Preface

Information in this report covers the period up to March 31, 2014. However, in some instances the reporting period extends beyond this to the time of writing the report: July 31, 2014. Examples include the current status of the Canadian Nuclear Safety Commission’s regulatory documents, the Nuclear Waste Management Organization’s (NWMO) Adaptive Phased Management (APM) approach, and Ontario Power Generation’s (OPG) Deep Geologic Repository (DGR).
Executive Summary

1.0 Introduction

This fifth Canadian 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* (hereinafter referred to as the Joint Convention) during the reporting period from April 2011 to March 2014. A collaboration of government, industry and the regulatory body, this report focuses specifically on the progress of long-term management initiatives for spent fuel and radioactive waste in Canada, revisions and updates to Canada’s fourth national report, and comments and issues raised at the Fourth Review Meeting, which took place in May 2012. Specifically, it includes additional information on:

- Canada’s progress in finding solutions for the long-term management and disposal of different types of radioactive waste and/or spent fuel
- continued implementation and ongoing funding of the Nuclear Legacy Liabilities Program (NLLP)
- the status of the Nuclear Waste Management Organization’s (NWMO) site selection process for a deep geological repository for the long-term management of Canada’s spent fuel
- the status of Ontario Power Generation’s (OPG) Deep Geologic Repository (DGR) for its low- and intermediate-level radioactive waste (L&ILW) site preparation and construction licence application

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 NWMO, for the long-term management of Canada’s spent fuel. The NWMO is responsible for implementing this plan. The NWMO is currently in the site selection phase of the process, with 14 communities interested in learning more about the project as of June 2014. For more information about the NWMO and the APM project, see sections G.16 and K.4.
- The NLLP is implementing Canada’s long-term strategy for dealing with nuclear legacy liabilities at Atomic Energy of Canada Limited (AECL) sites across Canada. These nuclear legacy liabilities are a result of 60 years of nuclear research and development carried out on behalf of the Government of Canada by the National Research Council and AECL. (Program progress and achievements are summarized in section K.6.2.) In 2013 the Government of Canada re-estimated the cost to implement the NLLP over 70 years to be $10 billion.
- The Canadian Environmental Assessment Agency (CEA Agency) and the Canadian Nuclear Safety Commission (CNSC) established a Joint Review Panel in January 2012 to review OPG’s environmental impact statement and other documents in support of OPG’s application for a site preparation and construction licence concerning a deep geological repository for its L&ILW. The Joint Review Panel is continuing with its public review of the information, including public hearings. Following the closure of the public record, the panel’s report on the environmental impacts of the repository will be prepared. The report will be submitted to the Minister of the Environment for decision. If permitted by the decision of the Minister, the panel will act as the Commission and decide whether to issue the requested licence. The environmental assessment (EA) decision is expected to be received in 2015. If permitted, a decision on the issuance of a site preparation and construction licence would be expected to follow shortly after. If the licence is issued, the earliest in-service date for the completed DGR facility would be approximately 2025.
- Canada continues to manage and address historic waste as a priority. The Port Hope Area Initiative (PHAI) will result in the long-term management of historic low-level radioactive waste in two above-ground mounds that will be constructed in the local communities. The $1.28 billion
Executive Summary

initiative includes two projects – the Port Hope Project and the Port Granby Project. A number of enabling activities have been initiated to prepare for the remediation and consolidation of the low-level radioactive waste (LLW), including construction of a wastewater treatment plant and radiological investigations of residential properties in Port Hope to identify occurrences of LLW not included in the major sites. For further information, see section K.6.3.1 and annexes 8.2.1.1 and 8.2.1.2.

- After the sale of the assets of AECL’s former CANDU Reactor Division to Candu Energy Inc. in October 2011, the Government of Canada formally turned its attention to the restructuring of AECL’s nuclear laboratories in 2012, with an announcement that it would engage in a competitive procurement process to restructure AECL’s management and operations. The government is seeking to implement a government-owned, contractor-operated (GoCo) model, as is done in other jurisdictions such as the United States and the United Kingdom. For further information, see annex 1.3.

