcome Waste Management Facility, in the Municipality of Port Hope, and the Port Granby Waste Management Facility, in the Municipality of Clarington. These facilities, which were established in 1948 and 1955 respectively, together contain roughly 1,000,000 cubic metres of low-level radioactive waste and contaminated soils. Both facilities have been closed to any additional waste emplacements for many years, pre-dating the formation of Cameco. The long-term management of these facilities will be addressed through the Port Hope Area Initiative. In addition, the Government of Canada has agreed to accommodate 150,000 cubic metres of wastes from the Cameco Port Hope Conversion Facility, arising from early operations of that site, also within the framework of the Port Hope Area Initiative. These wastes include drummed radioactive wastes, contaminated soils and decommissioning wastes.

ANNEX 6 – URANIUM MINE AND MILL FACILITIES

6.1 Background

Owned by Eldorado Gold Mines (a private company), the first radium mine in Canada began operating in 1933 at Port Radium in the Northwest Territories. 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 defence programs in the United Kingdom and the United States.

In 1943, Canada, the United Kingdom and the United States instituted a ban on private exploration and development of mines to extract radioactive materials. The Government of Canada also nationalized Eldorado Gold Mines in 1943, and established the federal Crown Corporation Eldorado Mining and Refining, which 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 the development of a uranium mine in the Beaverlodge area of northern Saskatchewan, and in 1953, milling the ore on site commenced. The Gunnar and Lorado uranium mines and mills began operating in the same area in 1955 and 1957, respectively. Several other small satellite mines also opened in the area in the 1950s, sending ore for processing to either Eldorado or the Lorado mills.

In Ontario, 15 uranium mines began production between 1955 and 1960 in the Elliot Lake and Bancroft areas. Ten of the production centres in the Elliot Lake area, and three in the Bancroft area, produced tailings. The last of these mines ceased operations and was decommissioned in the 1990s. (These former mining and milling sites are discussed in Annex 8.)

At present, all active uranium mines are located in Saskatchewan. Uranium mining is ongoing at Rabbit Lake, McClean Lake and McArthur River, with Cluff Lake currently carrying out decommissioning activities (see Annex 7.6). Cigar Lake is currently under construction, and the Midwest Project is currently at the environmental assessment stage, at which the CNSC personnel are compiling technical review comments. Uranium mills and operational tailings management facilities exist at McClean Lake and Rabbit Lake, as well as at Key Lake, where on-site deposits were mined out in 1997. Tailings deposition continues at Key Lake, since all the McArthur River ore is being processed there. Non-operational tailings management areas are located at Rabbit Lake, Key Lake and Cluff Lake. (The locations of operating and inactive uranium mining and milling sites in Canada are shown in Figure B.3.)

6.2 Province of Saskatchewan

Saskatchewan is the only province in Canada with operating uranium mines. In the past, mine and mill operators have requested harmonization in areas such as inspections and reporting requirements, involving Saskatchewan Ministry of Environment, Saskatchewan Ministry of Advanced Education, Employment and Labour and the CNSC. An agreement currently exists between the CNSC and the Province of Saskatchewan to encourage greater administrative efficiency in regulating the uranium industry. The agreement lays the groundwork for the two groups to coordinate and harmonize their respective regulatory regimes.

6.3 Operational tailings and waste rock management strategy

6.3.1 Overview

About one-quarter of the world's primary uranium production comes from uranium deposits in the Athabasca Basin in northern Saskatchewan. These deposits include:

- the current production sites of Rabbit Lake, Key Lake, McClean Lake and McArthur River,
- the Cluff Lake site, where production was terminated at the end of 2002, and
- sites of planned future production at Cigar Lake and Midwest.

The newer sites include the highest grade uranium ore bodies in the world (at McArthur River and Cigar Lake), averaging about 20 percent uranium. Some of these ores in the Athabasca Basin have high nickel and arsenic content (up to five and one percent, respectively), which introduces additional considerations into the management of tailings and waste rock resulting from the mining and milling of these ores.

6.3.2 Tailings management strategy

Mills with tailings management facilities (TMFs) are located at Rabbit Lake, Key Lake and McClean Lake. There is no mill at the McArthur River mine, because the ore is transported to Key Lake for processing. Similarly, mills are not planned at either Cigar Lake or Midwest. Ores will be transported to McClean Lake for initial processing, with final processing activities for Cigar Lake uranium solution to be divided between McClean Lake and Rabbit Lake.

All three sites currently use the same basic approach: previously mined open pits have been converted to engineered disposal systems for tailings. Although there are certain differences in detail, two basic principles underlie the containment of the tailings and their potential radionuclide and heavy metal contaminants:

- **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, resulting in the natural flow being directed toward the pit from every direction. This hydraulic containment feature is maintained throughout the operational life of the tailings facility by maintaining the pit in a partially dewatered state. Since water has to be pumped continuously from the pit, current water treatment technology results in high-quality effluent suitable for discharge to surface water.

- **Passive long-term containment, using the hydraulic conductivity contrast between the tailings and their surrounding geologic materials:** Long-term environmental protection is achieved through control of the tailings' geochemical and geotechnical characteristics during tailings preparation and placement. This control creates future passive physical controls for groundwater movement in the system, which will exist after the decommissioning of operational facilities.

The tailings contain a significant fraction of fine-grained materials (chemical precipitates formed during the ore processing reactions). Tailings 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 of the tailing mass; this is a slow process, with minimal advective contaminant flux, and a consequently high level of groundwater protection. Potential contaminant transport is further minimized by the geochemical properties of the tailings. Reagents are added during tailings preparation, to precipitate dissolved elements such as radium, nickel and arsenic to stable insoluble forms, which enables long-term concentrations in the tailings' pore water to remain low.

A constructed permeable zone around the tailings may be installed (in the form of sand and gravel) while 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. This natural permeable zone allows for subaqueous placement of tailings, which has advantages in terms of radiation protection and prevention of ice formation with the tailing mass. 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 geologic formations and groundwater system, as well as the tailings' properties, are used to acquire reliable data for the computer models used to predict long-term environmental performance based on the fundamental principles governing the system. This performance will be confirmed by post-decommissioning monitoring, which will be continued until stable conditions are achieved and for as long as desired thereafter.

Section 6.4 of this Annex provides 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 design evolutions – based on that experience – provide confidence in their performance, both now and in the future.

6.3.3 Waste rock management strategy

In addition to tailings from the milling process, uranium production results in large volumes of waste rock being removed before miners can access and mine the ore. The segregation of these materials according to their future management requirements is now a core management strategy. Material excavated from open pits is classified into three main categories: clean waste (both overburden and waste rock), special waste (containing sub-economic mineralization) and ore.

Clean waste
This term refers to waste materials that are benign with respect to future environmental impact, and that can be disposed in surface stockpiles or used on-site for construction purposes. These different types of materials are:

- Surficial soils with high organic content: When practical depths are present, a thin layer of surface soil is stripped, and separately stockpiled for replacement as the future surface soil layer during site reclamation activities.

- Overburden soils: A few metres of glacial till (typically around 10 metres) are present before the underlying sandstone rock is encountered. This material is either stockpiled separately for future use as fill during reclamation or used as the base for clean waste rock stockpiles.

- Waste rock: The Athabasca Basin is a sandstone basin that overlies the Precambrian Shield basement rock. The sandstone depth is shallow around the Basin perimeter, and increases to as much as 1,200 metres toward the centre of the Basin. Depths up to about 200 metres are practical for open pit mining, so that the sites at and near the Basin perimeter primarily feature this mining method.

- Large volumes (depending on the depth) of unmineralized sandstone are mined to reach the ore body. This material is stockpiled on the surface near the pit, and the stockpiles, minus whatever amount has been used for construction purposes, is subsequently reclaimed and vegetated. As mining approaches the ore body, a zone of altered (partially mineralized) rock is present. Both this halo of altered rock, and the basement rock below it, may contain small amounts of uneconomic uranium, and/or various metals such as nickel or arsenic.

- In some instances, due to the sulphide content, there is the potential for acidic leachate when the rock is exposed to moisture and oxygen from the atmosphere. This phenomenon of acid rock drainage (ARD) is common to many types of mining. Sophisticated methods are now available to segregate those amounts of waste rock, which represent a potential environmental risk – due to either ARD and/or dissolved contaminants in leachate – if left on the surface for the long term.

- This material, referred to as *special waste*, is managed differently from the environmentally benign waste rock. The segregation methods include borehole logging, collection and analyses of borehole samples prior to mining, and analyses of samples during mining. In addition to a retrospective laboratory analysis, real time analyses are made with an ore radiometric scanner to segregate each truckload – according to uranium content – as ore, special waste or waste rock, and direct it to the appropriate stockpile.

- Since uranium ore deposits are in secular equilibrium with its progeny, good correlations can be made between radioactivity of the ore and its uranium content. The latest technical development is the application of a handheld, portable scanner that uses x-ray fluorescence to perform field characterization for arsenic. This method has recently been tested at McClean Lake, and became operational for the mining of the most recent open pit there.

- Volumes of waste rock are much smaller for underground mining, but the same general considerations apply. Clean waste materials are stockpiled and used for construction or reclamation purposes. Any surplus amounts can be stockpiled, and the stockpiles reclaimed and vegetated. Special waste is either used as aggregate and underground backfill, or is returned underground to other mined areas or transferred to sites with mills or mined out open pits.

Special waste

As noted above, waste rock near ore bodies is potentially problematic, because it has some halo mineralization around the ore deposit, and is therefore potentially acid-generating in some instances and/or a source of contaminated leachates when exposed to an atmosphere containing oxygen. The disposal of this special waste in mined out pits and flooding, to cut off the oxygen supply from the atmosphere and stop oxidation reactions, is now a widely recognized solution. The special waste is segregated as it is mined, and temporarily stored on the surface on lined pads, with drainage collection systems for collection and treatment of runoff water. Following the completion of mining, the special waste is backhauled into the mined-out pit (see Figure 6.4.3.2). At a large pit with two or more zones, the direct transfer of special waste from the mining zone to a mined out zone is practical. Typically, any waste material with uranium content greater than either 300ppm U_3O_8 or 0.025 percent (250ppm) uranium is classed as special waste.

Similar to tailings facilities, extensive characterizations of natural geologic formations, groundwater system and waste rock properties are used to acquire reliable data for the computer models used to predict long-term performance. This performance is confirmed by post-decommissioning monitoring, which will be continued until stable conditions are achieved, and for as long as desired thereafter.

Ore

Typically, all material grading greater than 0.085 percent U has been classified as ore, and stockpiled to be fed to the mill. The cut-off grade for the mill may vary depending on market conditions for uranium.

