

CANADIAN NATIONAL REPORT

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

EIGHTH REPORT
AUGUST 2024



THE FOLLOWING ORGANIZATIONS
CONTRIBUTED TO THE REPORT:

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nwmo

ONTARIOPOWER
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Hydro
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Cameco

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A Sotera Health company

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Government of Canada (Canadian Nuclear Safety Commission, Atomic Energy of Canada Limited and Natural Resources Canada), the Nuclear Waste Management Organization, Ontario Power Generation Inc., Bruce Power, New Brunswick Power, Hydro-Québec, Cameco Corporation, Orano, Nordion (Canada) Inc., Best Theratronics, BWXT NEC and BWXT Medical.

Erratum denoting corrections to Canada's Eighth National Report for the Joint Convention

Following the final submission of Canada's Eighth National Report for the Joint Convention on August 16, 2024, CNSC staff identified corrections required. Details of these corrections are outlined below. It is important to note that these changes do not impact the report's conclusions, or Canada continuing to meet its obligations under the articles of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*.

For questions related to this report or the changes listed below, please [contact the CNSC](#).

1. Figure B.6, Organizations responsible for the long-term management of radioactive waste in Canada: This figure was updated to include used nuclear fuel in the list of NWMO responsibilities. The revised figure can be found on the CNSC's [Radioactive waste](#) web page.
2. Section K.5.2, Emergency Preparedness Review and Follow-Up Mission: The 2 bullets in this section were removed, as this information was not in the 2023 EPREV follow-up mission final report.

Preface

The *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (Joint Convention or Convention) is the only international legally-binding instrument that addresses the safety of spent fuel and radioactive waste management on a global scale.

The Joint Convention was adopted on September 5, 1997, at a diplomatic conference convened by the International Atomic Energy Agency (IAEA) in Vienna, Austria. The Convention was opened for signature on September 29, 1997, and entered into force on June 18, 2001. Canada was one of the first countries to ratify the Joint Convention on May 7, 1998.

The Joint Convention is an incentive convention that seeks to promote a high level of safety in the management of spent fuel and radioactive waste through a peer review process, every three years.

The objectives of the Joint Convention are to:

- achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management
- ensure that there are effective defenses against potential hazards in the course of such activities
- prevent accidents with radiological consequences and mitigate these consequences should they occur at any stage of spent fuel or radioactive waste management

The Joint Convention applies to:

- spent fuel arising from the operation of civilian nuclear reactors
- radioactive waste arising from civilian applications
- uranium mining and milling wastes
- discharges from regulated activities
- specific provisions on disused sealed sources

The structure of the Convention (as outlined in the Articles of the Joint Convention INFCIRC/546, dated December 24, 1997) is as follows:

- Objectives, Definitions and Scope of Application (Articles 1 to 3)
- Specific Safety Provisions (Articles 4 to 17)
 - o Articles 4 to 10: Safety of Spent Fuel Management
 - o Articles 11 to 17: Safety of Radioactive Waste Management
- General Safety Provisions (Articles 18 to 26)
- Miscellaneous Provisions (Articles 27 and 28)
- Meetings of the Contracting Parties (Articles 29 to 37)
- Final Clauses and other Provisions (Articles 38 to 44)

The IAEA serves as the Secretariat for the Joint Convention. The responsibility of implementing the obligations of the Convention on behalf of the Government of Canada has been delegated to the Canadian Nuclear Safety Commission (CNSC).

This report is Canada's Eighth National Report for the Joint Convention. The review period for the report is from April 1, 2020, to March 31, 2024. The radioactive waste inventory is reported as of December 31, 2023. The following organizations contributed to the development of this report: the CNSC, Natural Resources Canada, Atomic Energy of Canada Limited, the Nuclear Waste Management Organization, Ontario Power Generation Inc., Bruce Power, New Brunswick Power, Hydro-Québec, Cameco Corporation, Orano, Nordion (Canada) Inc., BWXT Medical and BWXT Nuclear Energy Canada Inc. (BWXT NEC).

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Executive Summary

1.0 Introduction

Canada's Eighth National Report demonstrates how Canada continued to meet its obligations under the articles of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* during the reporting period, from April 1, 2020, to March 31, 2024. This report is a collaboration between the Canadian Nuclear Safety Commission (CNSC), other federal government departments, and industry. It focuses specifically on the progress of long-term management initiatives for spent fuel and radioactive wastes in Canada, revisions and updates to Canada's Seventh National Report, as well as comments and issues outstanding from the Sixth Review Meeting and those raised at the Seventh Review Meeting, which took place in July 2022.

2.0 2019 Integrated Regulatory Review Service mission to Canada

In September 2019, the CNSC hosted an International Atomic Energy Agency (IAEA) Integrated Regulatory Review Service (IRRS) mission to Canada. The scope of the 2019 mission included all activities and facilities licensed by the CNSC, including the regulation of waste management activities. The 2019 IRRS mission confirmed that the CNSC has a strong regulatory framework and continues to ensure the safe operation of nuclear facilities in Canada.

The CNSC developed an action plan to address the findings of the 2019 IRRS mission. On February 18, 2020, the CNSC publicly shared Canada's response to each recommendation, suggestion and good practice. These actions show Canada's commitment to addressing the findings of the mission. A follow-up IRRS mission took place from June 3 to 10, 2024. During this follow-up mission, the international experts assessed Canada's implementation of the recommendation and suggestion on waste management. For further information, refer to section K.5.1.

One of the 4 recommendations was that Canada enhance its existing radioactive waste policy and establish an associated strategy to give effect to the principles stated in the Canadian Radioactive Waste Policy. This was also highlighted as a suggestion to Canada during the Seventh Review Meeting of the Joint Convention. Refer to section B.1.2 for information on the Government of Canada's modernized [Policy for Radioactive Waste Management and Decommissioning](#), released in March 2023, that has addressed this recommendation.

3.0 Canada's key highlights and current priorities

The Seventh Review Meeting did not identify any new challenges, Canada continued to make progress on the challenges from the Sixth Review Meeting. Canada proposed that these challenges remain open and be reported on at the Eighth Review Meeting. Since the Seventh Review Meeting, Canada has prioritized making progress on these challenges as highlighted below:

1) Decommissioning and remediation of Atomic Energy of Canada Limited sites

Canadian Nuclear Laboratories (CNL), under contract with Atomic Energy of Canada Limited (AECL), continues to accelerate decommissioning and remediation activities at AECL sites since the Seventh Review Meeting including:

- environmental assessment and licensing regulatory processes continued for the *in situ* decommissioning of the Nuclear Power Demonstration (NPD) reactor at Rolphton and *in situ* decommissioning of Whiteshell Reactor-1 (WR-1) reactor at Whiteshell Laboratories (WL)
- planning and preparation for additional interim storage for low-level waste (LLW) at Chalk River Laboratories (CRL) while awaiting construction and future licensing authorization to start operations of the near surface disposal facility (NSDF)

- ongoing evaluation of intermediate-level waste (ILW) storage requirements, including near- to medium-term capacity needs; CNL has completed the design of a new storage array for remote handled ILW and is making preparations to begin construction
- expansion of storage capacity at CRL for dry storage canisters containing spent fuel in order to accommodate the consolidation of CNL spent fuel at CRL until the Nuclear Waste Management Organization (NWMO) Adaptive Phased Management (APM) facility becomes available
- confirmation that 4 of the legacy tanks containing stored liquid wastes were empty and the handing over of building B207 for decommissioning
- progress with the Port Hope Area initiative (PHAI) cleanup, including:
 - construction of the final cell of the Port Hope waste management facility (WMF) was completed in 2021
 - continued progress on cleanup activities within the municipality of Port Hope
 - continued remediation at Port Granby including closing and capping the Port Granby engineered containment mound (ECM)

For more information on the decommissioning and remediation of AECL sites, refer to section K.2.1.

For more information on the acceleration of the three projects undergoing environmental assessment (NSDF, and the *in situ* decommissioning of NPD and WR-1), refer to section K.2.1.3.

For more information regarding the progress of decommissioning and environmental remediation at CRL, refer to annex 8.1.

For information on the progress of decommissioning at WL, refer to annex 8.8. To learn more about the PHAI, refer to section K.2.1.5, as well as annexes 7.2 and 7.2.1.

2) Long-term management of spent fuel and siting identification of an acceptable site in a willing host community for a spent fuel repository

There has been sustained momentum for implementing the long-term management approach for spent fuel in Canada ever since the NWMO received its 2007 mandate to implement the APM approach approved by the Government of Canada. The process for selecting a site for the APM deep geological repository (DGR) remains ongoing. As of March 2024, two candidate communities remain in the site selection process. Studies and community consultation continue in these areas. First Nation and Métis communities are also involved, as facilitated through a learning agreement with the NWMO. A site selection decision is expected in 2024, following which the APM DGR approach will transition to the process of detailed site characterization and regulatory decision making. For more information, refer to section K.2.2.

3) Canada's Integrated Strategy for Radioactive Waste

Canada's Integrated Strategy for Radioactive Waste (ISRW) was informed by more than two years of engagement with Canadians, Indigenous peoples and waste generators and owners, and was supported by detailed studies of both technical considerations and international best practices. The ISRW lays out two fundamental recommendations; 1) ILW and non-fuel –high-level waste will be disposed of in a deep geological repository with implementation by the NWMO, and 2) LLW will be disposed of in multiple near surface disposal facilities with implementation by waste generators. For more information, refer to section K.2.3.

4.0 Overarching issues from the Seventh Review Meeting

During the Seventh Review Meeting, overarching issues that arose from cumulative discussions within the country groups were identified. The Contracting Parties agreed that the following issues would be covered in the National Report, along with the measures taken to address these issues:

- competence and staffing linked to timetable for spent fuel management and radioactive waste management programmes (K.3.1)
- ageing management of packages and facilities for radioactive waste and spent fuel, considering extended storage periods (K.3.2)
- long-term management and disposal of disused sealed radioactive sources including sustainable options for regional and multinational solutions (K.3.3)
- inclusive public engagement on radioactive waste management and on spent fuel management programmes (K.3.4)

For details on each item, see section K.3.

5.0 Nuclear facilities undergoing decommissioning in Canada

The following nuclear facilities and sites are currently in the process of being decommissioned in Canada:

- Chalk River Laboratories
- Douglas Point Waste Management Facility
- Gently-1 Waste Management Facility
- Gently-2 Nuclear Generating Station (NGS)
- Gunnar mine site
- Nuclear Power Demonstration
- Whiteshell Laboratories

The Saskatchewan Research Council (SRC) Safe Low-Power Critical Experiment 2 (SLOWPOKE-2) in Saskatoon, Saskatchewan, was safely decommissioned in 2020, and the site was released for unrestricted use in 2021.

The status of decommissioning activities at these facilities can be found in section D.1.5 and annex 8.

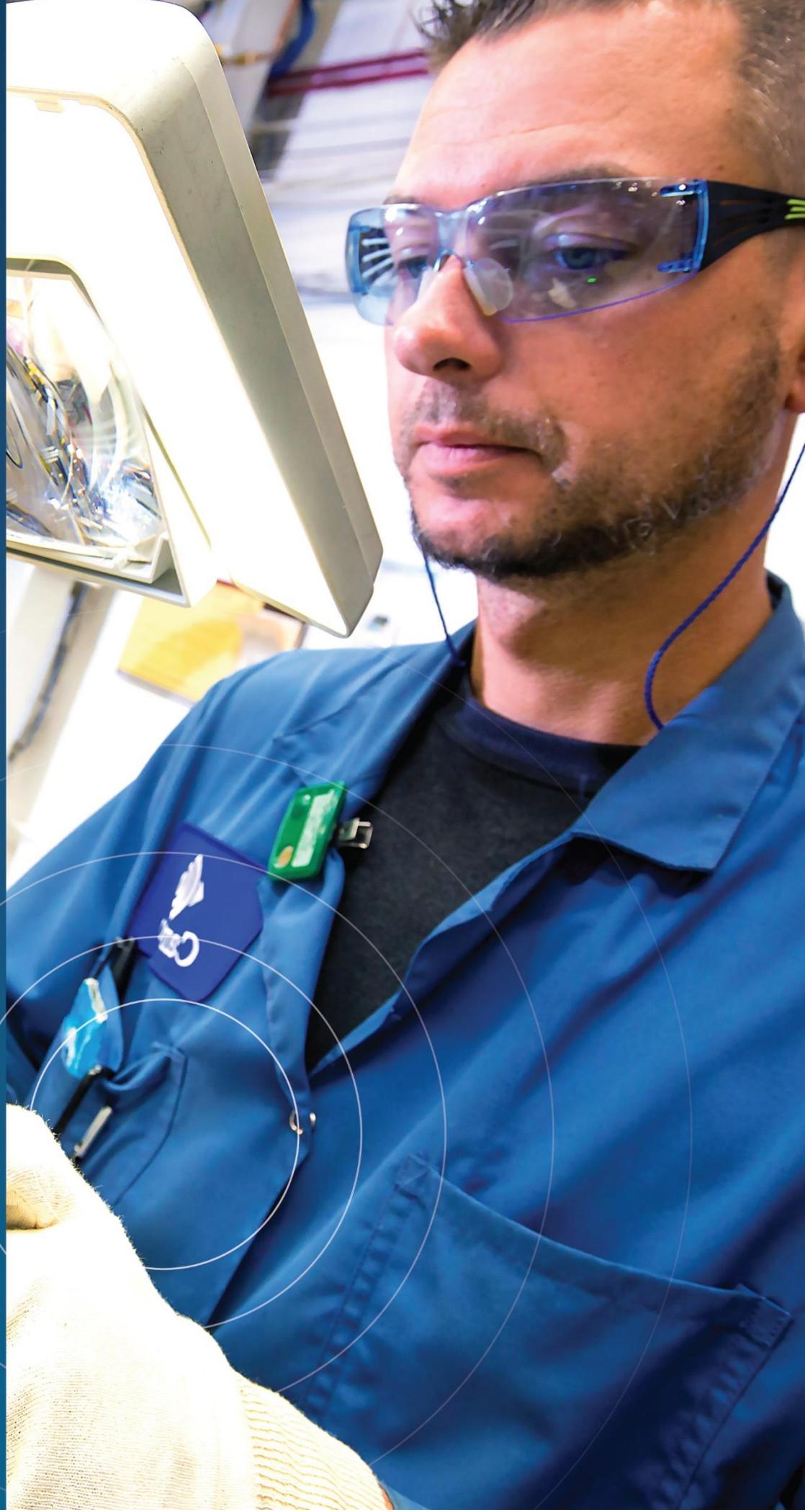
After achieving the objectives for decommissioning, Orano began the process to transfer to Cluff Lake to the province of Saskatchewan's Institutional Control Program (ICP). In 2023, after a public hearing, the CNSC revoked the licence, allowing the project to enter the final stages of transitioning into the province of Saskatchewan's ICP. This transfer is expected to be completed in 2024.

6.0 Conclusion

In Canada, spent fuel and radioactive wastes are currently managed in interim storage facilities that are safe, secure and environmentally sound. Interim storage facilities are continually monitored by the licensees with regulatory oversight by the CNSC to ensure continued fitness for service. Canada recognizes that enhanced, long-term management approaches will be required for its spent fuel and radioactive wastes, and it is making on progress on implementing solutions.

Canada's Eighth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management describes 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.

SECTION A
Introduction



Section A – Introduction

A.1 Background

The Government of Canada has jurisdiction over nuclear energy, and Natural Resources Canada (NRCan) is the department responsible for federal 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 supplies over 15 percent of Canada's electricity.
- the nuclear industry is a significant contributor to the Canadian economy, currently generating \$13 billion in economic activity and accounting for more than 70,000 highly-skilled direct and indirect jobs.
- Canada is the world's second largest producer and exporter of uranium, with production equivalent to \$ 1.1 billion in 2022.

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
- uranium refining and conversion
- nuclear fuel fabrication
- nuclear reactor operations
- nuclear research
- radioisotope manufacturing and use
- radioactive waste and decommissioning

The Government of Canada makes it a high priority to ensure the safety of persons and the protection of the environment from the various operations of the nuclear industry, and it 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 CNSC. In addition to NRCan and the CNSC, the Government of Canada organizations involved in the Canadian nuclear industry include:

- Atomic Energy of Canada Limited (AECL)
- Environment and Climate Change Canada (ECCC)
- Global Affairs Canada (GAC)
- Health Canada (HC)
- Impact Assessment Agency of Canada (IAAC)
- Transport Canada (TC)

Section E.2.7 of this report provides information on Canada's federal structure and detailed descriptions of the federal institutions involved in nuclear energy.

The following are the centrepieces of Canada's legislative and regulatory framework for nuclear matters: the *Nuclear Safety and Control Act* (NSCA), the *Nuclear Energy Act* (NEA), the *Nuclear Fuel Waste Act* (NFWA) and the *Nuclear Liability and Compensation Act* (NLCA). 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 section E.2.1.

Provincial governments are responsible for deciding their energy mix, including the role of nuclear energy. Provincial ministries may play roles in nuclear activities and radioactive waste management; the details of those roles are determined by each province.

A.2 Regulation of nuclear substances

Under the NSCA, one objective of the CNSC is to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to protect the health and safety of persons, the environment and national security, and to comply with the measures of control and international obligations to which Canada has agreed. A nuclear substance, as defined in section 2 of the NSCA, means: deuterium, thorium, uranium or an element with an atomic number greater than 92; a derivative or compound of deuterium, thorium, uranium or an element with an atomic number greater than 92; a radioactive nuclide; a substance that is prescribed as being capable of releasing nuclear energy or as being required for the production or use of nuclear energy; a radioactive by-product of the development, production or use of nuclear energy; and a radioactive substance or radioactive thing that was used for the development or production, or in connection with the use, of nuclear energy.

Both radioactive wastes and spent fuel contain nuclear substances and are therefore regulated in the same manner as any other nuclear substance. Section B.1.2 describes the policy on managing spent fuel and radioactive waste.