- On December 28, 2012, the Gentilly-2 Nuclear Generating Station was permanently shut down. For more information on the decommissioning of the facility, refer to annex 7.9.

3.0 Progress since the Fourth Review Meeting

During the peer review of Canada’s Fourth National Report in 2012, contracting parties to the Fourth Review Meeting identified long-term waste management challenges and planned measures to improve safety. The following section (3.1) provides an update and summarizes the progress made toward the long-term management of spent fuel and radioactive waste.

3.1 Canada continues progress for long-term management strategies by:

a. finding an acceptable site for a spent nuclear fuel (SNF) repository
b. developing long-term management options for radioactive waste
c. demonstrating the safety of old interim storage facilities to support re-licensing
d. addressing a wide variety of legacy wastes in several areas and in several forms which require treatment and disposal
e. addressing historic and legacy waste issues
f. implement “gap analysis” findings for improving the regulatory framework
g. updating, revising and developing new regulatory documents to provide guidance to the licensee
h. implementation of Fukushima Action Plan

3.1(a) Finding an acceptable site for a spent nuclear fuel (SNF) repository

Momentum has been sustained for implementing the long-term management approach for spent fuel since the NWMO received its 2007 mandate to implement the APM approach approved by the Government of Canada. Between 2011 and 2014, significant progress was made on the site selection process (initiated in 2010) as the NWMO worked with interested communities. The NWMO reached an important milestone on September 30, 2012, with its suspension of the “expressions of interest” phase for communities wishing to engage in the site selection process for a deep geological repository for Canada’s spent fuel. The NWMO reached a further milestone in 2012 with its initiation of Step 3, Phase 1 of the site selection process: desktop assessments with 20 requesting communities that had passed initial screenings. As of June 2014, 11 communities had completed the Step 3, Phase 1 process, out of which four communities were identified as having strong potential for proceeding with fieldwork. Currently, 14 communities are actively engaged in exploring interest in the project. For further information, see section K.4.
3.1(b) Developing long-term management options for radioactive waste

**Ontario Power Generation**

OPG’s plan for the long-term management of its L&ILW is a DGR 680 metres below the ground surface in argillaceous limestone at the Bruce nuclear site in the Municipality of Kincardine. The L&ILW DGR will be adjacent to OPG’s Western Waste Management Facility, where OPG centrally stores all its L&ILW from OPG-owned nuclear reactors. In 2011 OPG submitted to the CNSC its environmental impact statement, preliminary safety report and technical support reports for review. Subsequent to OPG’s submission and the appointment of a Joint Review Panel, a public review lasting 15 months and a public hearing with 25 hearing days was carried out. On June 3, 2014, the panel scheduled approximately two weeks of additional public hearing days in September 2014. It is expected that a decision on the environmental assessment will be made by the federal Minister of the Environment in 2015.

**Atomic Energy of Canada Limited**

The L&ILW at AECL sites is safely and securely stored according to the CNSC’s requirements. Current practice includes the use of above-ground concrete storage structures, commonly referred to as shielded modular above ground storage (SMAGS) structures, and below-ground structures such as bunkers and tile holes. The storage integrity is verified on an ongoing basis through appropriate monitoring of the containment and the surrounding environment. This L&ILW will be maintained in secure storage until permanent disposal facilities are available.

Several options are being considered for the long-term management of these radioactive wastes. The range of options includes surface, near-surface and deep geological facilities. The investigations are currently in the option-assessment stage. Feasibility studies are either planned or already underway to inform decision making on the types of waste management facilities required to safely manage these radioactive wastes over the long term. To date, these studies have included an assessment of the suitability of the Chalk River Laboratories (CRL) site to host a geological repository at a nominal depth of 500 to 700 metres in the bedrock, and conceptual and detailed designs for a very-low-level waste facility, also potentially at the CRL site.