6.3.4 Waste water treatment and effluent discharge

All mine and mill facilities provide water treatment systems to manage contaminated water collected from their tailings disposal facilities, as well as water inflows collected during open pit or underground mining, and problematic seepages from waste rock piles. The treatment processes vary from flow through to batch discharge systems, and largely rely on conventional physical settling and chemical precipitation methods found in the general metal mining industry. Typically, these sites have a single point of final discharge into the receiving environment; however, Key Lake operation has two discharge points. Uranium mines and mills also treat for radionuclides. Specifically, focus is placed on treatment for radium 226, using barium chloride precipitation. In the case of Rabbit Lake, additional treatment has been incorporated to reduce uranium levels in effluent discharge. The quality of effluent is controlled by regulatory approved codes of practice, as well as by effluent quality regulation.

In Northern Saskatchewan, effluent quality regulation ensures that Saskatchewan Water Quality Objectives (SSWQO) are maintained at the final point of discharge for the various facilities. If the effluent is found acceptable (i.e., in compliance with regulatory limits), it is released to the environment. Otherwise, the effluent is recycled to the water treatment plants or mill for reprocessing. In 2007, the total volume of treated wastewater that met SSWQO requirements and was subsequently discharged to the receiving environment was 10,304,840 cubic metres from five active uranium mining and or milling sites in northern Saskatchewan.

To reduce the impact of effluent discharges to the receiving environment, the uranium mining and milling facilities have developed ecological risk models to evaluate the impacts of treated effluent discharges. The prime concerns resulting from this work are chronic not acute, and relate to control of metals not radionuclides. The control of nickel and arsenic loading has been a core focus; however, more recently, attention has turned to molybdenum and selenium loadings. This broader spectrum of contaminants of concern has led to efforts to develop and install the next generation of treatment technology based on the use of membrane technology.

As such, a large reverse osmosis plant has been installed at the Key Lake facility. Additional application of this technology is expected at other northern Saskatchewan facilities, particularly for mining as opposed to milling effluent components, in which the low ionic content of the effluent makes membrane technology less difficult.

6.4 Waste management facilities

6.4.1 Key Lake

6.4.1.1 Tailings management

The purpose of tailings management at Key Lake is to isolate and store the waste residue from the milling process so that the public and the environment are protected from any future impact. Conceptually, this effort involves containing the solids and treating the water to quality standards acceptable for release to the environment. The waste metal precipitates removed during water treatment are disposed of as solids in the tailings management facility (TMF).

From 1983 to 1996, waste from the Key Lake mill was deposited in an above-ground TMF (AGTMF) that covered an area 600 metres by 600 metres (36 hectares) and 15 metres deep. The TMF was constructed five metres above the groundwater table by using engineered dikes for perimeter containment and a modified bentonite liner to seal the bottom and isolate the tailings from the surrounding soil infrastructure.

Since 1996, the mined-out Deilmann open pit has been used as the TMF. Commissioned in January 1996, it is used to store tailings produced by milling a blend of McArthur River ore and special waste from McArthur River and Key Lake. The TMF has a bottom drainage layer constructed on top of the basement rock at the bottom of the mined-out pit. Tailings are deposited on top of this drainage layer, and water is continually pumped out to promote solids consolidation of overlying tailings.

Tailings were initially deposited into the pit by sub-aerial deposition, with the water being extracted from the tailings mass through the bottom drain layer and the raise well pumping system. The facility was later changed to sub-aqueous deposition by allowing the pit to partially flood.

Through the use of a tremie pipe system, tailings are deposited under the water cover, providing benefits in terms of placement and attenuation of radon emissions. In this system, tailings are placed in the mined-out pit by using what is termed “a natural surround” containment strategy. Tailings and residual water on the surface are removed during tailings placement, both by the drainage blanket and by surrounding groundwater wells. The residual water extracted from the tailings mass is collected for treatment. The consolidated tailings form a low-permeability mass relative to the higher permeability area surrounding the tailings.

After decommissioning, groundwater will follow the path of least resistance (i.e., around the tailings rather than through them), which minimizes environmental impacts. At the end of 2007, the Deilmann TMF contained 3,090,000 tonnes (dry weight) of tailings.

Figure 6.1 – Deilmann Tailings Management Facility at Key Lake

6.4.1.2 Waste rock management

Waste rock management facilities include two special waste storage facilities and three waste rock storage areas. The waste rock disposal areas comprise primarily benign rock and, therefore, do not have containment or seepage collection systems. The special waste contains low (uneconomic) levels of uranium and other potential contaminants, so this material is contained in engineered facilities that consist of underliners and seepage collection systems. Material from one of the special waste areas is being reclaimed for blending with high-grade McArthur River ore for the Key Lake mill feed. All other waste rock and special waste areas are inactive.

To reduce the decommissioning liability associated with the Deilmann North waste rock pile, approximately 1,300,000 cubic metres of nickel-rich waste rock were excavated and disposed of in the Gaertner pit.

6.4.1.3 Contaminated industrial wastes

Contaminated industrial wastes are either recycled or landfilled in the above-ground tailings management facility (AGTMF). Leachates from these materials are collected by the AGTMF’s seepage collection system, and returned to the mill for process make-up water or treated and released to the environment. Typically, 5,000 cubic metres of industrial wastes are disposed of annually in this facility.

6.4.2 Rabbit Lake

6.4.2.1 Tailings management

The Rabbit Lake Above-Ground Tailings Management Facility (RLAGTMF) is about 53 hectares in area, and contains approximately 6.5 million tonnes of tailings, which were deposited between 1975 and 1985. These tailings were all derived from the processing of the original Rabbit Lake ore deposit. The tailings within the AGTMF are confined by earth-filled dams at the north and south ends, and natural bedrock ridges along the east and west sides. The AGTMF is currently undergoing long-term stabilization and progressive reclamation.

The original Rabbit Lake open-pit mine was converted to a tailings management facility in 1986 by using pervious surround technology. Since its commissioning, the Rabbit Lake in-pit tailings management facility (RLITMF) has been used as a tailings repository for ore from the Rabbit Lake, B-zone, D-zone, A-zone and Eagle Point mines. At the end of 2007, the RLITMF contained 6,750,000 tonnes (dry weight) of tailings.

The pervious surround, consisting of sand and crushed rock, is placed on the pit floor and walls in advance of the tailings deposition. The pervious material allows drainage of the excess water contained in the tailings to an internal seepage collection system, and also allows the water contained in the surrounding host rock to be collected, which maintains a hydraulic gradient toward the facility during operations. The collected water is treated prior to its release into the environment. Upon final decommissioning and return to normal hydro-geologic conditions, groundwater will flow preferentially through the pervious surround rather than the low permeability tailings. Discharge of contaminants will be limited to diffusion across the tailings/pervious surround interface.

Figure 6.2 (a) – Rabbit Lake In-pit Tailings Management Facility

Figure 6.2 (b) – Rabbit Lake In-pit Tailings Management Facility

6.4.2.2 Waste rock management

The Rabbit Lake site contains a number of clean and mineralized stockpiles of waste rock, produced over the course of mining various local deposits since 1974. Some of the waste rock has been used for construction material. For example, waste rock was used to construct the road and pervious surround for the RLITMF. Eagle Point special waste is stockpiled on a lined storage pad until it is returned underground as backfill. Some waste rock piles were used as backfill and cover material in their respective pits. One rock pile, consisting primarily of Rabbit Lake sediments, has been contoured and vegetated.

Current projections are that no waste rock will remain on surface at Eagle Point after the mining and backfilling of mined-out stopes is complete. The D-zone waste rock pile consists of 0.2 million cubic metres of primarily lake-bottom sediments and organics. This material may eventually be used as cover material for the B-zone waste rock pile. The A-zone waste-rock pile (28,307 cubic metres of clean waste) has been flattened and contoured. The B-zone waste pile contains an estimated 5.6 cubic metres of waste material stored on a pile covering an area of 25 hectares. Contaminated runoff and seepage from this pile is collected and treated prior to release into the environment. All the special waste from the A-zone (69,749 cubic metres), B-zone (100,000 cubic metres) and D-zone (131,000 cubic metres) open-pit mines was returned to the pits and covered with layers of waste rock and/or clean till before the mined-out pits were allowed to flood.

There are approximately 6.7 million cubic metres of predominantly sandstone, with some basement rock and overburden tills, stored on the West #5 waste rock pile adjacent to the RLITMF. Mineralized waste is stored on four piles (1.8 million cubic metres) adjacent to the Rabbit Lake Mill. Runoff and seepage from these areas are collected in the RLITMF.

6.4.2.3 Contaminated industrial wastes

Radioactive and other contaminated materials from the Eagle Point Mine and Rabbit Lake Mill are disposed of in the contaminated landfill site located on the west side of the RLAGTMF. It is estimated that 6,178 cubic metres of uncompacted waste were placed at this site in 2007.

6.4.3 McClean Lake

6.4.3.1 Tailings management

McClean Lake was the first new uranium mill built in North America in 15 years. The mill and TMF are state-of-the-art efforts in worker and environmental protection for processing high-grade uranium ore. Open-pit mining of the initial ore body (JEB) began in 1995. After the ore was removed and stockpiled, the pit was developed as a TMF. The design of the TMF has been optimized for performance, both during operation and in the long-term, by employing key features such as:

- Production of thickened tailings within the mill process (addition of lime, barium chloride and ferric sulphate) to remove potential environmental contaminants from solution and yield geotechnically and geochemically stable tailings.

- Transport of the tailings from the mill to the TMF through a continuously monitored pipe-in-pipe containment system.

- Final sub-aqueous tailings placement within the mined-out JEB pit for long-term, secure containment in a belowground facility.

- Use of natural surround as the optimum approach for long-term ground water diversion around the consolidated tailings plug.

- Subaqueous tremie placement of the thickened tailings below a water cover in the pit from a floating barge. This method minimizes segregation of fine and coarse material, prevents the freezing of the tailings and enhances radiation protection due to the attenuation of radon emissions by the water cover.

- Use of dewatering wells around the entire pit perimeter to minimize clean groundwater inflow while maintaining hydraulic containment during operations – that is, the water levels are maintained such that groundwater flow is toward the pit.

- A bottom filter drain feeding a dewatering drift and raise wells to allow collection and treatment of discharged pore water during tailings consolidation.

- Recycling of pit water by a floating barge and a pipe-in-pipe handling system.
- Complete backfilling of the pit, upon decommissioning, with clean waste rock and a till cap.

At the end of 2007, 1,246,800 tonnes (dry weight) of tailings were contained in the JEB TMF.

Figure 6.3 (a) – JEB Tailings Management Facility at McClean Lake

Figure 6.3 (b) – JEB Tailings Management Facility at McClean Lake

6.4.3.2 Waste rock management

Open-pit mining at McClean Lake has progressed from one pit to the next (JEB, Sue C, Sue A, Sue E), with Sue B now in progress (Figure 6.4 (a)).