A.3 Canadian regulatory philosophy and approach to safety

Canada actively promotes and regulates safety within the nuclear sector. Canada's approach is based on several factors, including:

- review of international standards (e.g., IAEA standards and guides) and continuous improvements to CNSC regulatory policies and standards
- consideration for the adoption of international recommendations, such as those regarding radiological dose limits to the public and workers, as outlined in the *Recommendations of the International Commission on Radiological Protection* (ICRP-103, 2007) issued by the International Commission on Radiological Protection (ICRP)
- consideration for provincial legislation in place for the protection of the environment. For example, limits for controlled releases of gaseous or liquid effluents or solid materials are adopted from complementary regulatory regimes (such as Ontario's Provincial Water Quality Objectives or *Metal Mining Effluent Regulations*) or derived from specific licence conditions (such as the derived release limits)
- consideration for the adoption of other standards established by organizations such as the Canadian Standards Association (CSA) Group

Canada's regulatory philosophy is based on the following:

- The primary responsibility for safety is retained by licensees throughout the lifetime of the facility and the duration of the activities. Licensees are directly responsible for managing regulated activities in a manner that protects health, safety, security and the environment, and that is consistent with Canada's domestic and international obligations on the peaceful use of nuclear energy.

- The CNSC is accountable to Parliament and to Canadians for assuring that these responsibilities are properly discharged.

The CNSC, therefore, ensures that the regulated parties are informed about requirements and provided with guidance on how to meet them, and then it verifies that all regulatory requirements are and continue to be met.

A.4 Audit of Canada's management of low and intermediate level radioactive waste

The Office of the Auditor General of Canada (OAG) serves Parliament by providing it with objective, fact-based information and expert advice on government programs and activities, gathered through audits. In 2021-2022, the OAG undertook an audit of the management of low- and intermediate-level radioactive waste in Canada. Low- and intermediate-level waste represents the majority of the volume of radioactive waste in Canada. Understanding how Canada manages radioactive waste and who manages it is important to minimize the burden of that on future generations. In particular the audit looked at performance in:

- managing radioactive waste inventories (Atomic Energy of Canada Limited)
- regulatory oversight of licensing and compliance programs (Canadian Nuclear Safety Commission)
- modernizing Canada's radioactive waste management policy (Natural Resources Canada)

[The OAG's report](#) concluded that "Overall, we found that Natural Resources Canada, the Canadian Nuclear Safety Commission, and Atomic Energy of Canada Limited did a good job of managing the low- and intermediate-level radioactive waste that makes up 99.5% of Canada's radioactive waste output." The report also found that our actions to manage waste "align with international standards that seek to protect the environment and the safety of current and future generations." This conclusion is consistent with the 2019 IRRS mission, which found the CNSC aligned with international standards in regulating waste.

A.4.1 Regulatory oversight of licensing and compliance programs (Canadian Nuclear Safety Commission)

The OAG audit resulted in a number of positive findings for the CNSC. The OAG found that CNSC staff applied a graded approach when verifying facilities that manage low- and intermediate-level radioactive waste and that the CNSC has established a regulatory framework for waste management that is aligned with international standards. The OAG also found that the CNSC had systematic and documented processes to develop risk-based plans for compliance verification activities.

The audit also highlighted 3 areas for improvement, which are reflected in the report recommendations. The OAG found that the CNSC should:

1. more consistently document the rationale behind its compliance planning decisions;
2. better integrate its compliance verification data and ensure effective controls for data entry;
3. have a more detailed implementation plan for its digital strategy that clearly articulates deliverables and associated timelines, and performance measures and targets to measure and track progress.

OAG audits are important undertakings in order to verify how we are fulfilling our mandate and serving the Canadian public. They also provide valuable feedback on how we can improve in these endeavours. Recommendations for improvements identified in the OAG's report are opportunities to learn and improve practices. In response to the audit, the CNSC is taking the following action on the recommendations:

- Updating existing relevant procedural documents to improve consistency in recording the rationale for decisions related to the planning of compliance verification activities

- Reviewing existing tools to identify areas for improvement, updating necessary documentation and assessing an integrated approach to capturing and managing the information to capture the compliance processes and improve them, where necessary
- Implementing a digital strategy (i.e. enhancing digital workspace capabilities for project management and workflow, modernizing digital regulatory capacity by replacing legacy applications with new information management systems and unifying the digital front door for an accessible CNSC to set the stage for external collaboration)

A.4.2 Managing radioactive waste inventories (Atomic Energy of Canada Limited)

The OAG audit found that, “The majority of Atomic Energy of Canada Limited’s inventory of radioactive waste consists of historic waste, most of which is contaminated soils dating back to the 1930s, and legacy waste, which is from past federal government operations. Atomic Energy of Canada has worked to better understand and address this waste through various initiatives, including the Port Hope Area Initiative.” The OAG also found that, “Atomic Energy of Canada was on track to fully characterize and remediate its historic radioactive waste, which is estimated to make up more than 86% of its total volume of radioactive waste” and that, “Atomic Energy of Canada Limited had publicly available plans to address all of its historic and legacy radioactive waste” as well as, “various activities underway to identify, manage, and prepare historic and legacy waste for storage or eventual disposal.”

The audit also highlighted two areas of improvement for Atomic Energy of Canada Limited (AECL), finding that it should:

- have effective controls in place to ensure its radioactive waste inventory database is accurate
- ensure that its public reporting clearly aligns its plans and activities with how it is addressing historic and legacy waste

In response to these recommendations, AECL oversaw CNL’s performance of extensive data verification for existing records of waste in storage as well as efforts to improve the quality controls over the data entry. AECL continues to oversee CNL’s performance of waste management activities, including the management of waste records. Starting in 2023, AECL began reporting radioactive waste inventories on its website, to communicate to the public the progress being made on addressing its radioactive waste inventory. AECL has committed to updating the radioactive waste inventory information on its website on an annual basis. AECL has also provided additional information on its website that explains to Canadians the linkage between the reported waste inventories and the progress being made on managing AECL’s radioactive waste.

A.4.3 Modernizing Canada’s Radioactive Waste Management Policy (Natural Resources Canada)

The OAG report did not direct any recommendation to Natural Resources Canada. However, it noted that Natural Resources Canada was modernizing the national radioactive waste management policy. Since the release of the report, in March 2023 the Minister of Energy and Natural Resources released the modernized [Policy for Radioactive Waste and Decommissioning \(the Policy\)](#) for Canada, which ensures the safe management of radioactive waste reflects the values and principles of Canadians and continues to align with international standards and best practices. The Policy is discussed in further detail in sections B.1.2 and K2.4.1 of this report.

A.5 Main safety issue

The main safety issue that this report addresses is the long-term management and disposal of spent fuel and radioactive wastes.

In Canada, developing and implementing the long-term waste management strategy for radioactive waste is the responsibility of the waste owner. Currently, interim storage of all waste forms is being conducted in a safe manner. The Canadian nuclear industry and the Government of Canada are developing long-term waste management solutions that will protect health, safety, security and the environment. Key initiatives

underway are described in section K of this report. Some of the most important challenges will be to bring these initiatives to fruition and to develop and implement appropriate long-term solutions that inspire and uphold the public's confidence.

The long-term management of radioactive waste from past practices has been a challenge for the federal and provincial governments as they develop and implement appropriate remedial strategies and long-term waste management solutions. Several initiatives have been completed or are underway to address these sites, as described in sections H.2.1 and K.2.1.

A.6 Main themes in Canada's Eighth National Report

The main themes in this report are as follows:

- The Government of Canada's departments and agencies and the nuclear industry have roles and responsibilities – confirmed in the Government of Canada's *Policy for Radioactive Waste Management and Decommissioning*, issued in 2023 – to ensure the safe management of spent fuel and radioactive wastes.
- The primary responsibility for safety rests with the licensees. All licensees take their responsibility for safety seriously and are able to raise adequate revenues to support safe operations.
- The Canadian safety philosophy and requirements, applied through the regulatory process, ensure that the risk to workers, the public and the environment that is associated with spent fuel management and radioactive waste management is kept as low as reasonably achievable (ALARA), with social and economic factors taken into consideration.
- The Canadian regulatory body has sufficient independence, authority and resources to ensure compliance with and enforcement of regulatory safety requirements that pertain to the management of spent fuel and radioactive wastes.
- The 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 wastes, and for the cleanup of wastes from past practices, like uranium mining and processing. Demonstrated through Canada's achievements in completing recommendations and suggestions from the sixth and seventh review meetings including the development of an integrated radioactive waste management strategy.

The following proposed good practices and good performance have been identified by Canada:

- From 2020-2023, with the support of other federal departments with responsibilities for radioactive waste, NRCan undertook an extensive engagement process to solicit the views and perspectives of Indigenous peoples and other interested Canadians on how they would like to see the radioactive waste policy modernized. In addition to the extensive engagement and outreach, specific to the waste policy, funding was provided to support engagement on the development of Canada's radioactive waste policy. The funding supported respectful, meaningful two-way dialogue and engagement throughout the policy review. It supported in-depth engagement with nine Indigenous groups, including written submissions to inform policy development and provide input on the draft Policy. For more information, see section K.3.4.2.
- The CNSC and the Federal Authority for Nuclear Regulation (FANR) established an International Internal Audit Collaboration Working Group (IIACWG) for nuclear regulatory bodies. This collaboration has allowed the two organizations to strengthen aspects of their respective mandates by sharing best practices and knowledge with regards to both internal audit functions and technical functions. The IIACWG has developed high-level guidance in the form of a methodology and audit program for Internal Audit Functions of nuclear regulatory bodies to audit the inspection process for nuclear power plants, radioactive waste management and storage facilities and regulated materials licensees (radioactive and nuclear material users). The IIACWG will be used to share best practices with the Internal Audit Functions of nuclear regulatory bodies. For more information see section K.4.1.

SECTION B
Policies and
practices



Section B – Policies and Practices

B.1 Reporting (Article 32(1))

This section addresses the obligations under Article 32(1) of the Joint Convention.

ARTICLE 32. REPORTING

- 1 In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:
- (i) spent fuel management policy;
 - (ii) spent fuel management practices;
 - (iii) radioactive waste management policy;
 - (iv) radioactive waste management practices;
 - (v) criteria used to define and categorize radioactive waste

B.1.1 Classification of radioactive waste in Canada

In 2021, as part of Canada's modernization of its waste regulatory framework, the CNSC published REGDOC 2.11.1, *Waste Management, Volume I: Management of Radioactive Waste*, which defines the four waste classes of radioactive waste that are used as the basis for waste classification in Canada. This regulatory document is complemented by the requirements and guidance in the CSA standard N292 series of standards.

Canada recognizes four main classes of radioactive waste:

- high-level radioactive waste (HLW)
- intermediate-level radioactive waste (ILW)
- low-level radioactive waste (LLW)
- uranium mine and mill tailings

Subclasses for LLW are also identified to provide better guidance on the appropriate waste management needs.

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

A definitive numerical boundary between the various categories of radioactive waste – primarily between LLW and ILW – cannot be provided, because activity limitations differ between individual radionuclides and radionuclide groups, and will be dependent on short- and long-term safety-management considerations.

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

B.1.1.1 High-level radioactive waste

High-level radioactive waste (HLW) is used or irradiated nuclear fuel that has been declared radioactive waste and/or waste that generates significant heat via radioactive decay. HLW typically has levels of activity concentration that range from 10^4 to 10^6 TBq/m³. HLW is associated with penetrating radiation, and thus shielding is required. HLW also contains significant quantities of long-lived radionuclides necessitating long-term isolation.

In Canada, “irradiated nuclear fuel” or “used nuclear fuel” are more accurate terms for spent fuel, as discharged fuel is considered a waste material even when it is not fully spent. Despite the name difference, in this report, the term “spent fuel” is used, and it is consistent with the terminology used in the Joint Convention.

Spent fuel is associated with penetrating radiation and contains significant quantities of long-lived radionuclides, necessitating long-term isolation. Waste forms derived from spent fuel (e.g., nuclear fuel reprocessing wastes) can also exhibit similar characteristics and would therefore be considered HLW.

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

B.1.1.2 Intermediate-level radioactive waste

Intermediate-level radioactive waste (ILW) generally contains long lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years. ILW needs no provision, or only limited provision, for heat dissipation during storage and disposal. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation.

B.1.1.3 Low-level radioactive waste

Low-level radioactive waste (LLW) contains material with radionuclide content above established unconditional clearance levels and exemption quantities set out in the *Nuclear Substances and Radiation Devices Regulations*, but generally has limited amounts of long-lived activity. For orientation purposes only, a limit of 400 Bq/g on average (and up to 4,000 Bq/g for individual waste packages) for long-lived alpha emitting radionuclides can be considered in the classification process. For long-lived beta and/or gamma emitting radionuclides, such as carbon-14, chlorine-36, nickel-63, zirconium-93, niobium-94, technetium-99 and iodine-129, the allowable average activity concentrations can be considerably higher (up to tens of kBq/g) and can be specific to the site and disposal facility. LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near-surface facilities.

There are two sub-classes of LLW, very-short-lived low-level radioactive waste (VSLLW) and very-low-level radioactive waste (VLLW).

B.1.1.3.1 Very-short-lived low-level radioactive waste

VSLLW is waste that can be stored for a decay period of not more than a few years (a time frame of two years is commonly used) and subsequently cleared for release. VSLLW includes radioactive waste containing only short half-life radionuclides typically used for research and biomedical purposes. Examples of such radioactive waste are iridium-192 and technetium-99m sources and radioactive wastes containing similar short half-life radionuclides from industrial and medical applications.

The main criterion used to identify VSLLW is the half-life of the predominant radionuclides. In general, the management of VSLLW should only be applied to radionuclides with a half-life of 100 days or less.

B.1.1.3.2 Very-low-level radioactive waste

VLLW has a low hazard potential and is above the criteria for unconditional clearance levels and exemption quantities. Long-term waste management facilities for VLLW do not need a high degree of containment and/or isolation; a near-surface repository with limited regulatory control is generally suitable. Typically, VLLW includes bulk material like low-activity soil and rubble, as well as some uranium wastes.

B.1.1.4 Uranium mine and mill tailings

Uranium mine and mill tailings are a specific type of radioactive waste generated during the mining and milling of uranium ore and the production of uranium concentrate. In addition to tailings, mining activities typically result in the production of large quantities of waste rock as workings are excavated to access the ore body. These wastes contain long-lived radionuclides that do not decrease significantly over extended time periods. In general, long-term management in near-surface facilities adjacent to mines and mills is the only practical option for these wastes, given the large volumes of waste generated in mining and milling operations.

B.1.2 Spent fuel and radioactive waste management policy

In Canada, matters that relate to nuclear activities and substances are under the jurisdiction of the Government of Canada. Natural Resources Canada (NRCan) has been charged with setting Canada's nuclear policies, including those that concern spent fuel and radioactive wastes.

In September 2019, the IAEA undertook an IRRS mission and concluded that Canada has a comprehensive framework for nuclear and radiation safety. The review included a recommendation that the government enhance the existing policy and establish an associated strategy to give effect to the principles stated in the Government of Canada's *Radioactive Waste Policy Framework*. As part of Canada's management response to the recommendation, the Government of Canada set out to review its existing policy for radioactive waste - *Radioactive Waste Policy Framework*. From 2020-2023, with the support of other federal departments with responsibilities for radioactive waste, NRCan undertook an extensive engagement process to solicit the views and perspectives of Indigenous peoples and other interested Canadians on how they would like to see the radioactive waste policy modernized.

The Government of Canada's modernized [*Policy for Radioactive Waste Management and Decommissioning*](#), (the Policy) released in March 2023, clarifies the roles and responsibilities of the Government of Canada, and of the waste generators and owners, and replaces the former policy framework. The Policy, which sets out that waste owners are responsible for funding and managing their nuclear wastes, and that the federal government is responsible for waste policy, regulation and oversight, focuses on four key priorities:

- protection of health, safety, security of people and the environment, and ensuring nuclear non-proliferation
- inclusive engagement, openness, and transparency on radioactive waste management and decommissioning matters
- recognition of Canada's deep commitment to building partnerships and advancing reconciliation with Indigenous peoples related to the management of radioactive waste and decommissioning, based on the recognition of rights, respect, collaboration and partnership
- global excellence in the fields of radioactive waste management and decommissioning.

The Policy also requires waste generators and owners to plan, develop, implement and maintain an Integrated Strategy for Radioactive Waste (ISRW), in order to ensure long-term management plans are put in place for all of Canada's radioactive wastes. Waste owners must engage with Indigenous peoples, provinces, territories, interested communities, including current and prospective host communities, scientific experts and other interested persons in Canada, to ensure that they can contribute to the ISRW, in an open and transparent manner. Further details on ISRW are included in section K2.3.

Under Canada's current policy, legislative and regulatory framework, spent fuel is considered to be a form of radioactive waste. The *Nuclear Fuel Waste Act* applies specifically to Canada's long-term management of spent fuel, while other legislation and policies on managing radioactive waste apply equally to spent fuel and other forms of radioactive waste.

In March 2021, version 2 of the CNSC's REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*, which gives an overview of the governance and regulatory framework for radioactive waste management and decommissioning in Canada. This overview provides the basis for the other documents in the CNSC's waste management series of regulatory documents. REGDOC2.11 outlines the philosophy that governs the CNSC's regulation of radioactive waste. The document indicates that, when making regulatory decisions about 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, as follows:

- generation of radioactive waste is minimized to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices
- management of radioactive waste is commensurate with its radiological, chemical and biological hazard to the health and safety of persons, to the environment and to national security
- assessment of future impacts of radioactive waste on the health and safety of persons and the environment encompasses the period of time during which the maximum impact is predicted to occur
- 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
- 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
- transborder 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 principles contained in REGDOC-2.11 are consistent with those contained in the IAEA safety standards. REGDOC-2.11 also recognizes the CNSC's commitment to optimizing regulatory effort, stating that the CNSC should 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
- achieve conformity with the measures of control and international obligations to which Canada has agreed concerning radioactive waste

B.1.3 Spent fuel management practices

B.1.3.1 Spent fuel in Canada

B.1.3.1.1 Spent fuel generated at nuclear power reactors

In Canada, spent fuel is stored in wet and dry states. 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 a dry storage facility. These dry storage facilities employ large, reinforced concrete canisters or containers. Each nuclear power plant (NPP) site in

Canada has enough space to store all the spent fuel produced during the licensed operating life of the station. A 600-megawatt CANDU nuclear reactor produces approximately 90 tonnes of heavy metal spent fuel annually.