Further, AECL completed a comprehensive review of its long-term decommissioning strategy in 2013. As a result of this review, AECL has included a near-surface LLW facility and a decommissioning landfill in its reference strategy for the CRL site. The feasibility of such facilities will now be studied.

**New Brunswick Power**

New Brunswick Power (NB Power) is currently investigating long-term management options for radioactive waste generated from the Point Lepreau Nuclear Generating Station.

In the meantime, a volume reduction strategy has been implemented whereby radioactive waste is sent to EnergySolutions’ Bear Creek Radioactive Waste Management Facility in Oak Ridge, Tennessee to be incinerated. The resulting ash and non-processable material, which is returned to NB Power, accounts for only approximately 6 percent of the storage volume previously occupied by the radioactive waste.

Further storage structures can also be built as needed in the future, as will be done for spent fuel canisters in 2014 and 2015.

**Uranium mines and mills**

Since 2011, applications to expand capacities of tailings management facilities (TMFs) have been made for all three milling sites in northern Saskatchewan.
Cameco is proposing to increase the tailings capacity at its Rabbit Lake operation. The expansion will involve the excavation of an additional pit to the north of the existing Rabbit Lake TMF. It is anticipated that the additional tailings capacity may extend the life of the Rabbit Lake operation to approximately 2028 or longer.

Cameco also proposes to increase the capacity of the Deilmann tailings management facility (DTMF), which is currently used to manage tailings generated at the Key Lake operation. The project will involve increasing the approved elevation of the tailings within the facility to about 505 metres above sea level. Extending the use of this facility is not expected to change the facility’s intended performance or require modification to supporting infrastructure over and above ongoing/planned activities conducted within the existing licensing framework. It is anticipated that the additional tailings capacity may extend the life of the Key Lake operation to approximately 2040 or longer.

AREVA has proposed to expand the existing McClean Lake TMF to provide the ability to store tailings above the currently approved elevation for consolidated tailings of 434 metres above sea level, through the construction of an embankment around the John Everett Bates (JEB) TMF perimeter and placement of a natural liner to contain the pond above the tailings during the operating period. It is anticipated that the additional tailings capacity may extend the life of the JEB TMF by 25 years.

3.1(c) Demonstrating the safety of old interim storage facilities to support relicensing

The following are examples of how Canada is demonstrating the safety of long-standing interim storage facilities to support relicensing activities.

Ontario Power Generation

The objective of OPG’s radioactive waste management program is to provide safe transport, handling, processing, and interim storage and monitoring of the spent fuel and L&ILW generated from OPG-owned reactors until alternative long-term radioactive waste management facilities are available. The OPG radioactive waste management facilities operate safely to protect the public, workers and the environment.

OPG’s radioactive waste storage facilities are designed to provide safe interim storage for both spent fuel and L&ILW. Storage facilities are designed to withstand design-basis earthquakes, to prevent water ingress, to be as watertight as practical for in-ground storage, to allow waste to be retrievable, to meet OPG radiation protection requirements and dose limits specified by the CNSC, and to lay out the radioactive waste in a manner that assists in the separation of radioactive materials from personnel for safe, efficient operation.

An aging management program has been implemented to quantify the factors affecting the aging of the facilities. Aging management plans have been developed for the critical, safety-credited structures, systems and components (SSCs) for the transportation of radioactive material, the storage of L&ILW and the storage of dry spent fuel. Ongoing inspection and maintenance ensures that the storage facilities maintain integrity throughout their design life. Aging management is especially important for the older storage components, such as quadricells and trenches. Aging management activities are in place to ensure the safety functions of the quadricells are maintained. Detailed inspections of the quadricell structures and routine monitoring of the interspace between the two concrete barriers are performed. Aging management activities for trenches include inspection of the exterior surfaces, periodic sealant re-caulking between the walls of the trenches and the surface asphalt, and sampling for water intrusion so the water can be removed, sampled for radioactivity and disposed of properly. Internal inspection of a sample of the trenches has been performed, and future internal inspections are planned. Overall, OPG’s radioactive waste storage components are in good to very good condition. All safety-credited components are continuously assessed and confirmed to be operating safely within their designed life.