Figure 6.4 (a) – Sue mining area at McClean Lake

The majority of the wastes removed from the JEB and Sue C open pits were overburden material or sandstone. The overburden and clean waste rock stockpiles are located near the pits. The pad for the waste rock stockpile has been constructed using overburden. Special waste, stockpiled while mining the Sue C and JEB pits, has been back-hauled into the Sue C pit (Figure 6.4(b)).

Figure 6.4 (b) – Special waste backhaul to Sue C Pit at McClean Lake

All wastes (exclusive of the overburden) from the Sue A pit were also deposited into the mined-out Sue C pit. This approach was conservative, due to the uncertainty regarding segregating special waste based on its arsenic content. An XRF method, which was successfully tested during Sue A mining, provides the capability to segregate special waste based on acid generating potential (using a simple laboratory test), radiological content (using the ore scanner) and a key non-radiological contaminant (arsenic, using an XRF scanner). Special waste from Sue E was also placed into the mined-out Sue C pit, while clean waste was placed into a separate Sue E waste rock stockpile. The total waste rock inventory at McClean Lake at the end of 2007 was 51.7 million tonnes of clean material (primarily waste rock) and 5.9 million tonnes of mineralized waste rock (special waste).

6.4.3.3 Contaminated industrial wastes

Chemically or radiologically contaminated waste materials originate from the mining, milling and water treatment areas of McClean Lake operation. All the contaminated material is collected in yellow dumpsters, distributed around the site and deposited in the landfill for chemical and radiological materials at the perimeter of the TMF. This landfill is within the hydraulic containment area of the JEB TMF. During final site decommissioning, these materials will be excavated and deposited into the JEB TMF. Approximately 1,040 cubic metres of waste has been landfilled in recent years.

6.4.4 Cigar Lake

6.4.4.1 Tailings management

Cigar Lake does not have a mill and does not produce tailings.

6.4.4.2 Waste rock management

There are five waste rock storage pads in operation at Cigar Lake. The current inventories result from test mining activities conducted at the site. Waste rock volumes are expected to increase substantially over the next few years as the construction of the operating mine is completed.

The first stockpile (stockpile A) has an unlined pad without seepage collection used for the storage of clean or benign waste rock. When possible, this rock is used as fill or construction material on site. The current stockpile contains approximately 40,863 cubic metres of clean waste rock.

A second stockpile (stockpile B) is used to store potentially acid reactive waste rock. Containment is provided by an impermeable liner and all drainage and decant waters are collected for treatment in the mine water treatment plant. The current stockpile contains approximately 2,080 cubic metres of waste rock.

The third stockpile (stockpile C) is used to store potentially acid reactive waste rock from underground. Containment is provided by an impermeable liner and all drainage and decant waters are collected for treatment in the mine water treatment plant. The current inventory for this waste rock stockpile is approximately 101,610 cubic metres.

The fourth stockpile (stockpile A-1) is used for storage of clean waste rock from shaft excavation. At the end of 2007, this stockpile contained approximately 20,208 cubic metres of clean waste rock. The overburden pile is the last waste rock stockpile. The current inventory for this waste rock stockpile is approximately 77,119 cubic metres. While some potentially acid reactive waste rock may be used as backfill in the mine, the majority of this material is eventually expected to be transported to the McClean Lake mine site for disposal in a mined-out pit.

6.4.4.3 Contaminated industrial wastes

This waste rock storage pile has already being addressed in stockpile B.

6.4.5 McArthur River

6.4.5.1 Tailings management

McArthur River does not have a mill and does not produce tailings.

6.4.5.2 Waste rock management

The McArthur River operation generates waste rock from production mining, development mining and exploration drilling. The waste rock is classified as either clean waste rock, potentially acid generating (PAG) waste rock or mineralized waste rock. The potentially acid generating and mineralized waste rock are temporarily stored on engineered lined containment storage pads. Leachate from these pads is contained and pumped to effluent treatment facilities. The segregated clean waste rock is disposed of on a pile that does not include the leachate containment and control systems.

The mineralized waste rock is shipped to the Key Lake operation and used as blend material for the ore feed to the Key Lake mill. The potentially acid-generating waste is crushed and screened, and the coarse material is used as aggregate for underground concrete backfilling operations. The clean waste is used for general road maintenance, both on site and on the haul road between McArthur River and Key Lake.

6.4.5.3 Contaminated industrial wastes

A transfer area, located adjacent to the mine headframe, is used to sort and temporarily store contaminated material. The contaminated material is shipped to the Key Lake operation, where it is disposed of in the AGTMF.

ANNEX 7 – DECOMMISSIONING ACTIVITIES

7.1 AECL Whiteshell Laboratories

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

The Whiteshell Laboratories facility is a nuclear research and test establishment located in Manitoba, on the east bank of the Winnipeg River about 100 kilometres northeast of Winnipeg, about 10 kilometres west of Pinawa and nine kilometres upstream from Lac du Bonnet. The major structures located on the site include a WR-1 reactor, the shielded facilities, research laboratories, and liquid and solid radioactive waste management areas, including the concrete canister storage facility for the dry storage of research reactor fuel.

WL is currently licensed under a Nuclear Research and Test Establishment Decommissioning Licence. This licence authorizes AECL to operate and undertake decommissioning activities at the facility until December 31, 2008. An application for the renewal of the licence beyond 2008 is being assembled, and will include a description of the work expected to be performed during the period of the renewed licensee.

The Canadian regulatory body has approved a Detailed Decommissioning Plan, which provides information, as required, under the *Class I Nuclear Facilities Regulations.* The initial six-year decommissioning licence covered only Phase 1 of a planned three-phase decommissioning program for the site. Activities planned in this initial phase include those directed toward the shutdown and decontamination of nuclear and radioisotope laboratory buildings and facilities, with the purpose of placing them in a safe and secure interim end state. The Van de Graaff Accelerator and the Neutron Generator have been completely decommissioned.

Major activities planned for the next licensing period include preparing for and undertaking demolition of the principal radioisotope laboratory building, advancing the plans for the standpipe remediation, and re-establishing the functions of the existing site liquid-waste treatment, active laundry and decontamination facilities into updated facilities, followed by the decommissioning of their existing buildings. Also included is the design and construction of associated enabling facilities, including a waste clearance facility, a waste handling facility, remediation and expansion of waste storage facilities, site infrastructure service systems reconfiguration, and the demolition of redundant non-nuclear service buildings. Activities planned for subsequent licensing periods include the final decommissioning of the WR-1 reactor, waste management area (WMA) storage structures, the shielded facilities and the enabling facilities.

The decommissioning of Whiteshell Laboratories will be completed in the period leading up to approximately 2024, with the exception of the reactor and the WMA, which are expected to remain under institutional control for another 200 years.

Figure 7.1 – Aerial view of Whiteshell Laboratories

7.1.1 Underground Research Laboratory (URL)

The Underground Research Laboratory (URL), located approximately 15 kilometres northeast of AECL's Whiteshell Laboratories in Manitoba, is an underground, experimental facility used for research into controlled blasting techniques, rock mechanics and hydrological studies associated with potential deep underground disposal of spent nuclear fuel and the behaviour of various materials under the conditions of storage in deep-rock formations. No spent fuel or high-level radioactive materials were ever placed in the URL.

Two underground radioisotope laboratories (using low levels of tracer isotopes) were licensed by the CNSC under its NSRDR. These laboratories were closed and decontaminated several years ago. The CNSC personnel confirmed this during an inspection conducted prior to the revocation of the CNSC's operating licence in 2003. The URL, therefore, is no longer a CNSC licensed site, and requires no further radiological decommissioning. The present URL Decommissioning Project is much more closely related to a mine shutdown than a nuclear decommissioning project, and is following the requirements of the Province of Manitoba's *Mines Act and Regulations.* Natural Resources Canada is currently conducting an environmental assessment of the URL Closure Project under the *Canadian Environmental Assessment Act*.

7.2 AECL Gentilly-1 Waste Management Facility

The Gentilly-1 Waste Management Facility consists of a permanently shut down, partially decommissioned prototype reactor and associated structures and ancillaries. This facility is presently in the long-term storage-with-surveillance phase of a deferred decommissioning program. Located on the south bank of the St. Lawrence River about 15 kilometres east of Trois-Rivières in the Province of Quebec, the Gentilly Complex accommodates both the Gentilly-1 Waste Management Facility and the Gentilly-2 Nuclear Generating Station, a CANDU 600 Megawatt unit.

The Gentilly-1 NGS consists of a CANDU-BLW-250 reactor and was put into service in May 1972. It attained full power for two short periods in 1972, and operated intermittently for a total of 183 effective full-power days until 1978, when it was determined that certain modifications and considerable repairs would be required. The station was put into a lay-up state in 1980, and the decision not to rehabilitate the station was made in 1982.

The main components of Gentilly-1 NGS were the reactor core, heat transport system, turbines and shielding. The reactor was heavy-water moderated, cooled by light water and fuelled with natural uranium, in the form of Zircaloy-clad UO_2 pellets. The reactor vessel was a vertical cylinder that contained a heavy-water moderator and was traversed by 308 pressure tubes and surrounding calandria tubes. The heat produced by the reactor fuel (mostly by boiling) was removed by the light water coolant and then pumped through inlet, outlet headers and feeder pipes in a closed circuit. The steam generated by the reactor core was separated from the liquid coolant in the steam drum before being delivered to the turbine generator.

The decision to permanently shutdown the reactor was made in 1984. A two-year decommissioning program began in April of that year to bring the Gentilly-1 NGS to an interim safe and sustainable shutdown state that is equivalent to storage with surveillance. The moderator was drained and shipped to other operating sites. Non-radioactive hazardous materials such as combustible and flammable materials, laboratory supplies and oils were identified and removed. The transfer of used fuel from wet storage in the reactor pool to dry storage in the canister storage area constructed for that purpose was completed in 1986. Major and minor decontamination activities (disassembly, decontamination and consolidation) were completed as required. All major radioactive or radioactively contaminated components not shipped to other licensed facilities were consolidated on site in either the reactor building or turbine building. Areas that possess significant residual contamination or radioactive materials have been reduced to a few locations. Radiological surveys were performed at the completion of each decommissioning activity.

7.3 AECL Douglas Point Waste Management Facility

The Douglas Point Waste Management Facility (DPWMF) is located at the site of the former Douglas Point Nuclear Generating Station (DPNGS) situated on the BNPD site. The DPNGS, which consists of a 200 MW CANDU reactor, was put into service in 1968. It was owned by AECL and operated by Ontario Hydro until 1984. During this operational period, the station generated 17 x 10^9 kWh of electricity and attained a capacity of 87.3 percent.