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

- small quantities of spent fuel that are transported to research facilities for experimentation or examination purposes and stored at those facilities
- fuel from the Nuclear Power Demonstration (NPD) which is in dry storage at the nearby CRL site

All Canadian nuclear power reactors were constructed with on-site spent fuel storage bays or water pools. Spent CANDU fuel is initially stored in light water with continuous heat removal capability. Criticality cannot be achieved with CANDU fuel in light water, independent of temperature. Spent fuel is then stored in dry storage facilities after a specified period of decay. Secondary or auxiliary bays were constructed at the Pickering A (Units 1 to 4) Nuclear Generating Station (NGS) and the Bruce A and Bruce B NGSs for additional storage. Since 1990, dry storage technology has been chosen at all the reactor sites for additional on-site interim storage.

All CANDU fuel bundles are fabricated from natural uranium oxide pellets contained in a zirconium-alloy (zircaloy-4) tube (cladding). Variations occur in the overall length, diameter and weight of the fuel bundles between reactors. The information that follows is based on averaged data. Normally, there are 30 uranium oxide pellets per fuel bundle 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 uranium oxide. Approximately 19.2 kg can be attributed to uranium (without the oxygen component).

Each year, 4,500 to 6,000 fuel bundles per reactor are added to the wet storage bays, based on 80% to 95% full power reactor operation.

B.1.3.1.2 Spent fuel generated at research reactors

As of March 2024, there were four operating research reactors in Canada:

- Royal Military College of Canada (RMC) (SLOWPOKE-2, 20 KW, Kingston, Ontario)
- École Polytechnique de Montréal (SLOWPOKE-2, 20 KW, Montréal, Québec)
- McMaster Nuclear Reactor (pool-type, 5 MW, Hamilton, Ontario)
- Zero Energy Deuterium-2 (ZED-2) (pool-type, 200 W, Chalk River, Ontario)

These reactors use low-enriched uranium (LEU) fuel.

The University of Alberta's SLOWPOKE-2 reactor in Edmonton, Alberta, was decommissioned in 2017, and the site was released for unrestricted use in 2018. The Saskatchewan Research Council's (SRC) SLOWPOKE-2 reactor in Saskatoon, Saskatchewan, was decommissioned in 2020, and the site was released for unrestricted use in 2021. These two reactors were using highly enriched uranium (HEU) fuel, and the fuel cores were returned to the U.S., the fuel's country of origin.

The ZED-2 reactor is operated occasionally and is mainly used for testing prototype fuel to determine fuel characteristics. ZED-2 uses mostly natural uranium, but it can use various fuel types, depending on the purpose. Spent fuel from ZED-2 is stored on-site at Chalk River Laboratories (CRL).

All SLOWPOKE-2 cores are pre-assembled and cannot be modified by the licensee. The cores can last 30 years (or more depending on usage) with the addition of beryllium reflector shims to compensate for reactivity decreases in fuel. When the added shims can no longer compensate for the decreased reactivity, the entire core can be replaced. Although the SLOWPOKE-2 reactors initially used HEU fuel, they were subsequently

converted to LEU or decommissioned, and the spent HEU cores were returned to the U.S., the fuel's country of origin. The LEU cores, once spent, are sent to CRL for storage.

Spent fuel from the McMaster Nuclear Reactor is stored in the reactor pool. Prior to 2020, spent fuel was shipped to a licensed spent fuel management facility in the U.S. McMaster is engaged with the NWMO in seeking alternate long-term spent fuel storage or disposal options.

In 2010, a project was undertaken to repatriate all inventories of spent HEU fuel from Canada to the U.S. As of 2019, all HEU from the SLOWPOKE research reactors had been returned to the U.S.

B.1.3.2 Wet storage technology

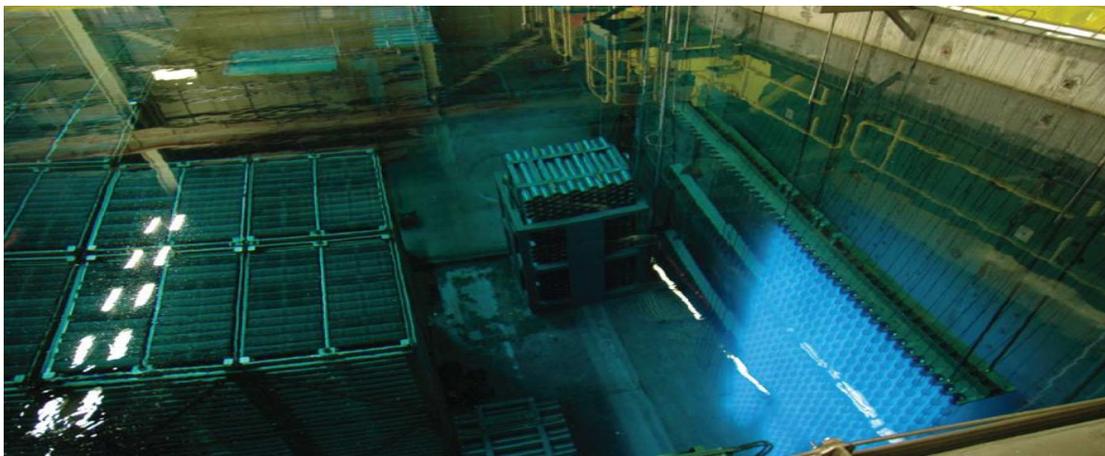
Spent fuel discharged from a nuclear reactor is stored initially in wet bays or water pools (see figure B.1). Wet bays, together with the cooling and purification systems, contain the spent fuel and associated radioactivity and provide good heat transfer to control fuel temperatures. The water also provides 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 purpose of the wet storage bays and their cooling and purification systems is to:

- provide safe temporary storage and handling of irradiated fuel, including defective bundles
- remove heat ejected by irradiated fuel bundles at a rate sufficient to keep water temperature within the design limits of the bay walls and floor
- reduce radioactivity in the bay to acceptable levels
- keep bay water in a demineralized state to minimize the corrosion of metal surfaces
- automatically control water levels

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

Figure B.1: Wet storage at the Bruce NGS



B.1.3.2.1 Bay liners

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

B.1.3.2.2 Storage in wet bays

A number of designs are used to hold spent fuel for storage in wet bays that are seismically qualified.

At the Ontario Power Generation (OPG) and Bruce Power (BP) facilities, baskets, trays and modules are stacked vertically in the bays within seismically qualified stacking frames. OPG and BP use a standardized site-specific, storage-transportation module that stores the fuel compactly. Fuel stored in baskets and trays is transferred to modules prior to being loaded into dry fuel storage containers. To reduce handling, the storage-transportation module is also suitable for holding the fuel during transportation. The modules are loaded directly into dry fuel storage containers and stacked, as shown in figure B.1.

New Brunswick (NB) Power transfers the spent fuel from the reactor to the spent fuel reception bay, where the fuel is stored in trays. From the reception bay, it is transferred to the spent fuel storage bay and remains in these trays for its seven-year wet storage period. From this location, the spent fuel is loaded into baskets and transferred to dry storage.

B.1.3.2.3 Water pool chemical control

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

- minimize corrosion of metal surfaces
- minimize the level of radioisotopes in the water and reduce radiation fields and radioiodine levels in the bay area
- maintain clarity of the bay water for ease of bay operation

Demineralized water is used to ensure purity. The chemistry lab collects and analyzes demineralized water samples regularly to ensure that any change in the water chemistry is addressed.

B.1.3.3 Experiences with wet storage

Early operating experiences at the CRL research reactor spent fuel bays (which began operation in 1947) and at the NPD and Douglas Point reactors have provided a basis for the successful operation of spent fuel bays in the current generation of power reactors. Those experiences, along with the development of high-density storage containers, inter-bay fuel transfers and remote handling mechanisms, contributed to establishing current safe-storage techniques. At CRL, the only wet storage still in operation are the NRU reactor rod bays.

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. 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, some radiation-induced deterioration of the liner has been detected at the Pickering NGS (where the first epoxy liner was used). Potential leaks in the Unit 1–4 primary bay were located and repaired before Pickering Units 1 and 4 were returned to service after an extended shutdown.

Extensive repairs were completed in 2002–03 at various locations in the Pickering 1–4 primary bay. Some repairs were conducted for the Pickering Unit 5–8 primary bay in 2016–17 and the Pickering Unit 1-4 auxiliary bay in 2023-24.

The Bruce A NGS also utilizes an epoxy polymer liner, which has experienced minor deterioration over time. A comprehensive inspection was completed in 2018 to assess the health of the liner. There were no leaks present and continued inspections are conducted frequently to ensure deterioration does not increase.

B.1.3.4 Dry storage technology

After a cooling period of 6 to 10 years in a wet bay (the exact cooling period is site-specific), spent fuel is then transferred to an interim dry storage facility.

Currently, three basic designs are used for the dry storage of spent fuel in Canada:

- Atomic Energy of Canada Limited (AECL) concrete canister
- AECL modular air-cooled storage (MACSTOR) system
- OPG dry storage container (DSC)

All transfers of spent fuel to dry storage are subject to IAEA surveillance. All loaded OPG DSCs in interim storage are also under the surveillance of the IAEA through the application of a dual sealing system.

B.1.3.4.1 AECL concrete canister

The AECL concrete canister fuel storage program was developed at Whiteshell Laboratories (WL) in the early 1970s to demonstrate that dry storage for spent 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 (WR-1) spent fuel. Further, the AECL concrete canister design is used at CRL for the dry storage of fuel bundles from the NPD reactor, the Point Lepreau NGS and the partially decommissioned Douglas Point (see figure B.2) and Gentilly-1 reactors.

The canister system comprises the following main components:

- fuel basket
- shielded workstation
- transfer flask
- concrete canister

The fuel basket is constructed of stainless steel and comes in three designs:

- a design to hold 54 bundles (used for fuel from Douglas Point and NPD)
- a design to hold 38 bundles, each of which is placed over a basket pin (used for fuel from Gentilly-1)
- a design to hold 60 bundles (used for fuel from Point Lepreau)

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 sub-assemblies 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 the workers.

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

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. Safeguards seals are applied as part of the canister plug so that the IAEA can maintain continuity of knowledge over the nuclear material.

There are two small-diameter pipes that allow the air between the liner and the fuel baskets to be monitored to confirm the integrity of the confinement barriers. The concrete canisters are supported on reinforced concrete foundations above the water table. Each canister holds six, eight, nine 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. 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 spent fuel.

Three barriers (defence in depth) ensure the containment of the radioactive products:

- fuel sheath
- fuel basket
- internal liner

Figure B.2: AECL concrete canisters at Douglas Point



B.1.3.4.2 AECL MACSTOR system

The MACSTOR system is a variant of the concrete canister storage technique. MACSTOR modules are currently installed and being operated at the Gentilly-2 NGS site in Quebec, the Cernavoda site in Romania, the Qinshan site in China and the Wolsong site in Korea.

The original MACSTOR design (MACSTOR-200) is a secure, reinforced concrete structure that houses 20 vertical steel cylinders, each of which holds 10 sealed baskets containing 60 spent fuel bundles. Each module can store 12,000 bundles of spent fuel. Each cylinder is secured to the top slab of the MACSTOR module, and two sampling pipes that extend to the outside of the module are provided at its base. These pipes allow for confirmation of the integrity of confinement. The MACSTOR-200 is used at the Gentilly-2 site (see figure B.3) and the Cernavoda site.

The newer design, MACSTOR-400, can store twice as much fuel with a marginal increase in construction costs when compared to the MACSTOR-200. The MACSTOR-400 houses 40 vertical steel cylinders, each of which can hold 10 sealed baskets containing 60 fuel bundles. In total, the module can store 24,000 bundles of spent fuel. The MACSTOR-400 is used at the Qinshan site and will be used at the Cernavoda site.

The heat of the spent fuel is dissipated primarily by natural convection through ventilation ports that extend through the concrete walls. 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 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 for the concrete canister. Both use the fuel basket, shielded workstation and transfer flask. The only essential difference between the two is the storage structure itself.

Figure B.3: MACSTOR-200 at Gentilly-2



B.1.3.4.3 OPG dry storage container

OPG currently operates three spent fuel dry storage facilities, located at the Darlington, Pickering and Western waste management facilities (WMFs). OPG dry storage facilities employ dry storage containers (DSCs) (see figures B.4 and B.5) for interim storage, on-site transfer and off-site transport of CANDU fuel. These containers are made of a lid and base. The base provides an inner cavity for fuel containment. Each one is designed to hold 384 fuel bundles stacked in modules and weighs approximately 60 tonnes when empty and 70 tonnes when loaded.

The containers are rectangular with walls of reinforced, high-density concrete sandwiched between interior and exterior shells made of carbon steel. The inner liner is an integral part of the containment boundary, while the outer liner is intended to enhance structural integrity and facilitate the decontamination of the surface of the DSCs. Helium is used as the inert cover gas in the DSCs cavity to protect the fuel bundles from potential oxidation reactions and to facilitate leak testing of the containment boundary. OPG dry storage facilities are located indoors. There are no anticipated radiological releases under normal operating conditions.

Figure B.4: OPG dry storage container

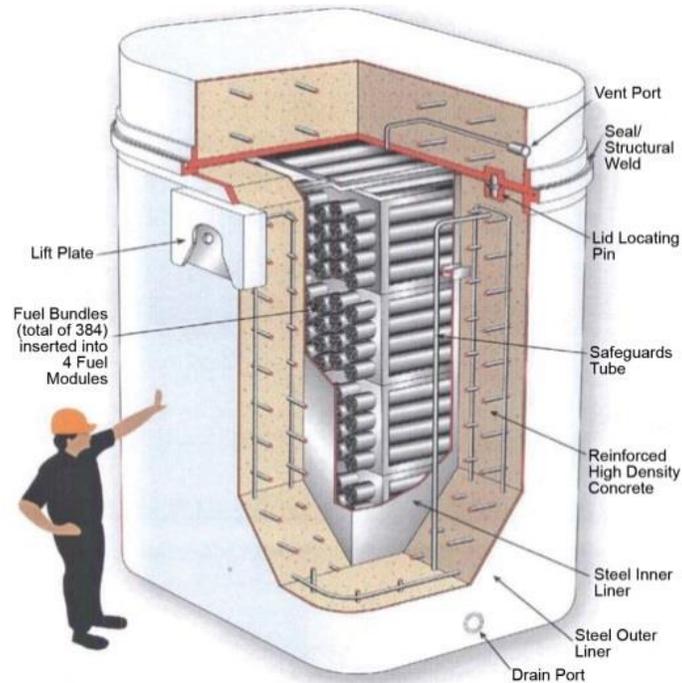


Figure B.5: Dry storage containers at an OPG WMF



B.1.3.5 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 have concluded that CANDU fuel bundles, whether intact or with defects, can be stored in DSCs for up to 100 years or more without losing integrity. Additional research is ongoing.

The experience gained at licensed dry storage facilities 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. DSCs have been used successfully and safely at the Pickering WMF since 1996. The safety performance of the facility has been excellent for the entire period. Both the dose rates and emissions from the processing and storage area have remained below regulatory limits. Analyses completed on DSCs stored at Pickering are assumed to be representative of DSCs stored at Darlington and Western WMFs due to the comparable storage conditions at each location.

The thermal and shielding analyses carried out for design and safety assessment purposes have been found to be conservative. Analyses and measurements carried out at the Pickering WMF indicate that the maximum fuel cladding temperature does not exceed 150 °C in dry storage. In addition, results of neutron dose rate calculations have demonstrated, as expected, that 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 DSCs.

To verify the results of the thermal analysis, an experimental thermal performance verification program was carried out in the summer of 1998. A DSC 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 DSCs containing 10-year cooled fuel. Temperatures were also measured at the interspaces between the DSCs, as were indoor and outdoor ambient temperatures. The results demonstrated the conservatism of the temperatures predicted analytically.

Similar assessments and measurements were performed on AECL MACSTORs and AECL concrete canisters to confirm and demonstrate the safe storage of spent fuel in these structures.

B.1.3.6 Spent fuel storage facilities

For a description of the spent fuel storage facilities in Canada, see annex 4.

B.1.3.7 Long-term management of spent fuel

Canada does not yet have a long-term WMF for spent fuel however, all spent fuel is currently held in interim wet or dry storage at the NGS where it was produced, with the exception of the spent fuel produced at the shutdown NPD facility, which is stored at CRL.

To address the long-term management of spent fuel, the three major waste owners – OPG, Hydro-Quebec (H-Q) and NB Power – established the Nuclear Waste Management Organization (NWMO) in 2002 in accordance with the *Nuclear Fuel Waste Act* (NFWA).

NWMO is responsible for implementing the Adaptive Phased Management (APM) approach that was selected by the Government of Canada for the long-term management of spent fuel (see sections G.7 and K.2. 2). OPG, NB Power, H-Q and AECL are responsible for the management of the spent fuel generated at their respective sites until the NWMO is ready to accept the spent fuel for management in a facility constructed using the APM approach. OPG is also responsible for the interim storage of the spent fuel generated at the Bruce NGSs.

B.1.4 Radioactive waste management practices

The radioactive content of wastes varies with the source; therefore, management techniques depend on the characteristics and volume of the waste.