Over OPG’s radioactive waste facility operating lifetimes, environmental targets have been met; radiation exposures to workers and the public have been far below regulatory limits and OPG control levels. OPG
has met its obligations arising from the Canada/International Atomic Energy Agency (IAEA) nuclear safeguards agreement, and the transport of nuclear substances and radiation devices has not resulted in a serious injury or radioactive release in the 40-year history of OPG and its predecessor company.

At OPG’s Western Waste Management Facility, the Waste Volume Reduction Building provides for the management of LLW, such as radioactive waste receiving and handling, compaction and incineration prior to storage. An incinerator and a box compactor are housed in the Waste Volume Reduction Building and are used to reduce volume for the LLW. OPG continues to implement waste minimization initiatives to reduce the environmental footprint for L&ILW from OPG’s nuclear generating stations.

Atomic Energy of Canada Limited

The Canadian nuclear industry and the Government of Canada are developing long-term radioactive waste management solutions that will protect health, safety, security and the environment. Currently, AECL stores the radioactive waste at various storage facilities in a safe manner. Legacy L&ILW is stored in historic facilities such as sand trenches. The operating facilities used for interim storage of radioactive waste include in-ground structures (tile holes and bunkers) for intermediate-level radioactive waste (ILW), and above-ground facilities for LLW. An above-ground, dry storage facility to store selected spent legacy research fuel, located in the Fuel Packaging and Storage (FPS) facility at CRL, is currently being commissioned. The storage structure will be engineered to last at least 50 years and will provide safe interim storage for the packaged fuel until a long-term management facility is available. All these facilities undergo regular maintenance and assessments to ensure interim storage of the radioactive waste in a safe manner.

AECL is seeking to repatriate much of the irradiated highly enriched uranium (HEU) spent fuel from its research reactors and the target residual material from medical isotope production to the United States through agreements with the United States Department of Energy and as part of the Global Threat Reduction Initiative, a broad international effort to consolidate HEU inventories in fewer locations around the world.

In 2012, AECL expedited the Tank 40D leak avoidance project to reduce the environmental risk of a leak in an aging storage structure. To date, AECL has removed 75 percent of the contents and processed it in the Waste Treatment Centre (WTC). Refer to section K.6.2.3 for more information.

New Brunswick Power

The storage structures and packaging used in the Solid Radioactive Waste Management Facility (SRWMF) are designed to provide at least two physical barriers to prevent the release of radioactive material to the environment.

These structures, which include vaults, quadricells, filter storage structures, retube canisters and spent fuel canisters, were built to achieve the attenuation of gamma radiation required to limit the maximum external contact dose rate to 25 µSv/h.

Radioactive waste destined for the SRWMF is packaged in containers to provide a second radiation barrier for storage purposes and to limit exposure of plant personnel while handling the material.

Storage methods and handling operations are done in accordance with the as low as reasonably achievable (ALARA) principle.

Canadian Nuclear Safety Commission

In March 2014, the CNSC published REGDOC-2.6.3, Aging Management, a regulatory document that sets out and provides guidance to licensees on the CNSC’s requirements for managing the aging of SSCs in a nuclear facility. REGDOC-2.6.3 defines aging management as the set of engineering, operational,
Executive Summary

inspection and maintenance actions that control, within acceptable limits, the effects of physical aging and obsolescence of SSCs that occur over time or with use. An aging management program or plan is a set of policies, processes, procedures, arrangements and activities for managing the aging of nuclear facility SSCs. Effective aging management ensures that required safety functions are reliable and available throughout the facility’s service life in accordance with the licensing basis.

The CNSC also has a rigorous, risk-informed, compliance verification program in place, which includes routine inspections at all nuclear facilities to ensure the radioactive waste management structures remain fit for duty. For more information, see section E.6.3.