The main components of DPNGS were the reactor, heat transport system, turbines and power generating equipment. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The reactor core contained 306 horizontal fuel containing pressure tubes and was surrounded by the heavy water moderator. The heat transport system pumps circulated the pressurized heavy water through the reactor coolant tubes to eight boilers, where the heat is transferred to the boiler steam and water system. The reactor primarily used heavy concrete, steel and water as shielding to protect the surrounding area from radiation during operation. Steam generated in the boilers was transferred to the turbine for power generation.

The DPNGS was permanently shutdown on May 5, 1984 and placed in an interim, safe and sustainable shutdown state. This interim state was referred to as the storage-with-surveillance state. The DPNGS then became the Douglas Point Waste Management Facility.

Following the shutdown of the reactor, the primary heat transport and moderator medium (heavy water) was drained and shipped to other operating sites. The booster rods were removed and shipped to the Chalk River Laboratories in February 1985. Non-radioactive hazardous materials such as combustible and flammable materials, laboratory supplies and oils were identified and removed. The transfer of used fuel from wet storage in the reactor pool to a dedicated dry storage facility was completed in 1987. Major and minor decontamination activities (disassembly, decontamination and consolidation) were completed as required. All major radioactive or radioactively contaminated components that were not shipped to other facilities licensed to receive them were consolidated on site. Areas that possessed significant residual contamination or radioactive materials have been reduced to a few locations, and radiological surveys were performed at the completion of each decommissioning activity.

The DPWMF is presently in the storage-with-surveillance phase of a deferred decommissioning program. For decommissioning purposes, the DPWMF is divided into three planning envelopes. Envelope A consists primarily of nominally uncontaminated buildings and structures, which may be decommissioned at any time, with health, safety and environmental concerns taken into account. Envelope B consists primarily of contaminated buildings, which will be decommissioned after allowing for a period of radioactive decay and after long-term waste management facilities become available. Envelope C includes the used fuel canister area.

A three-phase approach has been established for reactor decommissioning. Phase 1 brings the facility to a safe, sustainable shutdown state. Phase 2 is a period of storage – with-surveillance. Final decommissioning occurs in Phase 3. The DPWMF has completed Phase 1 and is currently in Phase 2.

7.4 AECL Nuclear Power Demonstration Waste Management Facility

The NPDWMF consists of a permanently shut down, partially decommissioned demonstration CANDU reactor and associated structures and ancillaries. The facility, which is presently in the interim storage-with-surveillance phase of a deferred decommissioning program, is located adjacent on the west bank of the Ottawa River in the Province of Ontario, some 25 kilometres upstream from the AECL CRL and 15 kilometres from the Town of Deep River. The NPD NGS, consisting of a 20 MW CANDU PWR, was placed in service in October 1962 and was operated by Ontario Hydro (now OPG) until May 1987. In 1988, operating and compliance responsibilities were transferred from Ontario Hydro to AECL, and the facility became the NPDWMF.

The facility produced electrical power for the Ontario Hydro grid, trained people for the commercial nuclear generating stations of Ontario Hydro, and performed experiments in process systems concepts to be incorporated in the design of the commercial nuclear generating stations. During this operations period, the station generated 3 x 10^9 kWh of electricity at a net electrical capacity factor of 65 percent.

The main components of the NPD NGS were the reactor, heat transport system, turbine and electrical power generator equipment. The reactor was heavy water moderated, cooled by pressurized heavy water and fuelled with natural uranium. The reactor core contained 132 horizontal fuel containing pressure tubes, and was surrounded by a heavy-water moderator. The heat transport system pumps circulated the hot pressurized heavy water through the reactor coolant tubes to a heat exchanger/boiler unit, where the heat was transferred to the boiler steam and water system. The reactor, boiler and auxiliary systems were installed below ground, and were surrounded by concrete shielding to protect the surrounding accessible areas from radiation during operation. Steam generated in the boilers was transferred to the turbine/generator for electrical power generation.

The NPD NGS was permanently shut down on May 24, 1987 and placed into an interim, safe and sustainable shutdown phase. This interim storage period is referred to as the storage-with-surveillance phase. Following the shutdown of the reactor, the heavy water from the primary heat transport and moderator systems was drained and shipped off site. The reactor was defuelled and the fuel bundles were transferred to CRL. Demineralizer system equipment was removed from the various nuclear process systems and transferred to CRL. Major and minor decontamination activities were completed as required. The facility was functionally divided into nuclear and non-nuclear areas, with any equipment or structures either radioactive or radioactively contaminated confined to the nuclear area. All cross connections between the two areas were blocked off, sealed or permanently locked.

7.5 AECL Chalk River Laboratories decommissioning activities

7.5.1 Pool Test Reactor

The Pool Test Reactor (PTR) was a type of reactor whose fuel elements were suspended in a pool of water that serves as the reflector, moderator and coolant. It was a low-power research reactor (less than 100 W) designed and built to conduct reactivity studies on irradiated fuel samples and to determine the cross-section of fission products. PTR usage then shifted to testing and calibration of self-powered flux detectors on a commercial basis.

The PTR began operating in 1957 and was permanently shut down in 1990. The fuel was removed and placed in a tile hole at the CRL. Since then, the PTR has been monitored and kept under surveillance, and is currently in a safe shutdown state. The decommissioning objective is to return the area to the site landlord for use as general active laboratory space at CRL.

The PTR consists of a pool, which is approximately 4.5 metres square by six metres deep and contains about 125,000 litres of water. Specific decommissioning activities undertaken with regard to the PTR include:

- removing the PTR equipment: aluminum-graphite reflectors, fission chamber, core plate and support, oscillator mechanism, core tube support brackets, control rod drive system and control rod support,
- draining and drying the pool,
- removing the de-ionized water supply and purification system from the pool,
- removing all electrical components associated with the facility, including metres, switches and panels. Wiring will be removed to clear termination points,
- removing all signs and fixtures associated with the facility from walls, floor and ceiling, and
- segregating and transferring all waste generated by the decommissioning project to Waste Management Operations for storage and disposal as appropriate.

The decommissioning is scheduled to begin following regulatory approval and is expected to last less than one year. The CNSC and NRCan approved the environmental assessment for this project in 2007. Lessons learned from the emptying of the NRX fuel rod bay will be incorporated into PTR planning documents. The Detailed Decommissioning Plan and other planning documents will be written and submitted to the CNSC for approval prior to PTR decommissioning. An application for decommissioning approval is expected during 2010.

7.5.2 Plutonium Recovery Laboratory

The Plutonium Recovery Laboratory was constructed in 1947, and was in operation from 1949 to 1957. During that period, it was designed to extract plutonium isotopes from enriched fuels used in research reactors. It is currently in storage-with-surveillance state. Following shutdown in 1957, the majority of the processing equipment was flushed, decontaminated and removed. The only process systems remaining are the fuel dissolver tanks, rod lifting mechanisms and basement sumps.

This facility has a footprint of about 514 square metres. Actual decommissioning activities are expected to be initiated in the next ten years, following regulatory approval to decommission. Decommissioning is to be carried out in three phases.

Phase I, which is expected to be carried out over a 2.5-year period, consists of the following activities:

- performing confirmatory radiological survey of all rooms in the building,
- completing isolation of process and service lines entering the building,
- removing all remaining process equipment and piping,
- completing decontamination of concrete rooms,
- removing the structure, including the steel frame, wood frame, cedar planks, asbestos shingles, roof and footing foundation,
- segregating solid wastes and transfer them to appropriate waste management facilities at CRL, and
- constructing covers for the exposed areas of the shielded concrete enclosure, and a wall to separate associated buildings.

Phase II will last for a period of no less than ten years, and will maintain and monitor the remaining structure during the storage-with-surveillance period.

Phase III of decommissioning will be completed within an estimated two-year period, and will consist of the following activities:

- performing a confirmatory radiological survey to update the hazard status,
- demolishing the shielded concrete enclosure and its footings/foundations,
- removing any contaminated soils within the boundary of the original building footprint,
- segregating solid wastes and transfer them to the appropriate waste management facilities at CRL, and
- Restore the site and release it for future use within the CRL facility.

7.5.3 Plutonium Tower

The Plutonium Tower was used to develop means to extract plutonium from fuel rods irradiated in the NRX reactor, and was operated for a few years in the late 1940s. The building was permanently shutdown in 1954. All process equipment was removed from the building, and an initial clean-up was carried out. Further decontamination and dismantling was carried out in the 1980s.

The Plutonium Tower building is 19.2 metres high and has a footprint of about 28 square metres. All process equipment was removed from this building. Other decommissioning activities include:

- conducting a confirmatory radiological survey of the concrete tower interior, annexes and underground pipe chase to update the hazard status,
- isolating process and service lines entering the building from neighbouring interconnected buildings,
- demolishing the annexes, concrete tower, building structure and footings/foundations,
- segregating solid wastes and transferring them to appropriate waste management facilities at the CRL, and
- removing any contaminated soil and backfilling from the area, as required.

Decommissioning activities are expected to begin once regulatory approval has been granted. The removal of the Plutonium Tower is expected to take approximately one year. An environmental assessment, which is currently being performed pursuant to the *Canadian Environmental Assessment Act*, will be completed in 2009.

7.5.4 Waste Water Evaporator

The Waste Water Evaporator, which was constructed in 1952, was used to process and treat radioactive liquid wastes produced by the NRX fuel reprocessing work conducted between 1952 and 1958. Some evaporation activities were also carried out between 1958 and 1967 to concentrate about 450 cubic metres of stored process wastes remaining from earlier fuel processing. The facility was shut down in 1971.

The Waste Water Evaporator has a footprint of about 130 square metres. One of the seven tanks is suspected to hold about 100 litres of radioactive liquid waste, while two other tanks are suspected to contain a small quantity of dried contaminated sludge.

Decommissioning activities for this building include:

- isolating process and service lines entering the building from neighbouring interconnected buildings,
- removing, treating and storing any liquid wastes from the tank, process lines and equipment,
- decontaminating process equipment, processing cells and other components in the building to remove contamination,
- removing process equipment, processing cell, building structure and footing/foundations,
- segregating solid wastes and transferring them to appropriate waste management facilities at the CRL, and
- removing any contaminated soil surrounding the building to a distance of one metre from the building footprint, and backfilling the area as required.

Actual decommissioning activities will be initiated in the next ten years, following regulatory approval to decommission. Removal of the Waste Water Evaporator is expected to take one year. An environmental assessment, which is currently being performed pursuant to the *Canadian Environmental Assessment Act*, will be completed in 2011.

7.5.5 National Research Experimental (NRX) Reactor

The NRX reactor, Canada’s first large-scale research reactor, commenced operation in 1947 and played a major role in developing the CANDU reactor. The reactor was used extensively for the testing of fuels and materials, and for nuclear physics research in support of the Canadian Nuclear Power program.