Certain types of radioactive wastes (such as waste from hospitals, universities and industry) contain only small amounts of radioactive materials with short half-lives, meaning the radioactivity decays within hours or days. After holding the waste until the radioactivity has decayed to acceptable levels as authorized by the CNSC, the waste can be disposed of by conventional means (e.g., in local landfill or sewer systems).

Radioactive waste from hospitals and universities is generally shipped to CRL for management. In some cases, radioactive waste is shipped to waste treatment facilities in the U.S. with the volume-reduced residues returned for storage by the waste owner in Canada.

Canadian methods for the management of radioactive waste are similar to those of other countries. As disposal facilities are not yet available in Canada for all radioactive wastes, emphasis is placed primarily on minimization, volume reduction, conditioning and interim or long-term storage of the wastes. Some of the waste may be reduced in volume (for example, 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.

Methods have been instituted to recover storage space by cascading waste after sufficient radioactive decay or reclaiming existing storage space through further compaction (super compaction), segregation, or both. As is the case with all nuclear activities, the facilities for handling radioactive waste must be licensed by the CNSC and conform to all pertinent regulations and licence conditions. The waste management objective across the nuclear industry is the same: to control and limit the release of potentially harmful substances into the environment.

In keeping with the Government of Canada's *Policy for Radioactive Waste Management and Decommissioning*, Canada has taken different approaches for managing HLW, ILW, LLW and uranium mine and mill tailings, commensurate with their risks in both the short and long term. 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 wastes. Long-term strategies and solutions for historic LLW are being implemented for the various regions of the country.

For a description of the radioactive WMFs in Canada, see annex 5.

B.1.4.1 Non-fuel high-level radioactive waste

The irradiated fuel bays at the Bruce B NGS store cobalt-60 produced from the harvesting of cobalt adjuster rods at the Bruce B NGS. The cobalt-60 initially produced is sold to Nordion (Canada) Inc. (Nordion) under an agreement between the two parties, where it is processed and converted into high-strength industrial and medical radiation sources. That agreement provides Nordion with an allowance to send the Cobalt-60 back to the Bruce B NGS to the amount that was originally supplied. A separate agreement between OPG and BP obligates OPG Western Waste Management Facility to take title of the spent cobalt that has been received into the Bruce B NGS irradiated fuel bay from Nordion.

B.1.4.2 Low- and intermediate-level radioactive waste

As the majority waste owners, AECL and OPG (which own 20 of Canada's 22 CANDU reactors) are responsible for the majority of the annual accumulated volume of low- and intermediate-level radioactive wastes (L&ILW), shown in Table D.6, section D.1.4. These volumes represent the waste generated from research and development activities at CRL (including from decommissioning and environmental remediation) and nuclear power production in Ontario respectively. Included in AECL's accumulation rate is L&ILW for long-term management from a number of small producers and users of radioactive materials (e.g., hospitals and universities). The other two CANDU reactors (owned by NB Power and H-Q) and Cameco's uranium processing and conversion facilities in Ontario generate the majority of the remaining waste. In general, the owners of L&ILW are licensed by the CNSC to manage and operate interim storage facilities for their radioactive wastes.

The majority of L&ILW from OPG owned CANDU reactors (including Bruce A and B) is safely stored in a central location at the Western WMF at the Bruce nuclear site in Kincardine, Ontario. Some ILW from unit refurbishments is stored at the Darlington and Pickering reactor sites within their respective WMFs. NB Power and H-Q have their own facilities for the interim storage of L&ILW at their reactor sites.

As described in section K.2.1, activities dealing with legacy radioactive waste and decommissioning liabilities at AECL sites are being advanced by CNL under a government-owned contractor-operated (GoCo) arrangement. For waste from research and development, AECL/CNL have waste storage facilities at two sites – CRL and WL – as well as at its three prototype reactor sites. As decommissioning progresses, L&ILW are to be consolidated at CRL for storage. Operational storage facilities include a bulk materials landfill for de-watered sewage sludge, shielded modular above-ground storage structures, concrete bunkers and tile holes. Additional capacity for LLW storage has been created at CRL while waiting for the NSDF to become operational for the disposal of LLW. This additional capacity is in the form of hard-standing structures to accept LLW packaged in approved sea containers. On behalf of AECL, CNL also accepts L&ILW from small generators, like those in hospitals, universities and small industries, on a fee-for-service basis.

In addition to existing interim storage facilities at CRL, a key enabling component is the proposed construction of the NSDF with a total planned disposal capacity of 1 million m³, scheduled to be available by 2030 for the disposal of LLW. Progress and achievements over the last three years are summarized in section K.2.1.2.

Radioactive waste from hospital nuclear medicine departments and from universities and similar facilities contains only small amounts of radioactive materials with short half-lives. The radioactivity of this waste normally decays within hours, days or months. Institutions like 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 LLW from past practices (referred to as historic waste) that was once managed in a manner no longer considered acceptable, but for which the current owner cannot be reasonably held responsible. Canada's historic waste inventory consists largely of refinery process residues in the area of Port Hope, Ontario. The Government of Canada has accepted responsibility for the long-term management of these wastes.

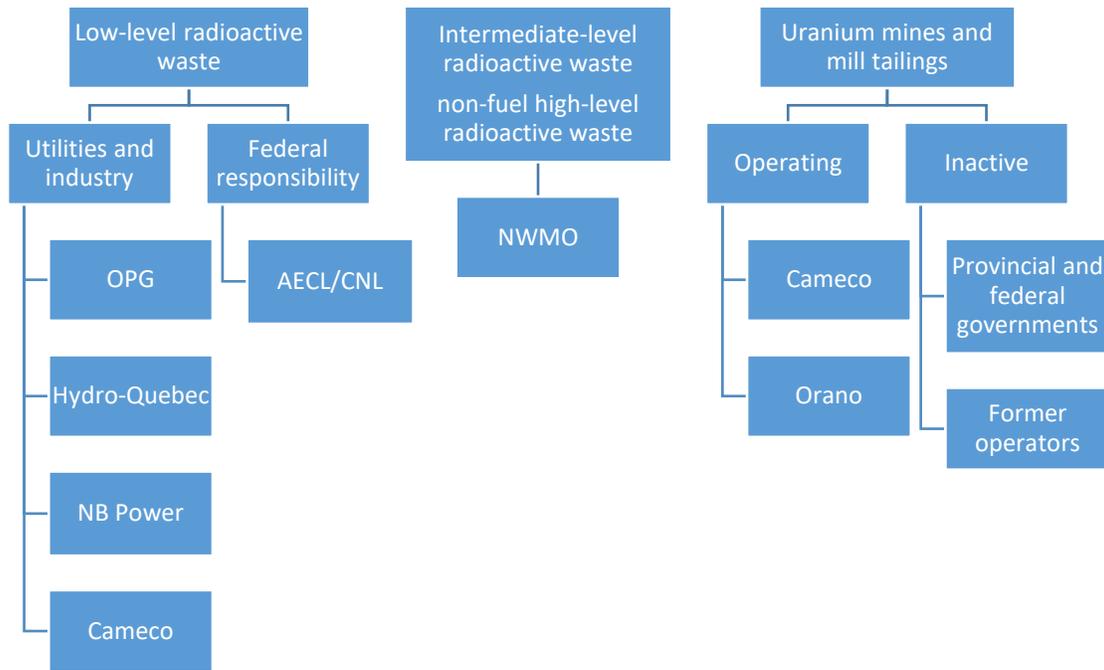
The bulk of Canada's historic LLW is located in the southern Ontario communities of Port Hope and Clarington. These wastes and contaminated soils amount to roughly 2.8 million m³ and relate to the historic operations of a radium and uranium refinery in Port Hope dating back to the 1930s. In March 2001, the Government of Canada and the local municipalities agreed on community-developed proposals as potential solutions for the cleanup and long-term management of historic LLW in the Port Hope area, and launched the Port Hope Area Initiative (PHAI). The PHAI and other initiatives that address historic waste are described in section K.2.1.5 and annex 7.2. These initiatives fall under the responsibility of AECL, and the work is delivered by CNL, based on a GoCo model.

Activities continue to be carried out in order to address the remaining historic LLW liabilities across Canada (non-Port Hope sites) and execute plans for their discharge. As part of one key objective, CNL will significantly reduce or eliminate liabilities by 2032 by safely executing remediation projects. This will facilitate the cost-effective long-term management of historic LLW, in keeping with the policy direction provided by AECL.

Legacy wastes (in the Canadian context) specifically date back to the Cold War and birth of nuclear technologies in Canada. These wastes are located at AECL sites. They include existing radioactive wastes and wastes resulting from decommissioning disused buildings and infrastructure, and from environmental remediation.

[B.1.4.2.1 Long-term management of low- and intermediate-level and non-fuel high-level radioactive waste](#)

Although 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 its long-term management. Figure B.6 shows the organizations that are responsible for the long-term management of radioactive waste in Canada.

Figure B.6: Organizations responsible for the long-term management of radioactive waste in Canada

On October 5, 2023, the Honourable Jonathan Wilkinson, Minister of Energy and Natural Resources, released a public statement accepting the recommendations put forward in the Integrated Strategy for Radioactive Waste (ISRW), which was developed by the NWMO in collaboration with waste owners and through engagement with the public and Indigenous peoples across Canada. The ISRW outlines a plan for the long-term management of all of Canada's radioactive wastes, particularly where disposal plans were not in place, such as for ILW, non-fuel HLW and some LLW. The final ISRW lays out two fundamental recommendations:

1. ILW and non-fuel high-level waste will be disposed of in a deep geological repository (DGR) with implementation by the NWMO (funded by waste owners).
2. LLW will be disposed of in multiple near-surface disposal facilities with implementation (and funding) by waste generators and waste owners.

With the ISRW accepted by the Minister, the NWMO has taken on an additional mandate of developing and implementing a plan for the disposal of ILW and non-fuel HLW in a DGR. The NWMO has committed to returning to the Minister by the end of 2025 with a consent-based siting selection process developed to initiate this work. The NWMO's work implementing a DGR for ILW and non-fuel HLW is separate from their work under the *Nuclear Fuel Waste Act* to implement Canada's plan for the long-term management of spent fuel. Further details on the ISRW can be found in section K.2.3.

Under the ISRW, waste generators and owners are still responsible for the disposal of their LLW. In alignment with the ISRW, OPG is moving forward with developing alternative solutions for the permanent disposal of low-level waste. OPG is starting the Low-Level Waste Initiative (LLWI) in 2024 with a learning phase as part of a province-wide opt-in process to seek willing host(s). In the learning phase, OPG will first engage with Indigenous Nations and communities, using a respectful approach of two-way dialogue, listening, learning and sharing to build a plan together for a low-level waste disposal facility (LLWDF).

AECL is responsible for the long-term management of LLW at its sites – CRL, WL and two partially decommissioned prototype reactors (Gentilly-1 and Douglas Point) – and for the long-term management of L&ILW for the proposed in-situ decommissioning projects at the partially decommissioned prototype reactor NPD and the research reactor WR-1 at WL. AECL is also responsible for the long-term management of the LLW it accepts from other Canadian licensees (mostly originating from hospitals and universities)

on a fee-for-service basis. Under a GoCo model, CNL delivers this work on behalf of AECL. For information on the AECL/CNL long-term waste management strategy for L&ILW, see section K.2.1.

Cameco is responsible for the long-term management of LLW at the Blind River Refinery, Port Hope Conversion Facility and Cameco Fuel Manufacturing Facility. Historic LLW located at the Port Hope Conversion Facility is eligible for disposal in the PHAI's long-term WMF. Other LLW is stored at the site pending decontamination for unconditional release or disposal at an appropriately licensed facility. For additional information, see annex 5.5.

B.1.4.3 Uranium mine and mill tailings

Uranium mining and milling wastes comprise three major waste streams: mill tailings, waste rock and waste water. After ore is removed from the ground, either by underground mining or from an open pit, it is milled. The ore slurry or run-of-mine ore (which is first crushed) is received by the mill and treated with chemicals; the uranium content in the ore is then extracted, leaving a waste product known as mill tailings. Due to 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.

The method used to manage tailings from uranium mine operations also 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 and the size of the deposit. Canada's operating mines (all of which are located in northern Saskatchewan) have high-grade ore deposits, compared to past mines operated in Canada; as a result, smaller volumes of tailings are being produced.

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 extent that the long-term care and control of these non-radioactive contaminants are what drive the level of care needed to manage it, not the radioactivity of the waste rock.

The waste water, or effluent, generated from mining and milling processes is treated as required. Treated water that is discharged to the environment is monitored to ensure it meets the regulatory standards prescribed by the provincial and federal governments. These limits ensure that the impact on the environment is minimal.

More than 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, 22 of which no longer receive waste material. The three remaining operational tailings management facilities (TMFs) are located in Saskatchewan. The ore mined at McArthur River is transported to Key Lake for milling, resulting in no tailings management areas (TMAs) at the McArthur mine site. Similarly, the ore from Cigar Lake is transported to McClean Lake for milling; tailings reside at the McClean Lake TMF. Both milling and mining have been conducted at Rabbit Lake, and as a result, tailings are managed at that site. All operational and inactive uranium tailings sites are the joint regulatory responsibility of the CNSC and the provinces and territories in which the sites are located.

TMFs have evolved over the decades, from the simple deposition of tailings into natural landforms, lakes or abandoned underground mines, 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) during operations to enhance radiation protection and to avoid the oxidization and winter freezing of the tailings.

Contaminated industrial wastes are typically recycled, deposited in underground workings, landfilled at the site-specific TMFs or designated locations (such as mined-out pits designated for contaminated waste). The quantities of contaminated industrial wastes are tracked and recorded. However, in the context of the overall

site inventory of radioactive wastes, the actual amount of low specific-activity material contained in this volume is negligible and is effectively accounted for.

In addition to the tailings produced from milling uranium ore, millions of cubic metres of waste rock are excavated to gain access to ore. In the northern Saskatchewan open-pit sites located within the Athabasca Basin, 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 secondary 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., locate it at the bottom of a flooded pit), which keeps it in an environment similar to that from which it was mined and prevents oxidation reactions. In underground mines, waste rock can be used in the mine as backfill material. Waste rock materials used for purposes underground are not classified as waste materials in the waste inventory. At sites with a waste segregation program, clean waste rock can be used for construction material.

The inventory of nuclear substances in some inactive uranium TMAs can cause some areas to be licensed as Class I nuclear facilities under the NSCA's *Class I Nuclear Facilities Regulations* (CINFR), which has implications for the licensing requirements and long-term management of such facilities. Those responsible for inactive TMAs with smaller inventories can be licensed for the possession of nuclear substances. These inactive tailings disposal areas and facilities remain under CNSC licence control in the absence of a suitable alternative (such as provincial institutional controls). However, the Government of Saskatchewan has developed such an alternative for the institutional control of decommissioned mining sites (not limited to uranium) on Crown land.

Current management practices for CNSC-licensed facilities use a lifecycle planning process. A preliminary decommissioning plan (PDP) and financial guarantees for decommissioning are integral to the licence approval process and are required in the first stages of CNSC licensing (site preparation and construction). The CNSC assesses the environmental and health effects of nuclear facilities and activities at every phase of their lifecycle or duration.

B.1.4.3.2 Operational tailings and waste rock management strategy

B.1.4.3.2.1 Overview

A significant portion of the world's primary uranium production comes from uranium deposits in the Athabasca Basin of northern Saskatchewan. These deposits are found at:

- the current production sites of Cigar Lake, and McClean Lake
- the McArthur River mine and Key Lake mill, which suspended production in 2018 due to prolonged market weakness; however, production restarted in 2022
- the Rabbit Lake mine and mill, which suspended operations indefinitely in 2016 and is currently in a state of safe care and maintenance

McArthur River and Cigar Lake are two of the highest-grade uranium ore bodies in the world. Some of the ore bodies in the Athabasca Basin contain other elements, such as nickel and arsenic, which brings additional considerations to the management of tailings and waste rock that result from mining and milling these ores.

Past production centres in Saskatchewan that are no longer actively producing uranium include:

- the Uranium City district mines and mills of Gunnar, Lorado and Beaverlodge
- the decommissioned Cluff Lake site, where production was terminated at the end of 2002 and is in the final stages of being accepted into the Province of Saskatchewan's Institutional Control Program; for long-term oversight, monitoring and maintenance by the province

B.1.4.3.2.2 Tailings management strategy

Mills with 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, the ore from Cigar Lake is transported to McClean Lake for processing.

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 details, two basic principles underlie the containment of the tailings:

- **hydraulic containment during the operational phase** – The water level in the pit at the start of tailings placement is well below the natural groundwater level in the area as a result of dewatering during mining. Dewatering creates a cone of depression in the groundwater system, which causes the natural flow to be directed toward the pit from every direction. This hydraulic containment feature is maintained throughout the operational life of the tailings facility by keeping the pit in a partially dewatered state. Since water has to be pumped continuously from the pit, the 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 by controlling the tailings' geochemical and geotechnical characteristics during tailings preparation and placement. This control creates future passive physical controls for groundwater movement in the system that will exist after the decommissioning of operational facilities.

The tailings contain a significant fraction of fine-grained materials (e.g., 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 very low hydraulic conductivity. When surrounded by a material with much higher hydraulic conductivity, the natural groundwater path travels around the impermeable plug of tailings.

Potential contaminant transport from the tailings is controlled by diffusion from the outer surface of the tailings mass; this is a slow process with minimal advective contaminant flux and, consequently, a 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 the prevention of ice formation with the tailings 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 and 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 that govern the system. This performance is confirmed during the life of the operation and through the post-decommissioning monitoring, which continues until stable conditions are achieved and for as long as is necessary thereafter.

Annex 6 provides site-specific details for the Athabasca Basin tailings facilities. The development of these facilities began over 30 years ago; their favourable operational experience and the design evolutions based on that experience inspire confidence in their performance, now and in the future.