3.1(d) Addressing a wide variety of legacy wastes in several areas and in several forms which require treatment and disposal

As described in section K.6.2, the Government of Canada initiated the Nuclear Legacy Liabilities Program (NLLP) to deal with legacy radioactive waste and liabilities at AECL sites. Program progress and achievements during the last three years of implementation are summarized in sections K.6.2.1 to K.6.2.3.

The inventory of legacy waste at AECL sites includes high-level radioactive waste (spent fuel), L&ILW, and liquid radioactive waste. The spent fuel will be safely stored at the AECL sites until a national deep geological repository becomes available. The process for the long-term management of Canada’s spent fuel is currently undertaken by the NWMO. The largest component of the legacy waste is L&ILW, which contains a wide variety of materials including spent ion-exchange resin, typical laboratory waste such as rubber, plastic and cellulose materials, and soil, concrete and rubble. This radioactive waste type is stored in various engineered storage facilities at the AECL sites until long-term management facilities become available. Legacy liquid radioactive waste is stored in monitored storage tanks, and a project to retrieve and cement the liquid radioactive waste has been initiated (as described in K.6.2.3).

A number of studies are currently underway to better define the waste processing and long-term management facilities required to deal with the wide variety of legacy radioactive waste types at AECL sites. This will help to define, for example, the volume reduction and waste immobilization technologies to be used, the extent to which buried waste can be managed in place over the long term, and the available options for the long-term management of the radioactive waste that needs to be recovered.

3.1(e) Addressing historic and legacy waste issues

Historic low-level radioactive waste (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 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 cleanup and management of historic LLW in Canada. Natural Resources Canada (NRCan) provides policy direction and funding to the LLRWMO to carry out its work. The LLRWMO has completed historic low-level radioactive waste cleanup 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.

AECL is currently commissioning a new above-ground dry storage facility to store selected spent legacy research fuel. The new dry storage system is located in a Fuel Packaging and Storage (FPS) facility. Spent legacy research fuel recovery operations will commence once the facility has been fully commissioned and regulatory approval has been received.

Over a 60-year period, liquid radioactive waste accumulated from various projects at AECL. At the time of the last report, the liquid radioactive wastes had been stored in 21 monitored storage tanks at AECL’s CRL site. Since that time, the liquid radioactive waste contained in seven of those tanks has been removed and managed through the CRL WTC. The contents of 13 of the 14 remaining tanks, together with the sludge residue from the seven emptied tanks, are to be retrieved and cemented by the Stored Liquid Waste Cementation (SLWC) Project using a field cementation system. Significant pre-project development work
has been undertaken. This includes engineering studies, development of waste product performance criteria, radiation dose evaluations and cement formulation and testing. SLWC project design activities are beginning in 2014.

The Tank 40D leak avoidance project deals with a single-walled, direct-buried tank from the 1950s. Tank 40D contained concentrated ion exchange regenerant waste; a leak of this waste to the ground would have a detrimental effect on the environment and would require expensive remediation. AECL took the opportunity to be proactive and reduce this risk using existing equipment, facilities and experienced resources years ahead of when risk would be reduced by the SLWC Project. To date, AECL has removed 75 percent of the contents (i.e., about 30 cubic metres of the liquid waste) and processed it in the WTC. In addition, not all the tanks (among the 20 tanks) are full, as some contain a heel of liquid and sludge. The SLWC objective is to retrieve and cement the inventory of the 20 tanks.

The final tank’s target residue material (TRM), held in the Fissile Solution Storage Tank (FISST), is to be repatriated to the United States, and a discrete project is underway to manage this inventory. See section K.6.2.3 for further information on AECL’s SLWC Project.

3.1(f) Implementing “gap analysis” findings for improving the regulatory framework

In response to one of the recommendations made by the IAEA’s Integrated Regulatory Review Service (IRRS), the CNSC conducted a gap analysis of the regulatory framework on radioactive waste management. This also included a five-year plan for new or updated regulations or regulatory guides, with the focus on spent fuel and radioactive waste. For more information, see section E.8.2.3.