The reactor is a vertical assembly of permanent tubes kept in a calandria, which contain the reactor fuel assemblies. The reactor is heavy-water-moderated and light-water-cooled, and has a power rating of 42 MW. After approximately 250,000 hours of operating time, the NRX reactor was shut down on January 29, 1992.

The NRX reactor facility is divided into three planning envelopes: the NRX reactor, the fuel storage bays and the ancillary buildings. The decommissioning of the NRX reactor is planned in three phases.

- Phase 1 will bring the facility to a safe sustainable shutdown state, suitable for an ensuing period of storage with surveillance.
- Phase 2 is the storage-with-surveillance period.
- Phase 3 is the removal of the NRX reactor through a series of decommissioning work packages and achievement of the final end state.

The NRX decommissioning process began with the permanent shutdown of the NRX reactor facility. Shutdown operations for the NRX reactor and ancillary buildings have been completed. And the phase 1 activities to establish a safe sustainable storage-with-surveillance state for the fuel storage bays are currently in progress.

The NRX fuel bays are made up of A and B bays. The A bay's fuel was removed in the late 1990s after the facility was shutdown – after which cleaning of the A bay commenced. An environmental assessment was completed and approved by the CNSC in 2007. The CNSC then approved two advanced decommissioning work packages to remove water from the A and B bays, and remove approximately 30 metres of wooden building structure over the bays, creating a fire separation between the bays and NRX reactor. As a result, the A bay was cleaned and emptied in 2007. Future work will include the decontamination and removal of a 30-metre section of building, which will be completed in 2008.

The B bay consists of a network of water-filled and sand/water-filled bays that were connected to the A bay in the early 1950s. Work was undertaken in the late 1950s to isolate the B bays from the A bay by using a series of concrete dividing walls. Sections of the B bays were drained and filled with sand, while the remaining sections were re-filled with water. Emptying of the B bays will commence once final work is completed on the A bay. Lessons learned from decommissioning the A bay will be incorporated into the planning for the B bays. An application for decommissioning approval is expected during 2009.

7.6 Cluff Lake Project

The Cluff Lake Project, which is owned and operated by AREVA, began in 1981 and was completed at the end of 2002, when ore reserves were depleted. More than 62 million pounds of U_3O_8 was produced over the 22-year life of the project. Site facilities included the mill and tailings management area (TMA), four open-pit and two underground mines, the camp for workers and site infrastructure. Cluff Lake was the first of the northern Saskatchewan uranium mines to move into decommissioning. The decommissioning licence was received from the CNSC in July 2004, and followed five years of public consultation, environmental assessment and regulatory review, and marked the completion of the planning phase of work to return the site to a natural state. The objective is to return the site as closely as practical to its original state in a manner that both protects the environment and allows traditional uses such as fishing, trapping and hunting to be carried out safely.

Site staff and contractors carried out decommissioning work between 2004 and 2006, with re-vegetation of restored areas carrying into 2007. An extensive follow-up monitoring program to assess the performance of the decommissioned site is now underway. A small number of staff remains on site to carry out the monitoring program and provide minor maintenance at restored areas. Ultimately, when all stakeholders judge the performance of the decommissioned site satisfactory, it is expected that the site will be transferred to the Province of Saskatchewan through the institutional control framework established by the *Reclaimed Industrial Sites Act* (see Section H.10.3).

The following sections briefly describe the main decommissioning activities.

7.6.1 Mill area

Decommissioning the mill involved two phases, which were completed in 2004 and 2005. The mill demolition work was broadly similar to demolition of other comparable size industrial facilities, with special measures needed to protect workers from residual contamination and industrial hazards, and to prevent the spread of contaminants into the environment. Only two inactive warehouses remain. These warehouses are used for storage and equipment repair during the post-closure monitoring period. Waste materials were disposed in one of the open pits at the site, together with much larger volumes of waste rock. Following the mill demolition, till material was placed throughout the former mill area to serve as a growth medium for native wood species planted at the site and to ensure that radiological clearance levels were achieved throughout the area.

Figures 7.2 (a) and (b) – (a) A photograph of the mill areas during operation, and (b) a photograph of the area following decommissioning but prior to the re-vegetation becoming established.

7.6.2 Tailings Management Area

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 consisted of a solids containment area, water-decantation area and water-treatment facilities. Thickened tailings were pumped to the solids containment area, where consolidation and liquid decantation occurred. The decant water, together with wastewater from other sources, was piped to a two-stage water treatment facility for radium-226 precipitation. The TMA is surrounded by two diversion ditches, which divert run-off from the upstream drainage basin around the TMA to the downstream water body.

Decommissioning of the TMA was initiated by covering the tailings with till in stages to promote consolidation. When consolidation was complete, the TMA cover was contoured to provide positive drainage, using locally available till with a minimum cover thickness of one metre, and then re-vegetated. The surface contour and vegetated cover promote run-off of rainfall and snowmelt, as well as evapo-transpiration of moisture to the atmosphere, which minimizes net infiltration through the tailings. Extensive characterization of the tailings and the site's geology and hydrogeology has been performed to acquire reliable data on which to base the assessment of long-term performance. One of the objectives of the follow-up monitoring program is to verify the key assumptions used in the long-term performance assessment.

Figures 7.3 (a) and (b) – Photographs show the TMA during operation and after decommissioning but prior to the re-vegetation becoming established.

7.6.1.1 Mining area

Mining involved four open pits and two underground mines. One open pit ("D" pit) and its associated pile of waste rock were reclaimed in the mid 1980s. Water quality data from the flooded pit shows stable, acceptable surface water quality, and native species of vegetation have been re-established on the waste rock pile.

Two open pits have been used for the disposal of waste rock, with one of these two pits also used to accept industrial waste during operations and decommissioning. This waste included the mill demolition waste.

The major decommissioning activities consisted of:

- dismantling and disposing of all above-ground structures,
- sealing all access openings (ramps, ventilation shafts) to the two underground mines, and allowing them to flood naturally,
- relocating waste rock to complete the backfilling of one open pit (Claude pit), then re-contouring and establishing vegetation on these areas,
- removing a portion of – and then re-contouring – the waste rock within another open pit (DJN pit) and then allowing this pit and the contiguous DJX pit to flood to the natural level to eventually form a small lake that meets surface water quality criteria,
- reclaiming the remaining Claude waste rock pile by re-sloping for long-term stability, compacting the waste rock surface, covering with till and establishing a vegetation cover, and
- re-contouring and establishing native vegetation on all disturbed areas.

Extensive characterization of the waste rock, the geologic formations in the area and the site hydrogeology has been performed to acquire reliable data for the assessment of long-term performance. One of the objectives of the post-closure monitoring program is to verify the key assumptions used in the assessment of long-term performance.

(a) – DJ operational

(b) – DJ decommissioned

(c) – "D" Pit approximately 20 years after decommissioning

Figures 7.4 (a), (b) and (c) – Photographs show one of the mining areas (DJ) during operations and after decommissioning but prior to re-vegetation becoming established.

7.7 Bruce Heavy Water Plant

The Bruce Heavy Water Plant (BHWP) was a Class IB nuclear facility contained within the boundaries of the Bruce nuclear site located in Tiverton, Ontario. It began producing heavy water in 1973 and continued until the last production facilities were shutdown in 1998. Decommissioning of some of the older production systems began in 1993.

The demolition of the BHWP was completed in 2006. The only standing activity associated with the demolition is the remediation of oil-contaminated soil from the effluent lagoons. The contaminated soil was removed from the lagoons and put into bioremediation cells during the summer of 2006. These remediation cells should be removed from the site in November of 2008.

Figure 7.5 – Demolition of the Bruce Heavy Water Plant site

ANNEX 8 – INACTIVE URANIUM MINES AND MILLS TAILINGS MANAGEMENT AREAS

8.1 Introduction

There are 20 tailings management sites that have resulted from the operation of uranium mines in Canada: 14 in Ontario, four in Saskatchewan and two in the Northwest Territories. (A map of their locations is included in Figure B.3.)

8.1.1 Saskatchewan

There are three inactive uranium tailings sites in Saskatchewan: Beaverlodge, Lorado and Gunnar. In addition to these sites, AREVA's Cluff Lake mining facility is currently being decommissioned (see Annex 7.6).

8.1.1.1 Beaverlodge

Cameco holds a waste facility operating licence (WFOL) for the Beaverlodge decommissioned uranium mine located near Uranium City, in the northwest corner of Saskatchewan. Mining of ore at his site began in 1950 and milling in 1953, with both activities continuing until closure in 1982. Decommissioning began in 1982 and was completed in 1985. Since then, the site has been in a monitoring and maintenance phase. All mine structures have been removed from the site; all but one of the open pits has been completely backfilled; and mine shafts have been capped and decommissioned according to Joint Regulatory Group (JRG) requirements.

All of the control structures associated with this site are passive. Three small water-level control structures exist but no effluent treatment plants. There are roads, waste rock piles and tailings management areas that are subject to inspection programs and local and area-wide environmental monitoring programs.

The Beaverlodge site has three tailings management areas, which contain 5.8 million tonnes of tailings and 4.3 million tonnes of uranium tailings disposed of underground – for a total of 10.1 million tonnes of lower-grade uranium mine tailings. In addition to this figure, there are approximately 5.1 million tonnes of waste rock on the site.

The site consists of 73 separate properties that cover approximately 744 hectares. There were 17 different mining areas; 10,161,000 tonnes of ore were recovered that averaged 0.25 percent uranium (0.10 to 0.43 percent ranges).

Figure 8.1 – Beaverlodge former mill area

8.1.1.2 Gunnar and Lorado

On April 2, 2007, the Government of Canada and the Government of Saskatchewan announced the first phase of the clean-up of closed uranium mine and mill sites in northern Saskatchewan (principally Gunnar and Lorado). Private sector companies that no longer exist operated these facilities from the 1950s until the early 1960s. When the sites were closed, the regulatory framework in place was not sufficient to ensure an appropriate containment and treatment of the waste, which has led to environmental impacts on local soils and lakes. The total clean-up cost, which the governments of Canada and Saskatchewan will share, will be $24.6 million.

The Gunnar mine site is located on the southern tip of the Crackingstone Peninsula, along the North shore of Lake Athabasca, approximately 25 kilometres southwest of Uranium City, Saskatchewan (see Figure 8.3). The Gunnar mine site has been closed since 1964, and has not been adequately decommissioned.