B.1.4.3.2.3 Waste rock management strategy

In addition to tailings from the milling process, uranium production yields large volumes of waste rock that are removed before ore can be accessed. The segregation of these materials according to their future management requirements is a core management strategy. Material excavated from open pits is divided into three main categories: clean waste (both overburden and waste rock), special waste (containing sub-economic mineralization) and ore.

B.1.4.3.2.3.1 Waste segregation

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 or various metals, such as nickel or arsenic.

In some instances, because it contains sulphide, there is the potential for acidic leachate when the rock is exposed to moisture and oxygen from the atmosphere. This acid rock drainage phenomenon is common to many types of mining. Sophisticated methods are now available for segregating those amounts of waste rock that represent a potential environmental risk if left on the surface for the long term, due to either acid rock drainage or dissolved contaminants in leachate.

This material, referred to as special waste, is managed differently than the environmentally benign waste rock. Segregation methods include borehole logging, collecting and analyzing borehole samples prior to mining, and analyzing samples during mining. In addition to a retrospective laboratory analysis, qualified geological interpretation of the mining faces reinforced with real-time analyses made with an ore radiometric scanner are used to segregate each truckload, based on uranium content, as ore, special waste or clean waste rock and direct it to the appropriate stockpile.

Because uranium ore deposits are in secular equilibrium with their progeny, good correlations can be made between the 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 been tested at McClean Lake and has since been incorporated into the mine site's overall waste rock management strategy.

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. Surplus amounts can be stockpiled, and the stockpiles reclaimed and vegetated. Special waste is either used as aggregate and underground backfill, returned underground to other mined areas, or transferred to sites with mills or mined-out open pits.

B.1.4.3.2.3.2 Special waste

As noted above, waste rock near ore bodies is potentially problematic. Because it has some halo mineralization around the ore deposit, the waste rock can potentially generate acid in some instances or become a source of contaminated leachates when exposed to an atmosphere containing oxygen. Disposal of this special waste in mined-out pits that are flooded to cut off oxygen from the atmosphere and stop oxidation reactions is now a widely recognized solution, provided that the pit is suitable for the long-term management of the risk. If it is not, engineered covers present an *in situ* solution to impede the interaction of oxygen and moisture with the special waste. As it is mined, the special waste is segregated and temporarily stored on the surface on lined pads, with drainage collection systems to collect and treat runoff water. After mining activities have ended, the special waste is backhauled into the mined-out pit. 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, waste material with uranium content greater than approximately 300 parts per million triuranium octoxide or 0.025 percent (250 parts per million) uranium is classed as special waste.

Like with tailings facilities, the 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 is continued until stable conditions are achieved and for as long as is necessary thereafter.

B.1.4.3.2.3.3 Ore

The cut-off grade that defines the threshold between ore to be processed through the mill and mineralized waste will vary, depending on market conditions for uranium. Typically, cut-off grades are in the order of 0.1% for the Saskatchewan mines.

B.1.4.3.2.4 Wastewater treatment and effluent discharge

Mine and mill facilities have water treatment systems to manage the contaminated water collected from their tailings disposal facilities, the water inflows collected during open-pit or underground mining, and seepages from waste rock piles. The treatment processes vary from flow-through to batch discharge systems and rely largely 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, the Key Lake operation has two treated-water discharge points. Uranium mines and mills also treat for radionuclides. Specifically, focus is placed on the 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 and by effluent quality regulation.

In northern Saskatchewan, effluent quality regulation ensures that the Saskatchewan Environmental Quality Guidelines are maintained in the receiving environment downstream of the operations. 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. During this reporting period (April 1, 2020, to March 31, 2024), the total volume of treated wastewater that met regulatory requirements and was subsequently discharged to the receiving environment was 15.1 million m³ from five active uranium mining and/or milling sites in northern Saskatchewan (see table B.1).

Table B.1: Active uranium mining/milling site waste water volumes

Active uranium mining and/or milling site in northern Saskatchewan	Total volume of waste water that met discharge requirements
Orano – McClean Lake ^[1]	4,855,851 m ³
Cameco – Rabbit Lake	2,830,000 m ³
Cameco – Cigar Lake	338,000 m ³
Cameco – McArthur River	2,250,000 m ³
Cameco – Key Lake (Horsefly Lake)	2,810,000 m ³
Cameco – Key Lake (Wolf Lake)	2,040,000 m ³
Total	15,123,851 m³

[1] 2023 discharge was lower than typical due to water treatment JEB WTP shutdowns due to scaling issues.

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 the 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 and chemical precipitation technologies.

B.1.4.3.3 Long-term management of uranium mine and mill waste

Cameco Corporation and Orano Canada Inc. (formerly known as AREVA Resources Canada Inc.) manage the only operating uranium mines and mills in Canada (see annex 6). Inactive uranium mine and mill sites are located in Ontario, the Northwest Territories and Saskatchewan, as described in annex 7.

The term “inactive” is used to describe several different types of inventories, including:

- tailings sites that are currently being decommissioned
- tailings sites at operating mill sites where closure activities have been partially completed or are in progress (e.g., Rabbit Lake and Key Lake)
- tailings sites at former milling locations, including recently decommissioned sites with engineered tailings containment systems, 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 near lakes (e.g., Port Radium)

These inactive sites are licensed by the CNSC. The site owners are responsible for monitoring and for any future maintenance or remedial work that may be required to protect human health and safety or the environment. Three former uranium mine tailings sites are located in Saskatchewan: Cluff Lake, and the Gunnar and Lorado sites. The Lorado and Cluff Lake sites have been decommissioned, and the Gunnar site is in the process of being decommissioned, as described in annexes 7.1.1.3, 7.1.1.4 and 7.1.1.2, respectively. The Cluff Lake project is in the process of transitioning to Saskatchewan's Institutional Control Program (which is discussed in section H.7).

B.1.4.4 Radioactive waste from uranium fuel fabrication and processing

In the past, wastes from uranium 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 WMF. Subsequent to 1988, the volume of LLW produced from these operations has been greatly reduced through incineration and the recovery and reuse of uranium-bearing materials. The residual volume of LLW is segregated, managed and stored at licensed facilities in Canada. LLW, containing an unimportant quantity of source material, is shipped for disposal in the U.S. at a hazardous waste landfill. In some cases, radioactive waste is shipped to waste treatment facilities in the U.S., and the volume-reduced residues are returned for storage by the waste owner in Canada.

Uranium fuel fabrication and processing waste consists of a variety of potentially uranium-contaminated wastes, including:

- contaminated zirconium
- contaminated combustible materials (e.g., wood, paper, gloves, coveralls)
- rubber and plastic
- oils and solvents
- metal
- sludges (sewage, process equipment and wash water)
- recoverable materials (ammonium nitrate, fluoride, calcined product and regeneration products)

B.1.4.5 Radioactive waste from nuclear power reactors

Radioactive wastes resulting from nuclear reactor operations are stored in a variety of structures located in radioactive WMFs, locations or sites across Canada. Prior to storage, the volume of the radioactive waste may be reduced by incineration, compaction, shredding, metal melting or other volume reduction techniques (such as resin processing) and laundering protective clothing. In addition, the NGS contains facilities for decontaminating parts and tools, and refurbishing and rehabilitating equipment. Radioactive wastes from NGSs consists of varying types of L&ILW, such as:

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

B.1.4.6 Radioactive waste from research reactors

At research reactors other than at CRL, radioactive waste is segregated into VSLLW and long-lived radioactive waste. VSLLW radioactive waste is stored on-site to allow for decay until it can be disposed of in a conventional manner. Long-lived radioactive waste is kept on-site temporarily until a sufficient quantity is accumulated for transportation to CRL for storage.

Typically, the research reactors operating in Canada do not produce liquid waste. The water is purified through filtration and ion exchange systems, then recycled back to the reactor. The spent ion exchange resins are stored with the long-lived radioactive waste and eventually sent to CRL.

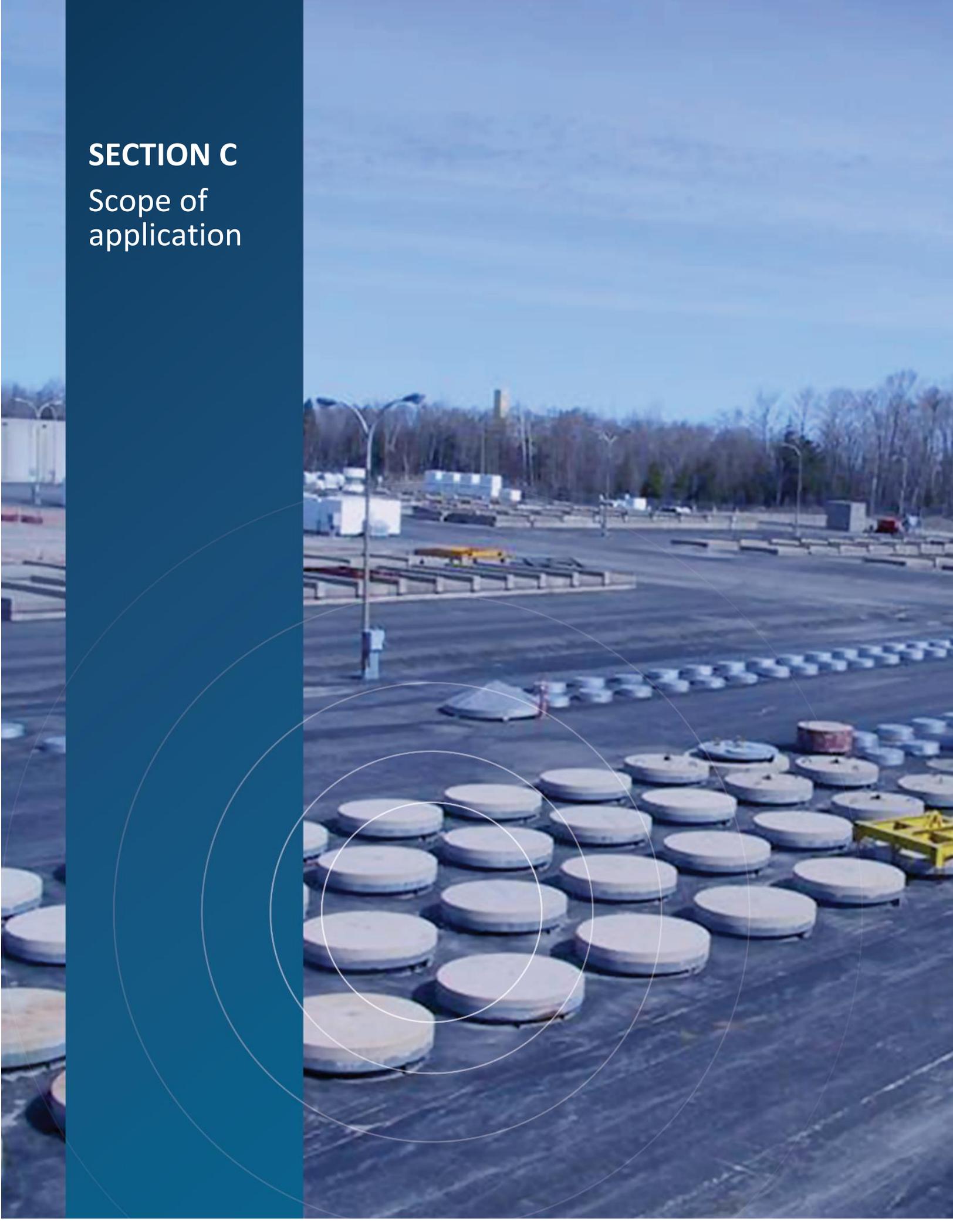
B.1.4.7 Radioactive waste from radioisotope production and use

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

B.1.4.8 Historic radioactive waste

Historic LLW in Canada refers to LLW that was managed in the past in a manner that is 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. AECL is responsible for the cleanup and safe management of historic LLW at sites across Canada for which the Government of Canada has accepted responsibility. This includes the PHAI and activities associated with the Low-Level Radioactive Waste Management Office. This work is delivered by CNL on behalf of AECL, based on a Government-owned, Contractor-operated (GoCo) model. Section K.2.1 provides more information on the decommissioning and remediation of historic sites.

SECTION C
Scope of
application



Section C – Scope of Application

C.1 Scope of application (Article 3)

This section addresses the obligations under Article 3 of the Joint Convention.

ARTICLE 3. SCOPE OF APPLICATION

1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.
2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.
3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.
4. This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

C.1.1 Introduction

REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*, defines radioactive waste as any material (liquid, gaseous or solid) that contains a radioactive nuclear substance, as defined in section 2 of the NSCA, and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive hazardous substances, as defined in section 1 of the *General Nuclear Safety and Control Regulations* (GNSCR).

Radioactive waste is 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 (NORM)
- radioactive waste generated by military and defence programs

C.1.2 Reprocessed spent fuel

Pursuant to Article 3(1) of the Joint Convention, Canada declares that reprocessing activities are not part of Canada's spent fuel management program; as such, they are not included in this report.

Note, however, that AECL conducted early reprocessing experiments at CRL from the 1940s to the 1960s. CNL stores liquid waste that resulted from these reprocessing experiments in three tanks. The last transfer of radioactive liquid solutions to any of these storage tanks occurred in 1968, and no liquids have been added

since then. Between 1958 and 1960, AECL conducted some experiments to convert high-level radioactive liquid solutions into a solid (glass). The program generated 50 glass blocks, each weighing about 2 kg, which are now safely stored on-site. Further information regarding the wastes from these experiments can be found in annex 5.1.1.

C.1.3 Naturally occurring radioactive material

Naturally occurring radioactive material (NORM) is material found in the environment that contains radioactive elements of natural origin. NORM primarily contains uranium and thorium (elements that also release radium and radon gas once they begin to decay) and potassium. These elements are naturally decaying and are considered a primary contributor to an individual's yearly background radiation dose.

In Canada, NORM is regulated by the provincial and territorial governments, each having its own specific regulations on the handling and disposal of the material. The *Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials* were developed by the Federal Provincial Territorial Radiation Protection Committee to harmonize standards throughout the country and ensure appropriate control of NORM. However, provincial regulations should also be consulted.

NORM is exempt from the NSCA and its associated Regulations, except in the following circumstances:

- when NORM is associated with the development, production or use of nuclear energy, as set out in the GNSCR
- when NORM is imported into Canada or exported from Canada, as set out in the NNIECR
- the transport of NORM when the specific activity is greater than 70 Bq/g (70 kBq/kg), as set out in the *Packaging and Transport of Nuclear Substances Regulations, 2015* (PTNSR, 2015) and the *Transport of Dangerous Goods Regulations* (TDGR)

In accordance with Article 3(2) of the Joint Convention, only non-exempt NORM is 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.1.4 Spent fuel and radioactive waste within military or defence programs

Under section 5 of the NSCA, the programs of the Department of National Defence are not subject to the NSCA or its associated regulations; however, the Royal Military College (RMC) SLOWPOKE-2 reactor is subject to the NSCA, because it is operated as a research reactor. Therefore, under Article 3(3) of the Joint Convention, the RMC SLOWPOKE-2 reactor is the only military or defence program addressed in this report.

C.1.5 Discharges

In Canada, each radioactive WMF with releases to the environment must have in place an approved effluent and emissions monitoring program that meets the requirements set out in CSA standard N288.5, *Effluent and emissions monitoring programs at nuclear facilities*. Some of these facilities also have performance indicators, such as administrative levels and action levels, to evaluate the effectiveness of the pollution prevention controls. For more information on effluent and emissions monitoring programs, see section F.4.6. Radiological effluent discharge levels for radioactive WMFs are listed in annexes 4, 5, 6 and 7.

SECTION D
Inventories
and lists



Section D – Inventories and Lists

D.1 Reporting (Article 32(2))

This section addresses the obligations under Article 32(2) of the Joint Convention.

ARTICLE 32. REPORTING

1. This report shall also include:

- (i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;
- (ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;
- (iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;
- (iv) an inventory of radioactive waste that is subject to this Convention that:
 - (a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;
 - (b) has been disposed of; or
 - (c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

- (v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1.1 Spent fuel management facilities in Canada

Table D.1 below lists the facilities in Canada that manage spent fuel.