The CNSC also initiated the introduction of the Administrative Monetary Penalties Regulations during the reporting period, which came into force in May 2013. For more information, refer to section E.3.2.

In addition, the CNSC contributes to and promotes the use of many of the CSA Group (formerly called Canadian Standards Association (CSA)) standards for the management of spent fuel and radioactive waste. In 2013, CSA standard N292.2, Interim Dry Storage of Irradiated Fuel, was revised and reissued; CNSC staff sat on the technical committee for this standard. A standard such as N292.2 is often referenced in licence conditions as a requirement with which the licensee must comply. As an interim measure, some gaps previously addressing improving the regulatory framework are bridged through national and international standards as the CNSC moves toward new regulations and guidance documents.

3.1(g) Updating, revising and developing new regulatory documents to provide guidance to the licensee

The CNSC is continually reviewing, updating and developing regulatory documents as the guidance and requirements for licensees are enhanced. Section E.6.2 provides a full list of the CNSC’s regulatory documents current to the reporting period.

In March 2012, the CNSC published regulatory document RD/GD-370, Management of Uranium Mine Waste Rock and Mill Tailings. This document provides guidance to the licensee for the sound management of mine waste rock and mill tailings during site preparation, construction, operation and decommissioning of new uranium mine or mill projects and/or of new waste management facilities at existing uranium mines and mills in Canada.

Additionally, the CNSC is currently working with the CSA Group committee on amendments to CSA standard N294-09, Decommissioning of Facilities Containing Nuclear Substances (2009), which is planned for release in 2014.
3.1(h) Implementation of Fukushima Action Plan

Canada responded effectively to the Fukushima nuclear accident and is applying the lessons learned to improve safety. The CNSC issued requests to the licensees to confirm the safety case for each facility and to address the lessons learned from Fukushima. After assessing the responses and examining its own regulatory framework, the CNSC developed an action plan with clear deliverables in the short, medium and long terms for both nuclear power plant licensees and the CNSC. The numerous activities to address the actions have included, but are not limited to:

- deterministic and probabilistic safety assessments
- revisions to regulatory documents
- enhancements to modelling and analysis tools
- installation of new equipment that enhances defence in depth
- upgrades to emergency plans
- proposals to amend regulations
- procurement of emergency mitigating equipment and backup power
- conduct of large-scale emergency exercises
- enhancements to near-boundary radiation monitoring

All the short-term actions have been completed and all remaining actions are scheduled for completion during the next reporting period. See sections E.3.2 and E.8.2.3 for more information.

The CNSC’s response to Fukushima was assessed by independent reviewers as being prompt, comprehensive and effective, and as taking into account the various lessons learned from the accident. In addition to the Fukushima review during the follow-up IRRS mission in 2011, the CNSC also established an external advisory committee of independent regulatory experts to assess its regulatory response to Fukushima. These reviews identified specific findings that complemented the draft CNSC Action Plan (in particular, related to emergency preparedness, communications, and human and organizational factors), as identified by the Commission during the public review phase of the draft report. CNSC staff incorporated activities to address these findings into its CNSC Integrated Action Plan, which covers not only nuclear power plants, but also other regulated nuclear facilities.

Overall, the actions taken by Canada will address the lessons learned from Fukushima and help prevent a similar accident or help mitigate its effects should it occur. For more information on Canada’s implementation of the Fukushima Action Plan, refer to the 2013 Canadian National Report for the Convention on Nuclear Safety, Sixth Report at nuclearsafety.gc.ca/eng/resources/publications

4.0 Conclusion

Spent fuel and radioactive waste in Canada are currently managed in interim storage facilities that are safe, secure and environmentally sound. Interim storage facilities are continually monitored by the licensees and regulator to ensure fitness for service. Canada recognizes that enhanced, long-term management approaches will be required for all its spent fuel and radioactive waste and is progressing towards solutions. This Fifth National Report identifies several key initiatives that demonstrate Canada’s commitment to identifying and implementing long-term management approaches that do not place an undue burden on future generations.