On June 15, 2007, a comprehensive environmental assessment for the Gunnar project began pursuant to the provisions of the *Canadian Environmental Assessment Act*. The federal authorities responsible for the assessment are the CNSC (responsible for issuing the licence for the project) and Natural Resources Canada (responsible for partially funding the project.) An environmental assessment is also being conducted by the Government of Saskatchewan, in accordance with the terms of the Canada-Saskatchewan Agreement on Environmental Assessment Cooperation.

The Lorado Uranium Mining Ltd. mill site is located north of Lake Athabasca in the northwest corner of Saskatchewan, approximately eight kilometres southwest of Uranium City (see Figure 8.2). EnCana West Limited (EWL) has been identified as the owner of the land on which a portion of the unconfined tailings from the Lorado milling operation exists. The remainder of the site is provincial crown land. In 2008, EWL negotiated an agreement with the Saskatchewan government. EWL has paid a significant amount of money in exchange for the government to assume current and future control and responsibility of the site. Work related to the remediation of the Lorado site will require the CNSC licensing and joint regulatory approvals.

Figure 8.2 – Lorado tailings site

Figure 8.3 – Aerial view of Gunnar Mine site

8.1.2 Northwest Territories

There are two licensed closed uranium mine and tailings sites in the Northwest Territories: Port Radium Mine and Rayrock Mine.

8.1.2.1 Port Radium

The Port Radium site is located in the Northwest Territories at Echo Bay on the eastern shores of Great Bear Lake, about 265 kilometres east of the Dene community of Déline at the edge of the Artic Circle. Mining at the Port Radium site occurred from 1932 to 1940, from 1942 to 1960 and from 1964 to 1982 – in the last instance, to recover silver. The site covers approximately 12 hectares, and is estimated to contain 1.7 million tons of uranium and silver tailings. The site was partially decommissioned in 1984, according to the standards of the day. In 2006, the federal government reached an agreement with the local community, and completed the remediation of the site in 2007 under a CNSC licence.

Indian and Northern Affairs Canada (INAC) will continue performance and environmental monitoring and reporting under the licence. The following are the results from the sampling of the radiological surface water for 2007:

- < 6 Bq/L for Radium-226
- < 0.1 Bq/L for Lead-210
- < 20 µg/L Uranium

These levels are below the discharge limits specified in the licence conditions, and below the Canadian Water Quality Guidelines and Health Canada’s drinking water criteria.

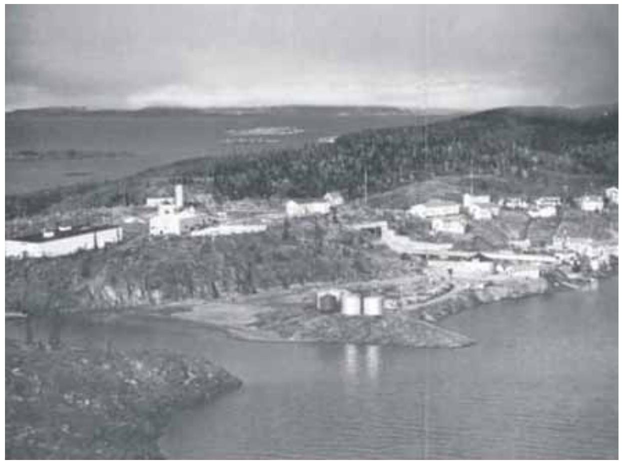


Figure 8.4 (a) – Aerial photo (1950s) of Port Radium Mine

Figure 8.4 (b) – Aerial photo of the Port Radium Mine (2002)

8.1.2.2 Rayrock

Uranium mining and milling occurred at the Rayrock site from 1957 until 1959, when it was abandoned. Following an environmental assessment and the issuance of an AECB licence (reissued as a CNSC licence in 2001), INAC decommissioned and rehabilitated the Rayrock site (including the capping of the tailings) in 1996. Performance monitoring and reporting of the results has been ongoing since 1996.

INAC sampled surface water for 2007 and reported the following radiological concentrations at the final point of control:

- 0.06 Bq/L for Lead-210
- 0.02 Bq/L for Polonium-210
- 0.09 Bq/L for Radium-226
- 0.01 q/L for Thorium-228
- 0.07 Bq/L for Thorium-230
- 0.01 Bq/L for Thorium-232
- 0.2 Bq/L for Uranium-234
- 0.0038 Bq/L for Uranium-235
- 0.0047 Bq/L for Uranium-238

For the 2007 sampling period, many of the radionuclide concentrations were below detection limits, and in all cases below the Canadian Water Quality Guidelines and Health Canada's drinking water criteria.

Figure 8.5 – Rayrock Mine

8.1.3 Ontario

8.1.3.1 Elliot Lake area

There are 12 inactive uranium mine sites and ten uranium tailings management areas (TMAs) in and around Elliot Lake, Ontario. All of the Elliot Lake uranium mines were brought into production between 1955 and 1958. By 1970, five of the mines had been shut down; by 1992, most had ceased operations. The last of the Elliot Lake uranium mines to be decommissioned – Stanleigh, Quirke, Panel, Stanrock and Denison mine sites – were essentially complete by the end of 1999. Currently, all of the sites have been substantively decommissioned, with all mine features capped or blocked, all facility structures demolished, and all sites landscaped and re-vegetated.

The uranium ore in the Elliot Lake area is classified as low grade (containing less than 0.1 percent U_3O_8). It also contains pyrite and uranium decay products such as radium-226. When exposed to oxygen and water, the tailings become acid-generating, and may mobilize contaminants. Most of the Elliot Lake TMAs, therefore, have some degree of effluent treatment system associated with each site. All of the TMAs have been closed, and all construction activities related to the containment structures have been completed. Currently, the mining companies conduct site-specific and regional environmental monitoring programs, operate the effluent treatment plants, and inspect and maintain the sites.

Rio Algom Ltd. is responsible for the Quirke, Panel, Spanish American, Stanleigh, Lacnor, Nordic, Buckles, Pronto and Milliken mine sites, and their associated TMAs, while Denison Mines Inc. is responsible for the Denison, Stanrock and Can-Met mine sites and their TMAs.

Decommissioning of uranium mines and mills is governed by the *Uranium Mine and Mills Regulations* under the NSCA. Two of the mine sites – Denison and Stanrock – currently have the CNSC uranium mine decommissioning licences in effect.

In 2004, Rio Algom Ltd. consolidated all of its Elliot Lake mine sites under one the CNSC licence: a waste facility operating licence governed by the *Class I Nuclear Facility Regulations* under the NSCA.

Effluent treatment and environmental monitoring

In Elliot Lake, there is a mixture of both dry and wet covers being used at the TMAs. Four of the TMAs – Lacnor, Nordic, Pronto and Stanrock – are engineered with dry covers, and vegetation has been established over the tailings at all of these sites. Active water treatment is required at all of the dry tailings management areas to correct for acid generation and radium dissolution in the effluent streams, according to the predicted performance for the dry tailings covers. It is expected that water treatment will be required for many more years to come at these sites, as the acid-generating potential of the tailings is slowly exhausted due to surface water infiltration and oxidation of the tailings.

The other TMAs – Quirke, Panel, Stanleigh, Spanish American and Denison – are all water covered, and most require some form of active water treatment. However, the extent of treatment required is greatly reduced over that of the effluents resulting from the dry cover TMAs (the water covers minimize exposure to oxygen and the resulting generation of acid). Many of these sites currently require only minimal treatment, and it is expected that the effluent treatment plants will not be required for the length of time predicted at the dry covers sites.

With respect to environmental monitoring, both of the licensees have each implemented two programs: the *TMA Operational Monitoring Program* and the *Source Area Monitoring Program*. The first collects data to track TMA performance, and supports decisions regarding the management and discharge compliance of the TMAs. The second program was developed to monitor the nature and quantities of contaminant releases to the watershed.

In addition to these measures, both Rio Algom Ltd. and Denison Mines Inc. have jointly implemented two watershed-wide programs, referred to as the *Serpent River Watershed Monitoring Program* (SRWMP) and the *In-Basin Monitoring Program.*

The SRWMP is designed to evaluate the effects of all mine discharges and water-level changes on the receiving watershed, focusing on water and sediment quality, benthos, fish health and radiation and metal doses to humans and wildlife. The Serpent River watershed is comprised of more than 70 lakes and nine sub-watersheds, which cover an area of 1,376 square kilometres and drain into Lake Huron via the Serpent River.

The *In-Basin Monitoring Program* is a companion program to the SRWMP that focuses on the risks to biota feeding at the TMAs by monitoring the physical, chemical and ecological conditions at the TMAs, including the tracking of ecological changes. Both programs run in five-year cycles. The first cycle was completed in 1999; the second cycle summary report was completed in 2007.

The Rio Algom Ltd. and Denison Mines Inc. mine sites are licensed by the CNSC for possession, care and maintenance of nuclear substances that are found in the tailings management areas. There are no emissions from the tailings management areas, with the exception of surface water run-off. Tailings management area waters are treated as required by the licensees, prior to release, and meet the discharge limits that are set in each individual licence. After being treated, they discharge into the Serpent River watershed, and are further diluted by the watershed until they ultimately discharge into Lake Huron via the Serpent River. Biological effects monitoring programs have indicated some impairment of the lake’s bottom living benthic invertebrate community in the initial receiving water bodies but no significant impairment of the downstream watershed.

These sites will continue to require monitoring and active management until effluents meet discharge criteria without treatment. These sites will then require some form of ongoing (permanent) care and maintenance.

Community involvement

With respect to community involvement, the mining companies maintain a public presence in Elliot Lake, offering facility tours, a Web site and a public information program that keeps the community and city council updated with respect to on-going activities at the sites. The Serpent River Region Environmental Committee (SRECC), a local environmental committee, attends facility inspections along with the CNSC and the Joint Regulatory Group (who represent the other federal and provincial regulators that have an interest in the Elliot Lake operations). Over the last several years, the CNSC personnel have conducted outreach activities in Elliot Lake, hosted open houses and attended a public forum hosted by the SRREC.

Figure 8.6 (a) – Aerial view of the Stanleigh Mine site, prior to decommissioning

Figure 8.6 (b) – Aerial view of the Stanleigh Mine site after decommissioning

8.1.3.2 Agnew Lake

The Agnew Lake Mine, located about 25 kilometres northwest of Nairn Centre, Ontario, ceased operation in 1983. The uranium mine site was decommissioned and monitored by Kerr Addison Mines from 1983 until 1988. The site was then turned over to the Province of Ontario in the early 1990s. The Ministry of Northern Development and Mines holds a CNSC Waste Nuclear Substance Licence for the Agnew Lake idle tailings site. The CNSC personnel conduct a compliance inspection of the Agnew Lake Mine once every three years. The Ministry of Northern Development and Mines reported the following 2007 sampling results for the radiological surface water at the final point of control:

- Radium-226: <0.01 Bq/L
- Lead-210: 0.1 Bq/L
- Polonium-210: <0.01 Bq/L
- Thorium-230: <0.01 Bq/L

These levels are below the Ontario Provincial Water Quality Objectives (PWQO).