Table D.1: Facilities in Canada that manage spent fuel

Facility	Owner	Location	Purpose/feature
Bruce Nuclear Generating Station	OPG	Tiverton, Ontario	Wet storage
Chalk River Laboratories	AECL	Chalk River, Ontario	Dry storage
Darlington Nuclear Generating Station	OPG	Clarington, Ontario	Wet storage
Darlington Waste Management Facility	OPG	Clarington, Ontario	Dry storage
Douglas Point Waste Management Facility	AECL	Tiverton, Ontario	Dry storage
Gentilly-1 Waste Management Facility	AECL	Bécancour, Quebec	Dry storage
Gentilly-2 Nuclear Generating Station	H-Q	Bécancour, Quebec	Wet storage [1]
Gentilly-2 Waste Management Facility	H-Q	Bécancour, Quebec	Dry storage
McMaster Nuclear Research Reactor	McMaster University	Hamilton, Ontario	Wet storage
National Research Universal	AECL	Chalk River, Ontario	Wet storage

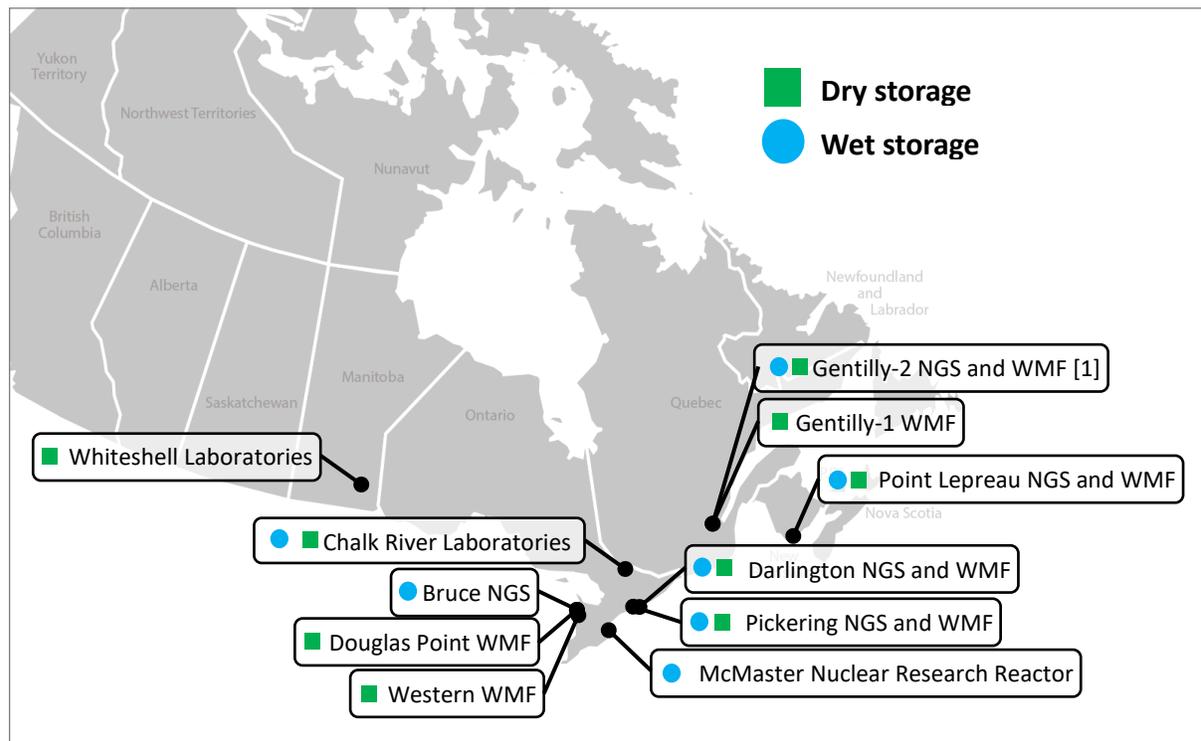
Facility	Owner	Location	Purpose/feature
Pickering Nuclear Generating Station	OPG	Pickering, Ontario	Wet storage
Pickering Waste Management Facility	OPG	Pickering, Ontario	Dry storage
Point Lepreau Nuclear Generating Station	NB Power	Maces Bay, New Brunswick	Wet storage
Point Lepreau Waste Management Facility	NB Power	Maces Bay, New Brunswick	Dry storage
Western Waste Management Facility	OPG	Tiverton, Ontario	Dry storage
Whiteshell Laboratories	AECL	Pinawa, Manitoba	Dry storage

[1] As of December 2020, all spent fuel at Gentilly-2 has been transferred to dry storage.

For detailed descriptions of the facilities listed in table D.1, see annex 4.

Figure D.1 below shows the facilities in Canada that manage spent fuel, as listed in table D.1.

Figure D.1: Facilities in Canada that manage spent fuel



[1] As of December 2020, all spent fuel at Gentilly-2 has been transferred to dry storage.

D.1.2 Inventory of spent fuel in Canada

Table D.2 below shows the total volume of HLW in Canada and its respective volume, expressed as a percentage of the total volume of all radioactive waste in Canada.

Table D.2: Total volume of high-level waste in Canada

Waste category	Volume (as of December 31, 2023)	Percentage of total
High-level radioactive waste	13,937 m ³	0.6%

Table D.3 below inventories spent fuel in wet storage in Canada.

Table D.3: Inventory of spent fuel in wet storage in Canada as of December 31, 2023

Facility	Number of spent fuel bundles in wet storage ^[2]	Kilograms of uranium ^[1]
Bruce Power Nuclear Generating Station	672,441	12,733,447
Darlington Nuclear Generating Station	301,004	5,765,394
McMaster Nuclear Research Reactor	38	39.93
National Research Universal	623	2,512
Pickering Nuclear Generating Stations	375,449	7,454,847
Point Lepreau Nuclear Generating Station	38,626	742,429

[1] Inventory includes depleted uranium, enriched uranium, natural uranium, and thorium in spent fuel.

Figure D.2 below shows the number of spent fuel bundles in wet storage in Canada as of December 31, 2023, as inventoried in table D.3.

Figure D.2: Number of spent fuel bundles in wet storage in Canada as of December 31, 2023

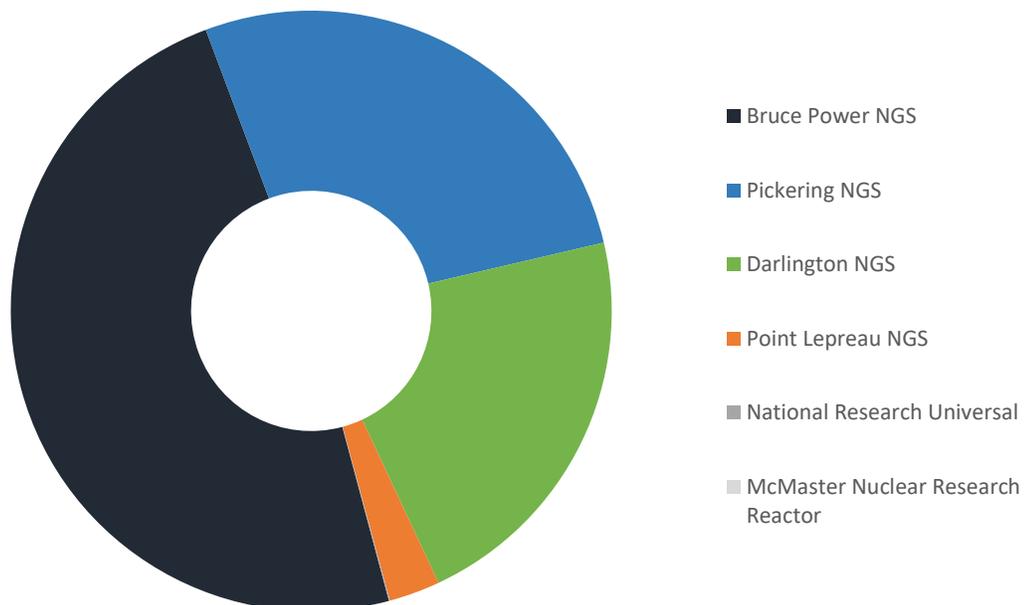


Table D.4 below inventories spent fuel in dry storage in Canada.

Table D.4: Inventory of spent fuel in dry storage in Canada as of December 31, 2023

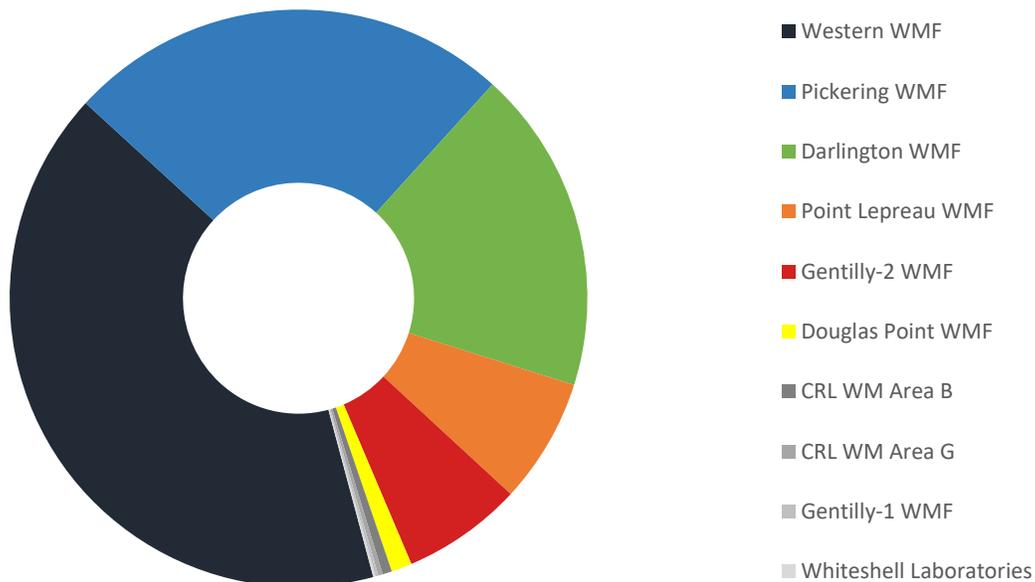
Facility	Number of spent fuel bundles in dry storage ^[2]	Kilograms of uranium ^[1]
CRL Waste Management Area B (spent research reactor fuel)	10,109	36,834
CRL Waste Management Area G	4,886	65,385
Darlington Waste Management Facility	349,349	6,674,282
Douglas Point Waste Management Facility	22,256	299,827
Gentilly-1 Waste Management Facility	3,213	67,596
Gentilly-2 Waste Management Facility	129,925	2,469,204
Pickering Waste Management Facility	479,926	9,533,729
Point Lepreau Waste Management Facility	134,997	2,571,693
Western Waste Management Facility	789,494	15,026,502
Whiteshell Laboratories	2,360	24,479

[1] Inventory includes depleted uranium, enriched uranium, natural uranium, plutonium and thorium in spent fuel.

[2] Inventory is reported as fuel bundles, rods, fuel assemblies and/or other items.

Figure D.3 below shows the number of spent fuel bundles in dry storage in Canada as of December 31, 2023, as inventoried in table D.4.

Figure D.3: Number of spent fuel bundles in dry storage in Canada as of December 31, 2023



D.1.3 Radioactive waste management facilities in Canada

Table D.5 below lists the facilities in Canada that manage non-spent fuel radioactive waste.

Table D.5: Facilities in Canada that manage non-spent fuel radioactive waste

Facility	Owner	Location	Purpose/feature
Non-fuel HLW			
Bruce Nuclear Generating Station	OPG	Tiverton, Ontario	Storage of non-spent fuel HLW
LLW and ILW			
Best Theratronics Manufacturing Facility, Kanata	Best Theratronics	Kanata, Ontario	Storage of disused sealed sources and depleted uranium shielding (LLW and ILW)
Blind River Refinery	Cameco	Blind River, Ontario	Storage of LLW
BWXT Medical	BWXT Canada Ltd	Ottawa, Ontario	Storage of LLW and ILW
BWXT Nuclear Energy Canada (NEC) Peterborough	BWXT NEC	Peterborough, Ontario	Storage of LLW
BWXT NEC Toronto	BWXT NEC	Toronto, Ontario	Storage of LLW
Cameco Fuel Manufacturing Facility	Cameco	Port Hope, Ontario	Storage of LLW
Chalk River Laboratories	AECL	Chalk River, Ontario	Storage of LLW and ILW
Darlington Waste Management Facility	OPG	Clarington, Ontario	Storage of ILW
Douglas Point Waste Management Facility	AECL	Tiverton, Ontario	Storage of decommissioning reactor waste (LLW and ILW)
Gentilly-1 Waste Management Facility	AECL	Bécancour, Quebec	Storage of decommissioning reactor waste (LLW)
Gentilly-2 Waste Management Facility	H-Q	Bécancour, Quebec	Storage of LLW and ILW
Nordion Manufacturing Facility, Kanata	Nordion	Kanata, Ontario	Storage of disused sealed sources (ILW)
Nuclear Power Demonstration	AECL	Renfrew County, Ontario	Storage of decommissioning reactor waste (LLW and ILW)
Pickering Waste Management Facility	OPG	Pickering, Ontario	Storage of ILW
Point Lepreau Waste Management Facility	NB Power	Maces Bay, New Brunswick	Storage of LLW and ILW
Port Hope Conversion Facility	Cameco	Port Hope, Ontario	Storage of LLW
Radioactive Waste Operations Site 1	OPG	Tiverton, Ontario	Storage of LLW and ILW
Western Waste Management Facility	OPG	Tiverton, Ontario	Storage of LLW and ILW
Whiteshell Laboratories	AECL	Pinawa, Manitoba	Storage of LLW and ILW

Facility	Owner	Location	Purpose/feature
LLW from past practices			
Deloro Mine Site	Ministry of the Environment, Conservation and Parks of Ontario	Deloro, Ontario	Management of LLW from past practices
Greater Toronto Area	AECL/Regional Municipality of Peel, Ontario	Greater Toronto Area, Ontario	Management of LLW from past practices
Port Granby	AECL	Port Granby, Ontario	Management of LLW from past practices
Port Hope ^[1]	AECL	Port Hope, Ontario	Management of LLW from past practices
Uranium mining and milling waste			
Agnew Lake	Ontario Ministry of Mines (formerly Ontario Ministry of Northern Development and Mines)	Agnew Lake, Ontario	Management of uranium tailings and waste rock
Beaverlodge	Cameco	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Bicroft	Barrick Gold Corporation	Bancroft, Ontario	Management of uranium tailings and waste rock
Cigar Lake	Cameco	Athabasca Basin, Saskatchewan	Management of waste rock
Cluff Lake	Orano	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Denison	Denison Mines Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Dyno	EnCana West Limited (EWL) Management Ltd.	Bancroft, Ontario	Management of uranium tailings and waste rock
Gunnar	Saskatchewan Research Council	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Key Lake	Cameco	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Lacnor	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Lorado	Saskatchewan Research Council	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Madawaska	EWL Management Ltd.	Bancroft, Ontario	Management of uranium tailings and waste rock
McClellan Lake	Orano	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
McArthur River	Cameco	Athabasca Basin, Saskatchewan	Management of waste rock

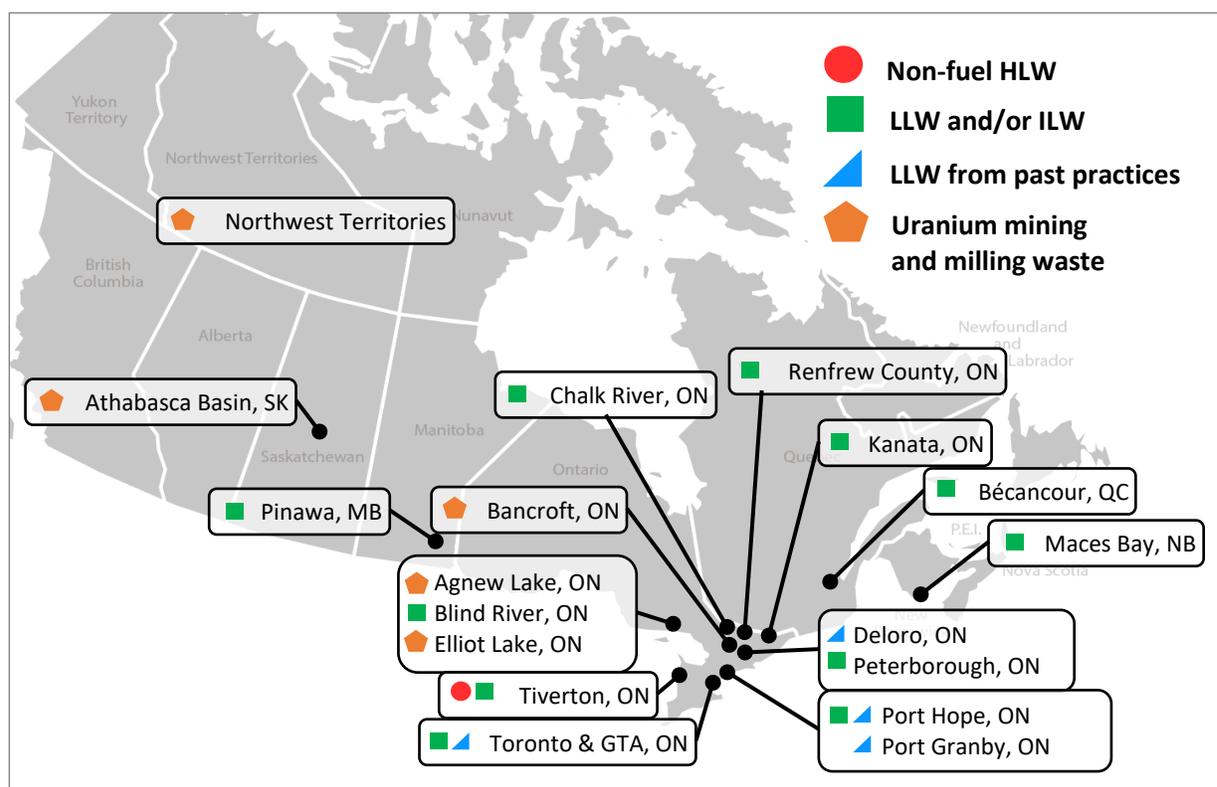
Facility	Owner	Location	Purpose/feature
Milliken	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Nordic	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Panel	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Port Radium	Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) (formerly, Indigenous and Northern Affairs Canada)	Northwest Territories	Management of uranium tailings and waste rock
Pronto	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Quirke 1 and 2	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Rabbit Lake	Cameco	Athabasca Basin, Saskatchewan	Management of uranium tailings and waste rock
Rayrock	Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) (formerly, Indigenous and Northern Affairs Canada)	Northwest Territories	Management of uranium tailings and waste rock
Spanish American	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Stanleigh	Rio Algom Ltd.	Elliot Lake, Ontario	Management of uranium tailings and waste rock
Stanrock/Can-Met	Denison Mines Inc.	Elliot Lake, Ontario	Management of uranium tailings and waste rock

[1] Remediation of the Welcome WMF was completed in 2019 and construction of the final cell of the Port Hope WMF was completed in 2021. Waste from the Welcome WMF is now reported under Port Hope.

For detailed descriptions of the facilities listed in table D.5, see annexes 5, 6 and 7.

Figure D.4 below shows the facilities in Canada that manage non-spent fuel radioactive waste, as listed in table D.5.

Figure D.4: Locations of sites in Canada that manage non-spent fuel radioactive waste



D.1.4 Inventory of radioactive waste in Canada

Table D.6 below shows the total volume of L&ILW and uranium mine and mill tailings in Canada and their respective volumes, expressed as a percentage of the total volume of all radioactive waste in Canada.