8.1.3.3 Bancroft area

Uranium tailing management sites also exist at the Madawaska, Dyno and Bicroft mines in the area surrounding Bancroft, Ontario. The Madawaska Mine has been inactive since 1983, while operations at the Dyno and Bicroft sites ceased in the early 1960s.

8.1.3.3.1 Dyno Idle Mine Site

The Dyno Idle Mine property is located at Farrel Lake, about 30 kilometres southwest of Bancroft, Ontario. The mill circuit at Dyno operated between April 1958 and April 1960. The property consists of an abandoned, sealed underground uranium mine; a mill, which has been largely demolished; a tailings area; two dams; and various roadways. The site is managed and monitored by EnCana Corporation, which holds a CNSC Waste Nuclear Substance Licence for the Dyno Idle Mine site.

During the sampling period of 2007, EnCana West Ltd. provided the following results for the radiological surface water at the final point of control:

- Concentrations of uranium were measured to be 0.00078 mg/L in the spring of 2007, and 0.00067 mg/L in the fall of 2007. Both of these samples are well below the interim PWQO for uranium (0.005 mg/L).

- Concentrations of radium-226 in samples collected in the spring and fall were 0.1 Bq/L and 0.4 Bq/L, respectively. Concentrations of radium-226 are lower than the PWQO (0.6 Bq/L).

- Concentrations of thorium-230, measured in the spring and fall, were below detection limit (<0.01 Bq/L).

- Concentrations of polonium-210, measured in the spring and fall, were both at the detection level (0.01 Bq/L).

- Concentrations of lead-210, measured in the spring and fall, were below the respective detection limits (<0.1 Bq/L and <0.02 Bq/L).

Figure 8.7 – Main tailings dam, Dyno Mine site

8.1.3.3.2 Madawaska Mine Site

The Madawaska Mine property is located six kilometres southwest of the town of Bancroft, Ontario on Highway 28. Initial mining and milling operations at Madawaska (Faraday) Mine ran from 1957 until 1964, and again from 1976 to 1982. Reclamation activities were carried out from 1983 to 1992. The Madawaska site has a decommissioning approval licence from the AECB (now the CNSC). Madawaska Mines Limited holds the licence, and the site is monitored and managed as part of a joint venture by EnCana West Limited.

During the sampling period of 2007, EnCana West Ltd. provided the following results for the radiological surface water at the final point of control:

- During the spring 2007 sampling event, the concentration of uranium was measured at 0.006 mg/L, slightly exceeding the PWQO (0.005 mg/L). During the fall 2007 sampling event, the concentration of uranium was 0.05 mg/L, also greater than the PWQO. These uranium concentrations are consistent with the data collected from 1989 to 2006.

- Concentrations of radium-226, measured during the spring and fall sampling events, were 0.01 Bq/L and 0.09 Bq/L, respectively, and are below the PWQO (0.6 Bq/L).

- During the 2007 sampling events, concentrations of thorium-230, polonium-210 and lead-210 were below detection limits (<0.01 Bq/L, <0.01 Bq/L and <0.01 Bq/L, respectively, for the spring samples, and 0.01 Bq/L, <0.005 Bq/L and <0.02 Bq/L, respectively, for the fall samples).

8.1.3.3.3 Bicroft Tailings Storage Facility

The uranium tailings stored in the Bicroft Tailing Storage Facility resulted from processing low-grade uranium ore at the Bicroft mine from 1956 to 1962. Remediation work has included vegetation of exposed tailing in 1980, and upgrading of dams in 1990 and 1997. In 2005, the Barrick Gold Corporation (Barrick) was issued a Waste Nuclear Substance Licence for the Bicroft Mine. The effluents discharge results generally meet the PWQOs results, with a few exceptions. As part of its licence application, therefore, Barrick conducted a Screening Level Human Health and Ecological Risk Assessment (SLHHERA) to demonstrate that there is no unreasonable risk to the health, safety and the environment, and to support a five-year surface water-sampling program. The most recent sampling data provided by Barrick is from 2005. The results for the radiological surface water at the final point of control are 0.87 Bq/L for radium-226 and 35 ppb for uranium.

Figure 8.8 – South tailings basin spillway at Bicroft Tailing Storage Facility

8.2 Contaminated lands

8.2.1 Contaminated land under institutional control

8.2.1.1 Consolidated cells

Three historic above-ground waste consolidation cells are being managed under institutional controls. These engineered consolidation cells are located in Fort McMurray (Alberta), Fort Smith (Northwest Territories) and the Passmore in Toronto (Ontario). The CNSC has exempted these cells from a requirement for licensing until 2016.

Historic waste from a cell in Tulita (Northwest Territories) has been repackaged, and the repackaged materials are currently being managed at the site of the old cell under a CNSC licence. The LLRWMO is currently pursuing a plan that would see these wastes transported to a disposal facility by October 2008.

A buried cell of uranium-contaminated material was established in Peterborough (Ontario) in 2004. It is currently being managed under institutional controls, and has been temporarily exempted by the CNSC from the requirement for licensing.

An above-ground contaminated soils consolidation cell is located on Lakeshore Road in Toronto. It is being managed under a CNSC licence.

The materials in the Peterborough and the Lakeshore Road consolidations cells do not meet the federal government's definition of historic waste. They are contaminated materials being managed by a third party.

8.2.1.2 Fort McMurray

The Lower Town site and Waterways sites in Fort McMurray, Alberta (located at the junction of the Athabasca and Clearwater rivers) were the southernmost terminals of the Northern Transportation Route (NTR). It was at these sites that the uranium ore was offloaded from water barges and transferred to trains for transport to Port Hope, Ontario, for processing. The contaminated soils associated with these sites were cleaned up during the period of 1992 to 2002, and consolidated into a purpose specific engineered containment cell constructed adjacent to the municipality's landfill site. The cell, which contains approximately 42,500 cubic metres of contaminated soils, is fenced and monitored by the LLRWMO. The cell has not yet been licensed by the CNSC, and a formal licence application for the cell is pending the federal government's review of its waste management strategy.

8.2.1.3 Fort Smith

The Town of Fort Smith is located on the west bank of the Slave River, just north of the border between Alberta and the Northwest Territories. Fort Smith was a staging point along the NTR where cargo (including the uranium ore from the Port Radium Mine) was portaged around four sets of rapids on the Slave River. In 1998 and 2001, contaminated soil and building material, discovered on private and public lands in the town, were cleaned up and transferred to a temporary storage cell constructed near the town's landfill site. The covered cell, which contains approximately 350 cubic metres of contaminated soils, is signed and fenced, and monitored by the LLRMWO. The temporary storage cell has not yet been licensed by the CNSC, and a formal licence application for the mound is pending the federal government's review of its waste management strategy.

8.2.1.4 Passmore Storage Cell

The Passmore Storage Cell is located in the Malvern Community of Toronto, Ontario (northeast part of Toronto). Malvern is a planned community that involves the redevelopment of agricultural lands into residential, light industrial and commercial uses. One of the redeveloped farms was used in the late 1940s and early 1950s as the site of a radium recovery operation. During the course of redevelopment activities, residual pieces of radium-bearing materials and contaminated soils, originating from the recovery operation, were deposited on residential lots. In 1993, the Malvern Remedial Project was established as a joint Canada-Ontario initiative to address the radium contamination in the Malvern Community.

Under the management of the LLRMWO, a clean-up program was conducted, which involved the excavation and transportation of the contaminated soil to the Passmore Avenue site, where the soil was sorted into licensable, mildly contaminated and clean fractions. The licensable material (approximately 50 cubic metres) was transferred off site to an existing licensed facility. The mildly contaminated fraction was consolidated into a purpose specific engineered containment cell constructed on the Passmore Avenue site. The cell, which contains approximately 10,000 cubic metres of contaminated soils, is fenced and monitored by the LLRWMO. The cell is under institutional control, and measures for placing it under regulatory control are being considered.

8.2.1.5 Tulita

The hamlet of Tulita is located in the Northwest Territories on the east bank of the Mackenzie River, just south (upstream) of the Great Bear River confluence. (The Great Bear River is the water link between Great Bear Lake and the Mackenzie River.) Tulita was a staging point along the NTR where the uranium ore from the Port Radium mine was transferred from small-river to large-river barges. Most cargo transfers occurred directly from barge to barge; however, on one occasion, the bags of ore were off-loaded from the barges and temporarily stored over the winter on private properties in the community. In 1992, 1999 and 2001, the LLRMWO conducted clean-ups of those private properties, and consolidated the contaminated soils into a temporary storage cell, constructed on hamlet-owned land near the airport. The covered cell, which contained approximately 867 cubic metres of contaminated soils, was signed and fenced, and is monitored by the LLRMWO.

In 2007, the material in the cell was repackaged for transportation to the Port Radium Mine site for incorporation into the tailings basin before it was capped. The logistics proved too difficult, however, and the repackaged material has been stored at the site of the original cell, under a CNSC licence, until an alternative storage solution is determined. The LLRWMO is currently pursuing a plan that would see these wastes transported to a disposal facility by October 2008.

8.2.1.6 Peterborough

An empty field that used to house an assay company in the 1960s was found to be contaminated with uranium ore. A clean-up took place in 2004, and the resulting 300 cubic metres of material were placed in a lined cell under the parking lot of a new warehouse. The cell is marked on all property plans, and is being managed under institutional controls.

8.2.1.7 Lakeshore Road

In 1999, radium contaminated soils were consolidated into an above-ground cell at the Lakeshore Road property in Toronto. The property was the site of a factory that produced weapons sights and other radio-luminescent devices. The cell contains approximately 2,000 cubic metres of mildly contaminated soil. In January 1, 2006, the Toronto Regional Conservation Authority (TRCA) was issued a CNSC Waste Nuclear Substance Licence for the Lakeshore Road Storage Mound.

8.2.1.8 Deloro

The Deloro Mine Site Clean-up Project is an initiative of the Ontario Ministry of the Environment (OMOE) designed to clean up the abandoned mining, refining and manufacturing site located at Deloro, Ontario. The OMOE assumed responsibility for this site in 1979, when the site owner failed to comply with ministry orders to control the contamination that was leaving the site.

Although not a uranium mine, the 202-hectare property was the location of mining, refining and manufacturing activities for more than 100 years. The site is located along the banks of the Moira River, beside the eastern boundary of the Village of Deloro (population of 180).

The environmental legacy at the Deloro Mine Site includes contamination of soils, sediments, groundwater and surface water, with arsenic, cobalt, copper, nickel and low-level radioactive waste. Only two to six percent of the waste material on the Deloro Mine Site consists of low-level radioactive wastes. Arsenic remains the contaminant of main concern.