Table D.6: Total volume of L&ILW in Canada

Waste category	Volume (as of December 31, 2023)	Percentage of total
Low-level radioactive waste	2,290,766 m ³	98.5%
Intermediate-level radioactive waste	21,963 m ³	0.9%
Uranium mine and mill tailings	218.6 million tonnes	

D.1.4.1 Non-fuel high-level radioactive waste

Table D.7 below inventories non-spent fuel HLW in storage in Canada.

Table D.7: Inventory of non-spent fuel high-level waste in storage in Canada as of December 31, 2023

Facility	Description of stored waste	Storage method	On-site waste inventory as of December 31, 2023	
			Volume (m ³)	Activity (TBq)
Bruce Power	Disused cobalt-60 sealed sources	Pool storage	3	N/A

Note: N/A means “not available.”

D.1.4.2 Low- and intermediate-level radioactive waste

Table D.8 below inventories L&ILW in storage in Canada.

Table D.8: Inventory of low- and intermediate-level waste in storage in Canada as of December 31, 2023

Facility	Description of stored waste	Storage method	On-site waste inventory as of December 31, 2023			
			ILW		LLW	
			Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)
Best Theratronics Manufacturing Facility, Kanata	Disused cobalt-60 sealed sources, disused cesium-137 sealed sources, depleted uranium shielding components	Pool storage or dry containers	<1	191	<1	N/A
Blind River Refinery	Non-combustible process waste	LLW: 205 L-drums	nil	nil	1,520	N/A
BWXT NEC, Peterborough	Solid waste from processing	LLW: 205 L-drums, waste boxes	nil	nil	5	<1
BWXT NEC, Toronto	Solid waste from processing	LLW: 205 L-drums, skids	nil	nil	35	<1
Cameco Fuel Manufacturing Facility	Non-combustible process waste	LLW: 205 L-drums	nil	nil	605	N/A
Chalk River Laboratories	Research reactor and isotope production waste, external waste, decommissioning waste	ILW: tile holes, bunkers and legacy tanks ILW/LLW: shielded modular above-ground storage (SMAGS) LLW: sand trenches, low-level storage buildings, recoverable surface storage areas, modular above-ground storage (MAGS) and bulk materials landfill	5,507 ^[3]	N/A	161,748 ^[3]	N/A

Facility	Description of stored waste	Storage method	On-site waste inventory as of December 31, 2023			
			ILW		LLW	
			Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)
	Contaminated soils	Luggers, 205 L-steel drums, B-25 containers in SMAGS, sand trenches and recoverable surface storage areas	nil	nil	164,202	N/A
	Decommissioning waste	ILW: tile holes and bunkers LLW: MAGS, SMAGS, recoverable surface storage areas	355	N/A	26,297	N/A
Darlington Waste Management Facility	Interim storage of intermediate-level reactor refurbishment waste from Darlington	ILW: retube waste containers stored inside Darlington storage overpacks	1,558 ^[10]	145,200 ^[9]	nil	nil
Douglas Point Waste Management Facility	Decommissioned reactor waste	Reactor building	6	N/A	48 ^[2]	N/A
Gentilly-1 Waste Management Facility	Decommissioned reactor waste	Reactor building	2	N/A	1 ^[2]	N/A
Gentilly-2 Waste Management Facility	Interim storage of low-and intermediate-level operational waste from former reactor	ILW: Spent filters in concrete vaults of first radioactive waste storage area (ASDR) LLW & ILW: Spent resins and any others waste in concrete vaults of second radioactive waste storage area (IGDRS)	359.4	50	518.3 ^[4]	3,383

Facility	Description of stored waste	Storage method	On-site waste inventory as of December 31, 2023			
			ILW		LLW	
			Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)
Nordion Manufacturing Facility, Kanata	Disused cobalt-60 sealed sources	Pool storage or dry containers	12	5,468	nil	nil
Nuclear Power Demonstration	Decommissioned reactor waste	Reactor building	Nil ^[1]	nil	180 ^{[2][1]}	2
Pickering Waste Management Facility	Interim storage of intermediate-level reactor refurbishment waste from Pickering A (Units 1 to 4)	ILW: dry storage modules	1,012	2,104 ^[7]	nil	nil
Point Lepreau Waste Management Facility	Operational waste: drums, filters and compactible/non-compactible boxed waste	LLW: concrete vault structures ILW: concrete vault structures, filter storage structures and refurbishment canisters	385.7	794	1,460.8	177.4 ^[5]
Port Hope Conversion Facility	Non-combustible process waste	LLW: 205 L-drums	nil	nil	2,300	N/A
	Decommissioning waste	Drums or other appropriate industrial packaging	nil	nil	2,100	N/A
Radioactive Waste Operations Site-1	Interim storage of low- and intermediate-level reactor waste generated by Douglas Point and Pickering A (Units 1 to 4)	ILW: in-ground storage structures (trenches, tile holes) LLW: in-ground storage structures (trenches)	5	12 ^[6]	325	<1 ^[6]
Western Waste Management Facility	Interim storage of low- and intermediate-level reactor waste generated by Bruce Power,	ILW: in-ground storage structures (trenches, tile holes, in-ground containers) and above-ground storage structures	11,858 ^[8]	56,702 ^[6]	90,638	86 ^[6]

Facility	Description of stored waste	Storage method	On-site waste inventory as of December 31, 2023			
			ILW		LLW	
			Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)
	Darlington, and Pickering A and B	(retube waste storage building, quadricells) LLW: above-ground storage structures (low-level storage buildings, steam generator storage buildings)				
Whiteshell Laboratories	Decommissioning waste	ILW: in-ground concrete bunkers and storage tanks LLW: above-ground concrete bunkers, recoverable surface storage areas	903 ^[1]	N/A	18,379 ^[1]	333

Note: N/A means “not available”.

[1] Volumes reported in 2019 included proposed in-situ disposal waste. As per reporting guidelines, proposed in-situ disposal quantities have not been included in the current inventory, since they have not yet been classified as waste. Note that forecasted future waste estimates are reported on the IAEA Spent Fuel and Radioactive Waste Information System (SRIS)

[2] Volumes have been reduced through waste minimization approaches, including methods to physically reduce the size of the waste materials such as incineration and compacting. In addition, materials transferred to the CRL site for storage, which are captured in the CRL inventories

[3] This increase, relative to reporting in 2019, is due to revised assumptions based on operational experience – i.e., more containers were opened and inventoried, which led to adjusted assumptions on the waste volumes in other containers. Furthermore, some of the increase is the result of a full review of the waste accounting, and adjustments made as a result. Notably, a certain volume of waste was previously included in future years projections, instead of being captured as existing waste

[4] Hydro-Québec carried out a major project to reduce the volume of radioactive waste inventories stored at the site.

[5] Not including resin activity, which has not previously been assessed

[6] Approximate activity based on 2013 inventory report

[7] Approximate activity after 35 years of decay

[8] Includes station in-tank spent resin volumes assumed to be eventually transferred to WWMF and stored long-term

[9] Approximate activity from eMWaste, a waste inventory tracking software

[10] Retube fuel channel components from Darlington refurbishment

Figure D.5 below shows the volume of LLW in storage in Canada as of December 31, 2023, as inventoried in table D.8.

Figure D.5: Volume of low-level waste in storage in Canada as of December 31, 2023

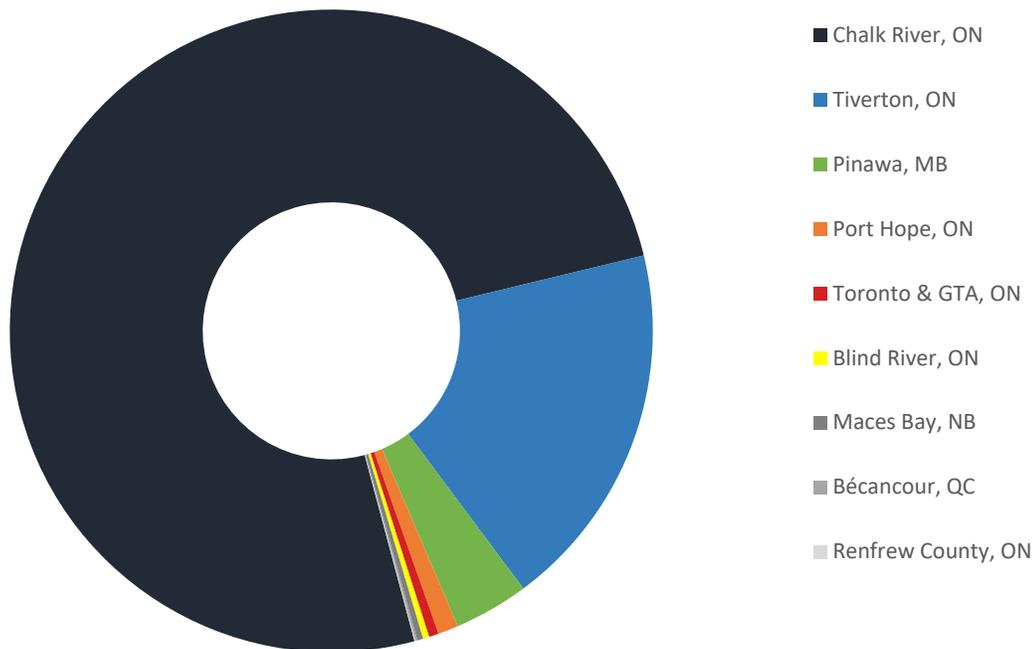
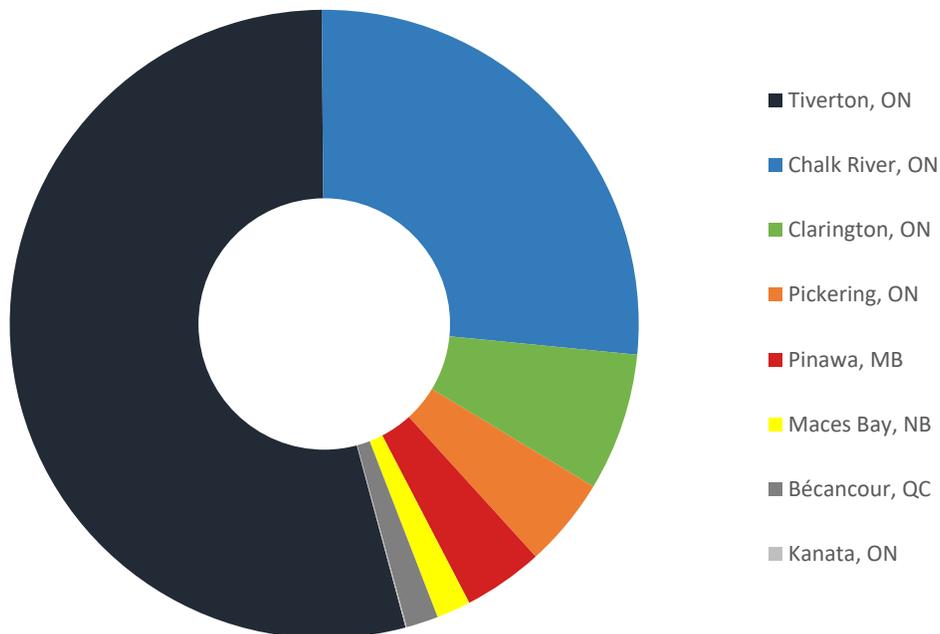


Figure D.6 below shows the volume of ILW in storage in Canada as of December 31, 2023, as inventoried in table D.8.

Figure D.6: Volume of intermediate-level waste in storage in Canada as of December 31, 2023



D.1.4.3 Low-level radioactive waste that has resulted from past practices

Table D.9 below inventories LLW that has resulted from past storage practices in Canada.

Table D.9: Inventory of low-level waste that has resulted from past storage practices in Canada

Site name or location	Description of stored waste	Storage method	LLW	
			Volume (m ³)	Activity (TBq)
Deloro Mine site ^[1]	Contaminated soils and historical tailings	<i>In situ</i> (fenced-in area)	34,500	2
Greater Toronto Area	Radium-contaminated soils, radium contamination fixed to structural elements in buildings	<i>In situ</i> and consolidated storage	2,412 ^[4]	N/A
Port Granby ^[3]	Waste and contaminated soils	Consolidated storage in Long-term Waste Management Facility	802,800	160
Port Hope ^{[2][3]}	Waste and Contaminated soils	<i>In situ</i> and consolidated storage, including Long-term Waste Management Facility	980,692	259

Note: N/A means “not available”.

[1] Site no longer under licence by the CNSC.

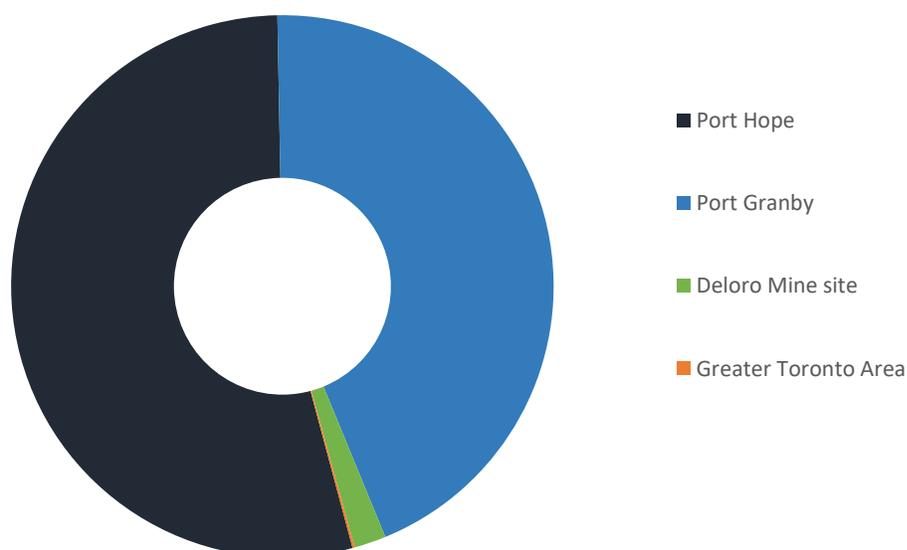
[2] Port Hope also incorporates the waste previously reported in the Welcome Waste Management Facility.

[3] Represents waste emplaced into long-term waste management facility and/or currently in a historic temporary storage location. Volume inventory is estimated, as official quantities are captured in mass.

[4] Completion of additional characterization in 2023 identified a lower volume compared to previous reported estimates.

Figure D.7 below shows the volume of LLW that has resulted from past storage practices in Canada as of December 31, 2023, as inventoried in table D.9.

Figure D.7: Volume of low-level waste that has resulted from past storage practices in Canada as of December 31, 2023



D.1.4.4 Uranium mining and milling waste

D.1.4.4.1 Operational mine and mill sites

Table D.10 below inventories uranium tailings and waste rock in storage at operational mine and mill sites in Canada.

Table D.10: Inventory of uranium tailings and waste rock in storage at operational mine and mill sites in Canada as of December 31, 2023

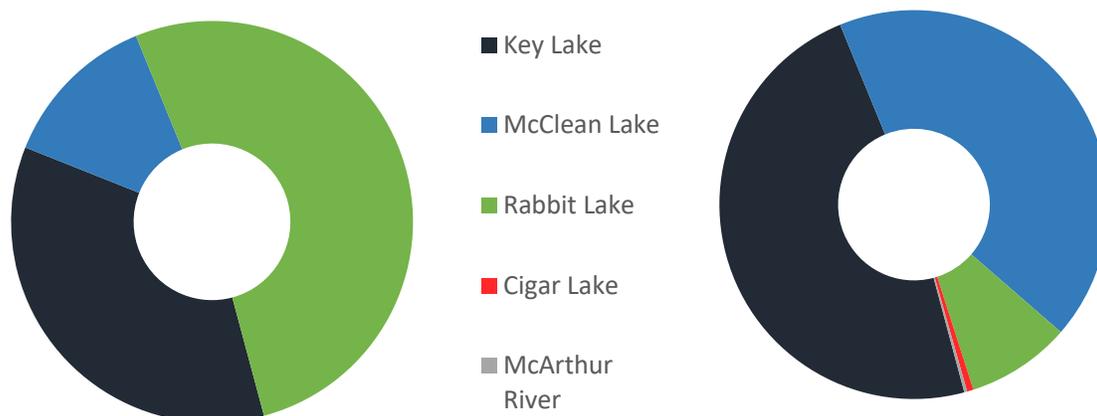
Operating mine and mill site	Storage method	On-site waste inventory as of December 31, 2023		
		Tailings	Waste rock	
		Mass (tonnes)	Mineralized (tonnes)	Non-mineralized (tonnes)
Cigar Lake	No tailings on-site; ore is transported to McClean Lake for milling	nil	787,000	123,000
Key Lake	Deilmann TMF	6,350,000 ^[1]	1,040,000	68,010,000
McArthur River	No tailings on-site; ore is transported to Key Lake for milling	nil	107,000	71,000
McClean Lake	In-pit TMF	2,406,199 ^[2]	13,700,000	46,200,200
Rabbit Lake	Rabbit Lake in-pit TMF	9,130,000	2,340,000	13,085,000

[1] Includes tailings accumulated from the processing of ores from McArthur River.

[2] Includes tailings accumulated from the processing of ores from Cigar Lake.

Figure D.8 below shows the mass of uranium tailings and waste rock in storage at operational mine and mill sites in Canada as of December 31, 2023, as inventoried in table D.10.

Figure D.8: Mass of uranium tailings and waste rock in storage at operational mine and mill sites in Canada as of December 31, 2023



D.1.4.4.2 Decommissioned and inactive tailings sites

Table D.11 below inventories uranium tailings and waste rock in storage at decommissioned and inactive tailings sites in Canada.

Operations at the sites in table D.11 pre-dated current waste segregation practices. As a result, the breakdown between mineralized and non-mineralized waste rock is not available.