The overall objective of the Deloro Mine Site Clean-up Project is to remediate the abandoned mining and industrial complex by isolating and containing the wastes and engineering the site to protect people and the environment. The draft clean-up plan is intended to isolate and contain the various contaminants, totalling about 650,000 cubic metres in volume, within the boundaries of the Deloro Mine Site. None of the existing waste materials will be taken off-site.

In general terms, the draft clean-up plan proposes to:

- excavate and consolidate the most contaminated materials under engineered covers made of clay, sand, topsoil, loam and clay liner,
- use engineered clay caps to cover the less contaminated materials,
- manage surface and groundwater to minimize contact with the wastes, and
- treat contaminated surface water leaving the site.

The clean-up will focus on four main areas where different industrial, mining and manufacturing activities took place: industrial area, tailings area, Young's Creek and mine area. The project will be implemented in three phases. The first phase includes an environmental assessment and the CNSC decisions related to the assessment, a regulatory technical review of the project and licensing. Subsequent phases will include the clean-up and consolidation of materials at the site, followed by a phase of long-term inspection, monitoring and maintenance.

Based on the project description and the letter of intent, a screening level environmental assessment is required, pursuant to the CEA Act, before the CNSC can consider providing the OMOE with an authorization (through licensing) to conduct remedial work at the Deloro Mine Site. The CNSC delegated responsibility to conduct the technical studies and associated public consultation to the OMOE as the proponent. The CNSC approved the environmental assessment screening guidelines at a public hearing in 2003.

From the project schedule provided by the OMOE, the CNSC personnel anticipate presenting the environmental assessment screening report at a CNSC hearing in February 2009 if no further revisions to the resubmitted environmental assessment study report are required. Based on the environmental assessment schedule, and in accordance with the CEA Act, the authorities responsible for the project (the CNSC and Fisheries and Oceans Canada) are expected to make decisions on the project in 2010.

With respect to public consultation, the OMOE conducts public meetings and open houses, has a project-specific area on the OMOE Web site, and meets regularly with three liaison committees to keep them informed and to gather input and comments.

8.2.2 Historic contaminated lands

8.2.2.1 Fort Fitzgerald

From the early 1930s to the 1950s, uranium ore was transported by the NTR from Port Radium on Great Bear Lake, Northwest Territories to the railhead at Waterways (now Fort McMurray, Alberta). Contaminated sites at Fort Fitzgerald exist within 100 metres of the river's edge. As part of the NTR, the sites were used as docks and boat launches. Radiological surveys were conducted in 2004, 2005 and 2006. Data from all the surveys were summarized in 2006, and the material volume was updated to approximately 10,000 cubic metres.

8.2.2.2 Sahtu Region

The Sahtu Region contaminated sites exist in isolated locations along the Great Bear River, and at one remote end of Great Bear Lake in the Northwest Territories. Clean-up activities conducted by the LLRWMO at one site removed the highest-grade material, and brought readings down to below background levels. In 2003, the ten sites along the Great Bear River were characterized; only two sites require the care of institutional controls by the Sahtu Land and Water Board and INAC. The results of the characterization were provided to the communities of Déline and Tulita. Further characterization work is planned for 2008 to identify the volume of contaminated soil at the site.

The landowners and administrators of these Northwest Territories sites have been informed of the radiological contamination, and are aware of the requirement for restrictions on construction activities at the sites. They also know about the need to contact the CNSC if construction activities were ever to occur.

8.2.2.3 Toronto, Ontario

Toronto area contaminated sites include radium contaminated soils on lands owned by the Province of Ontario, the Toronto Regional Conservation Authority (TRCA), Ontario Realty Corporation (ORC) and private landowners. Contaminated sites also included radium contamination fixed to structural elements in privately owned buildings.

The contaminated soils are generally covered, or occur in areas of low use (primarily open space). One former scrap metal yard is fenced and is undergoing characterization by ORC for both radiological and non-radiological contaminants. The contaminated material in buildings is isolated behind double walls and ceilings.

The owners of the properties are aware of these control measures, and the tenants are restricted from construction activities that would compromise these safeguards. The owners are also aware of the process that requires the CNSC to be contacted and given the opportunity to assess any proposed construction or land-use changes. The CNSC maintains contact with the owners/managers of the sites through visits and phone conversations, and conducts site visits once every three years.

8.2.2.4 Port Hope Area Initiative for the long-term management of historic low-level radioactive wastes

On March 29, 2001, an agreement was signed between the Government of Canada (represented by the Minister of Natural Resources) and the communities of Port Hope, Hope Township and Clarington for the construction of long-term waste management facilities for historic low-level radioactive wastes and for the clean-up of contaminated sites in the Port Hope area. The wastes consist of about two million cubic metres of LLW and contaminated soils, containing radium-226, uranium and arsenic as the primary contaminants.

With this agreement, the Government of Canada began an initiative to evaluate and implement a long-term solution for the management of the wastes from the Port Hope area sites. The initiative has been divided into two projects that accord with municipal boundaries. The Port Hope Project entails the clean-up and long-term management of wastes from various contaminated sites in the Municipality of Port Hope – formerly the Town of Port Hope and Hope Township. The Port Granby Project involves the implementation of a long-term management approach for radioactive wastes at the existing Port Granby Waste Management Facility in the Municipality of Clarington.

Single purpose-built facilities are being planned to manage the wastes from each clean-up project: the Port Hope Long-Term Waste Management Facility (PHLTWMF) and the Port Granby Long-Term Waste Management Facility (PGLTWMF). The PHLTWMF, with an estimated design capacity of 1.8 million cubic metres, is planned to accept a variety of wastes from the area. These include wastes from the major unlicensed sites in the Municipality of Port Hope such as the Alexander Street ravine, the waterworks, the viaducts area, the Mill Street south site, the landfill and the harbour. Other wastes, such as contaminated roadways and soils from private properties, will also to be included, along with wastes from Cameco’s Welcome Waste Management Facility, and specified historic wastes from the Cameco conversion facility. Wastes from consolidation sites and temporary storage sites within the community that are being temporarily managed by the LLRWMO will also be included, along with non-radiologically contaminated industrial wastes, as requested by the municipality and provided for in the agreement.

The PHLTWMF is planned for an expanded site at the existing Welcome Waste Management Facility located in the Municipality of Port Hope, which currently contains an estimated 500,000 cubic metres of low-level wastes and contaminated soils. An environmental assessment process has been completed for this project. The implementation phase of the project is expected to last for seven years, pending successful completion of the licensing process, which will be followed by long-term monitoring and surveillance.

The PGLTWMF, with an estimated design capacity of 600,000 cubic metres, is being planned to accept wastes only from the existing Port Granby Waste Management Facility, which is currently owned and operated by Cameco, and located in the Municipality of Clarington. The site considered for these wastes is immediately northwest of the existing facility and away from the Lake Ontario shoreline. The implementation phase of this project is expected to last for six years, once the environmental assessment and licensing processes are concluded. Long-term monitoring and surveillance will follow this phase.

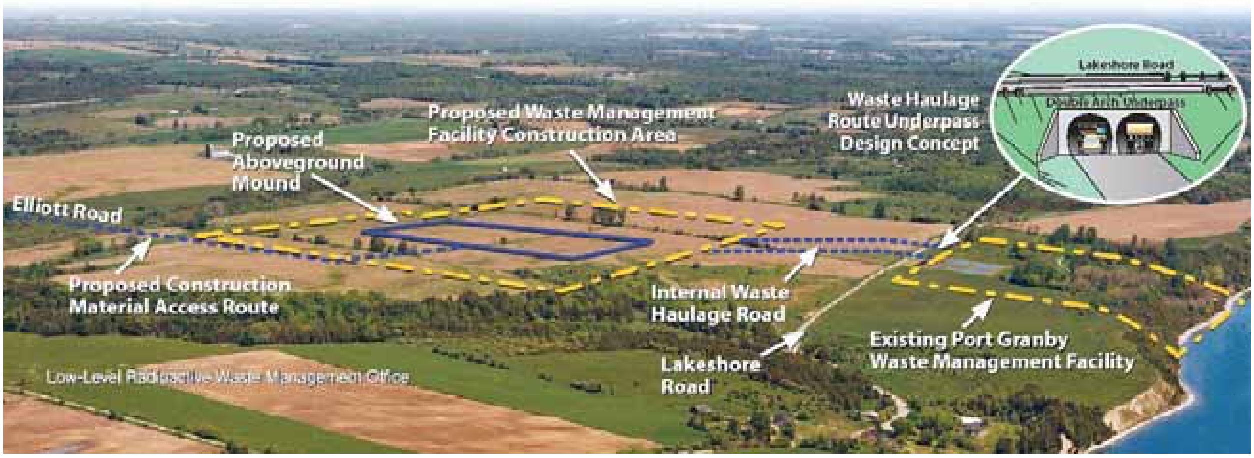


Figure 8.9 – Port Granby concept diagram

8.2.2.5 Port Hope contaminated sites

A number of contaminated sites have been identified in the Municipality of Port Hope. Some of these sites are known as major unlicensed sites, others are known as small scale sites, and there are also some licensed and unlicensed temporary storage and consolidation sites. Although many of these sites are not currently licensed by the CNSC, the CNSC is aware of them and is comfortable with how they are being managed. The sites are safe for casual access, pending implementation of the project known as the Port Hope Area Initiative, which will remediate them once the long-term waste management facilities for the project have been developed.

The major sites are generally well known by the community and municipality, and will not be further developed until the historic waste deposits can be removed to an appropriate storage facility. Small pockets of contaminated soils, however, also exist on roadways and municipal road allowances, and on municipal, private and commercial properties. These sites are known collectively as small-scale sites.

The development of these sites (which may include common activities such as road repair, infrastructure repair and maintenance, property re-grading/landscaping, and private or commercial property development or renovation) is accommodated under the Construction Monitoring Program, an administrative program between the LLRWMO and the Municipality of Port Hope.

The municipality forwards projects that require municipal building permits to the LLRWMO for review and action. This action often results in a radiological monitoring of excavated materials in construction areas. If contaminated soils that need to be removed are identified, they are accepted at the Pine Street Extension Temporary Storage Site, a CNSC licensed storage facility. The project may then continue as planned. The LLRWMO also accepts applications to the program directly from residents for projects that do not require building permits.

Larger projects, which may negatively impact upon the LLRWMO’s ability to receive wastes at its temporary storage site (it currently has a receiving capacity of approximately 5,200 cubic metres), are accommodated through the construction of small purpose built consolidation or storage sites. In the long-term, through the PHAI, the objective is to consolidate this material within the purpose built Port Hope Long-Term Waste Management Facility.