Table D.11: Inventory of uranium tailings and waste rock in storage at decommissioned and inactive tailings sites in Canada as of December 31, 2023

Site name or location	Storage method	On-site waste inventory as of December 31, 2023	
		Tailings Mass (tonnes)	Waste rock Mass (tonnes)
Decommissioned tailings sites			
Cluff Lake	Tailings management area – surface	3,230,000	18,400,000
Inactive tailings sites			
Agnew Lake	Lake-vegetated, above-ground tailings	510,000	N/A
Beaverlodge	Above-ground tailings and mine backfill	5,700,000 ^[1]	4,800,000

Site name or location	Storage method	On-site waste inventory as of December 31, 2023	
		Tailings Mass (tonnes)	Waste rock Mass (tonnes)
Bicroft	Above-ground tailings in two areas	2,000,000	N/A
Denison	Flooded, above-ground tailings in two areas	63,800,000	N/A
Dyno	Above-ground tailings	600,000	N/A
Gunnar	Above-ground tailings	4,400,000	N/A
Key Lake	Above-ground TMF	3,579,781 ^[2]	reported in table D.10
Lacnor	Above-ground tailings	2,700,000	N/A
Lorado	Above-ground tailings	360,000	N/A
Madawaska	Above-ground tailings in two areas	4,000,000	N/A
Milliken	Tailings management area	150,000	N/A
Nordic	Above-ground tailings	12,000,000	N/A
Panel	Flooded, above-ground tailings	16,000,000	N/A
Port Radium	Above-ground tailings in four areas	907,000	N/A
Pronto	Above-ground tailings	2,100,000	N/A
Quirke 1 and 2	Flooded, above-ground tailings	46,000,000	N/A
Rabbit Lake	Above-ground TMF	6,500,000	reported in table D.10
Rayrock	Above-ground tailings in north and south tailings piles	71,000	N/A
Spanish American	Flooded, above-ground tailings	450,000	N/A
Stanleigh	Flooded, above-ground tailings	19,953,000	N/A
Stanrock/Can-Met	Above-ground tailings	5,750,000	N/A

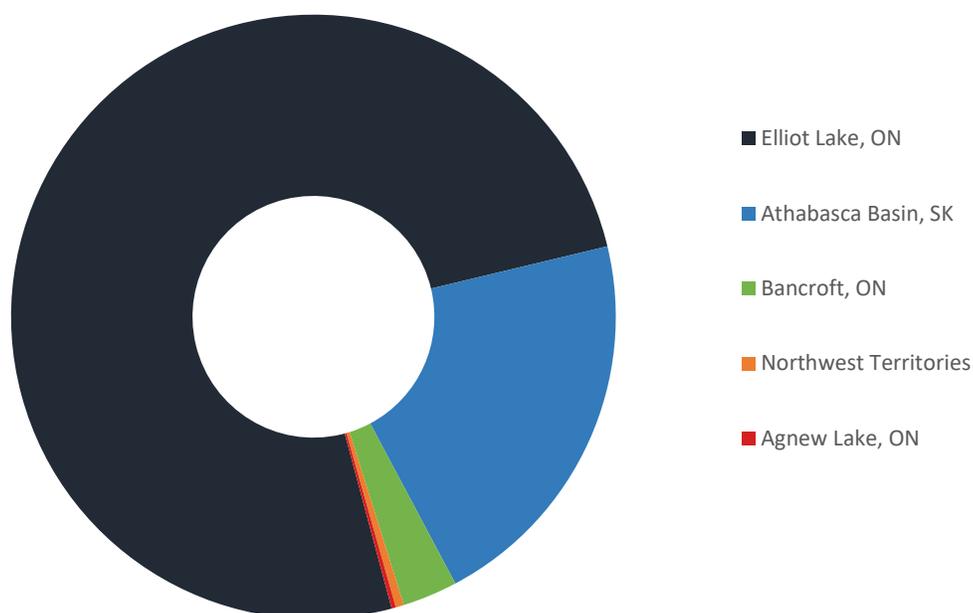
Note: N/A means “not available”.

[1] Tailings volume does not include 4,300,000 tonnes that have been used as backfill.

[2] Based on monthly production reports between 1983 and 1996. In 1996, tailings placement switched to the Deilmann TMF.

Figure D.9 below shows the mass of uranium tailings and waste rock in storage at decommissioned and inactive tailings sites in Canada as of December 31, 2023, as inventoried in table D.11.

Figure D.9: Mass of uranium tailings and waste rock in storage at decommissioned and inactive tailings sites in Canada as of December 31, 2023



D.1.5 Nuclear facilities undergoing decommissioning in Canada

Table D.12 below lists the nuclear facilities currently in the process of being decommissioned in Canada and includes the status of the decommissioning activities at those facilities.

Table D.12: Nuclear facilities undergoing decommissioning in Canada

Facility	Decommissioning status
Chalk River Laboratories	A number of CRL nuclear facilities are at different stages of decommissioning. The dedicated isotopes facilities (Multipurpose Applied Physics Lattice Experiment (MAPLE) and new processing facility) remain in an extended shutdown state. The NRU reactor was permanently shut down in March 2018, then de-fuelled and de-watered, and it continues to move through the shutdown state to achieve storage-with-surveillance conditions. The National Research Experimental (NRX) reactor and the active waste disposal system remain in storage-with-surveillance. A few other facilities have been newly turned over to facilitate decommissioning, such as the nuclear fuel fabrication facility and tritium facility. The NRX ancillary buildings, fuel storage bays, plutonium recovery laboratory, plutonium tower, wastewater evaporator and filter water storage reservoir are at different stages of active decommissioning.
Douglas Point Waste Management Facility	Following acceptance of a licence amendment in November 2020, the Douglas Point WMF has commenced phase 3 of decommissioning. The licence is valid for 10 years and includes all decommissioning activities

Facility	Decommissioning status
	for the site but excludes the final reactor dismantling. This will be the subject of a follow up hearing once the surrounding systems have been removed and access is permitted to finalize the methodology to dismantling the reactor.
Gentilly-1 Waste Management Facility	The Gentilly-1 reactor is in storage-with-surveillance. Ongoing monitoring confirms that the facility continues to remain in a safe SWS state.
Gentilly-2 Nuclear Generating Station	The Gentilly-2 NGS was shut down in December 2012. Since then, many activities have taken place to prepare for the storage-with-surveillance phase, including the complete defueling of the reactor core, draining of the light water circuits, draining of the heavy water circuits, transfer of oils from some internal systems, and transfer of used resins from internal systems. Since December 2020, all of the spent fuel is out of the fuel bay and in dry storage.
Gunnar mine site	Since the issuance of their licence, SRC began remediation work at the Gunnar mine site, which has included developing borrow areas and haul roads, consolidating, re-grading and covering tailings at both Gunnar main and central tailings areas. SRC is implementing remediation plans and continues the construction of landfills and the consolidation of waste (both radioactive and hazardous wastes) and work to remediate the tailings located in Langley.
Nuclear Power Demonstration	NPD is in storage-with-surveillance. In this state, facilities are monitored and maintained to promote radioactive decay.
Saskatchewan Research Council SLOWPOKE-2	<p>After 38 years of operation, the SRC SLOWPOKE-2 facility was decommissioned. In July 2020 the decommissioning activities reached the end state objective of the SRC's Detailed Decommissioning Plan (DDP).</p> <p>The Commission determined that the unconditional release and unrestricted use criteria had been met. In 2021, the Commission revoked the SRC's decommissioning licence and issued a licence to abandon, authorizing the release of this facility from CNSC regulatory control.</p>
Whiteshell Laboratories	WL consists of many individual facilities. A number of these facilities are in the process of active decommissioning, while others remain in storage-with-surveillance. For example, all systems and components of the SLOWPOKE Demonstration Reactor have been removed, with the exception of the pool liner and cover. The main research building (building 300) is undergoing decommissioning and demolition in a phased manner. The WR-1 is currently in storage-with-surveillance.

For further information on the decommissioning status of the facilities listed in table D.12, see annex 8.

SECTION E

Legislative
and
regulatory
systems



Section E – Legislative and Regulatory Systems

E.1 Implementing measures (Article 18)

This section addresses the obligations under Article 18 of the Joint Convention.

Section 9 of the *Nuclear Safety and Control Act* (NSCA) sets out the objects of the CNSC as follows:

- (a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to:
 - (i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,
 - (ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and
 - (iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and
- (b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph (a).

E.2 Legislative and regulatory framework (Article 19)

This section addresses the obligations under Article 19 of the Joint Convention.

ARTICLE 19. LEGISLATIVE AND REGULATORY FRAMEWORK

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.
2. This legislative and regulatory framework shall provide for:
 - (i) the establishment of applicable national safety requirements and regulations for radiation safety;
 - (ii) a system of licensing of spent fuel and radioactive waste management activities;
 - (iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;
 - (iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;
 - (v) the enforcement of applicable regulations and of the terms of the licences;
 - (vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and radioactive waste management.
3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

E.2.1 Establishment of the Canadian legislative and regulatory framework

The following are the statutes used to regulate and oversee the nuclear industry in Canada, which include the management of radioactive waste and spent fuel: the *Nuclear Safety and Control Act* (NSCA), *Nuclear Energy Act* (NEA), *Nuclear Fuel Waste Act* (NFWA) and *Nuclear Liability and Compensation Act* (NLCA). The nuclear industry is also subject to the *Impact Assessment Act* (IAA), the *Canadian Environmental Protection Act* (CEPA) and the *Fisheries Act*. The NSCA is the main legislation that deals with nuclear safety considerations. In Canada, an act is a means by which a law is made by Parliament.

A number of Government of Canada departments are involved in administering this federal legislation. 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 legislation and regulations in force in the individual provinces and territories where nuclear-related activities are carried out. Where an overlap occurs in jurisdictions and responsibilities, the CNSC takes the lead in efforts to harmonize regulatory activities, including joint regulatory groups, which involve provincial and territorial regulators.

E.2.1.1 *Nuclear Safety and Control Act*

The NSCA was passed by Parliament on March 20, 1997, and came into force on May 31, 2000, replacing the *Atomic Energy Control Act*. This was the first major overhaul of Canada's nuclear regulatory regime since the creation of the Atomic Energy Control Board in 1946. The NSCA provides legislative authority for all nuclear industry developments, including health and safety standards for nuclear energy workers, environmental protection measures, security of nuclear facilities and public input in the licensing process. The NSCA can be viewed online at laws.justice.gc.ca.

The CNSC was established in the NSCA as an independent regulatory body responsible for regulating the use of nuclear material in Canada and the nuclear fuel cycle. The NSCA sets out the CNSC's mandate, responsibilities and powers. It authorizes the CNSC to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in Canada. The NSCA empowers the CNSC to make regulations (see section E.2.2.2 for more details).

Under the NSCA, the CNSC's mandate covers four major areas:

- regulation of the development, production and use of nuclear energy in Canada to protect health, safety and the environment
- regulation of the production, possession, use and transport of nuclear substances, and the production, possession and use of prescribed equipment and prescribed information
- implementation of measures respecting international control of the development, production, transport and use of nuclear energy and substances, including measures respecting the non-proliferation of nuclear weapons and nuclear explosive devices
- dissemination of scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and use of nuclear substances

Regulations made in accordance with the NSCA have been crafted to ensure that public health and safety are protected. For example, these regulations include:

- radiation dose limits consistent with ICRP recommendations
- regulations that govern the transport and packaging of nuclear materials

- specifications for enhanced security at nuclear facilities, including spent fuel dry storage and radioactive waste management facilities
- the authority to issue an order for remedial action in hazardous situations

E.2.1.2 Nuclear Energy Act

The NEA came into force concurrently with the NSCA in 2000. It is a revised version of the *Atomic Energy Control Act* (1946), and is intended to address the development and use of nuclear energy, without the regulatory aspects of the *Atomic Energy Control Act*, which were moved to the NSCA. The NEA can be viewed online at laws.justice.gc.ca.

The NEA gives the designated government minister 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
- 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 licences, discoveries, inventions, improvements and patent rights

E.2.1.3 Nuclear Fuel Waste Act

Through the Government of Canada's 2002 *Nuclear Fuel Waste Act* (NFWA), the Nuclear Waste Management Organization (NWMO) was federally mandated to design and implement Canada's plan for the safe, long-term management of the country's used nuclear fuel.

The need for the NFWA was derived from an environmental assessment process initiated over 30 years ago in which the governments of Canada and Ontario directed Atomic Energy of Canada Limited (AECL) to develop the concept of deep geological disposal of nuclear fuel wastes. While an independent environmental assessment panel concluded the technology itself was demonstrated to be technically feasible, the concept of deep geological disposal lacked broad public support at that time. A key recommendation that emerged from the panel's review to support the development of an approach to nuclear fuel waste management that could achieve broad public support was the need to create a nuclear fuel waste management agency.

In Canada, three provincial utilities, Ontario Power Generation (OPG), Hydro-Québec, and New Brunswick Power own approximately 98 % of the spent fuel in Canada, with AECL owning most of the remainder. The NFWA required nuclear energy corporations to establish a waste management organization (now called the Nuclear Waste Management Organization – The NWMO) 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 financial institutions to finance their long-term waste management responsibilities. The NFWA also required the waste management organization to prepare and submit a study to the Government of Canada on proposed approaches for the long-term management of the waste, along with a recommendation on which one of the proposed approaches should be adopted. The NFWA required this analysis to include feedback from comprehensive public consultations – which includes Indigenous peoples – and be evaluated in terms of social and ethical considerations.

Under the NFWA, the Government of Canada was responsible for reviewing the study prepared by the waste management organization and selecting a long-term management option from those proposed. The Government of Canada is also responsible under the NFWA for providing oversight of the waste management organization during the implementation of the selected approach. The NFWA can be viewed online at laws.justice.gc.ca.

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 geological disposal
- the Adaptive Phased Management (APM) approach which combines the three previous options in one flexible, adaptive process for making management decisions

On June 14, 2007, the Government of Canada announced that it had selected the APM approach for the long-term management of spent fuel. This approach recognizes that the people who benefit from nuclear energy produced today must take actions to ensure that wastes are dealt with responsibly and without unduly burdening future generations. The approach is also sufficiently flexible to adjust to changing social and technological developments. The NWMO is required to implement the government's decision according to the NFWA, with funding from the nuclear energy corporations.

Over the past several years, a number of key government decisions contributed to implementing the APM approach. In April 2009, the Minister of Natural Resources approved a funding formula which ensures that sufficient money is set aside in trust to pay for the full lifecycle cost of this approach. On August 14, 2009, the Minister of Natural Resources entered into a memorandum of understanding with the NWMO regarding Indigenous engagement. The memorandum clarifies the roles and responsibilities of the Crown and the NWMO with respect to their obligation to consult with Indigenous peoples about this project and in relation to the NFWA.

Since early 2010, the NWMO has been moving forward with its consent-based siting process to identify a safe, secure and suitable site for a DGR to manage spent fuel in an informed and willing host community. A number of communities have inquired about the project and are exploring their interest with the NWMO. As of March 2024, Wabigoon Lake Ojibway Nation - Ignace in northwestern Ontario and Saugeen Ojibway Nation - South Bruce in southern Ontario were still considered as potential host areas for the project. The NWMO expects to identify a single, preferred site by November 2024 (see section K.2.4 for more details).

E.2.1.4 Nuclear Liability and Compensation Act (NLCA)

The NLCA entered into force on January 1, 2017, and replaced the *Nuclear Liability Act*. The NLCA establishes the legal regime that would apply in the event of a Canadian nuclear incident that results in civil damages. The NLCA is administered by NRCAN, which also has responsibility for policy direction. The NLCA can be viewed online at laws.justice.gc.ca.

The NLCA places total responsibility for civil nuclear damage on the operator of a nuclear installation. As of January 1, 2020, the operator is liable for up to \$1 billion in damages. The NLCA requires the operator to carry at least half of this liability with insurance that may, subject to approval by the minister, be supplemented by alternate financial arrangements. The NLCA also provides for establishing a nuclear claims tribunal in the event of a serious nuclear incident which would deal with claims for compensation when the Government of Canada deems it to be in the public interest, having regard to the extent and estimated cost of the damage.

The NLCA also features:

- expanded categories of compensable damage to address environmental damage, economic loss and costs related to preventive measures
- a longer time period for submitting compensation claims for bodily injury (30 years versus the current 10 years)
- the process for establishing a quasi-judicial claims tribunal to replace the court system, if necessary, to accelerate claims payments and to provide an efficient and equitable forum
- In 2021, NRCan undertook its first five-year review of the C\$1 billion liability limit under the NLCA, and its enabling regulations. The five-year review of the C\$1 billion liability limit builds on Canada's experience, regulatory leadership, and global reputation in the nuclear space. One of the findings of this review suggested review of the financial security requirements for low-risk installations to determine if they remain appropriate, along with the existing indemnity fee structure. NRCan is currently undertaking subsequent work to update liability limits for existing low-risk installations, that includes waste management facilities. This work may result in the addition of new categories of installations for waste management facilities, such as deep geological repositories (DGRs)

The NLCA also enables Canada to implement the *Convention on Supplementary Compensation for Nuclear Damage*, an international treaty under the auspices of the IAEA, which provides a liability and compensation regime to address damages, including those arising from transboundary and transportation incidents. Canada delivered the ratification documents for that Convention on June 6, 2017.

E.2.1.5 *Impact Assessment Act*

The IAA and its regulations establish the legislative basis for the federal practice of impact assessments in most regions of Canada and can be viewed online at laws.justice.gc.ca. Impact assessment is a planning and decision-making tool used to assess the positive and negative environmental, economic, health and social effects of proposed projects, as well as impacts on Indigenous Nations and communities.

The purpose of the IAA is to:

- foster sustainability, ensure respect of government commitments concerning the rights of Indigenous Nations and communities
- include environmental, social, health and economic factors in the scope of assessments
- establish a fair, predictable and efficient impact assessment process that enhances Canada's competitiveness and promotes innovation
- consider positive and adverse effects
- include early, inclusive and meaningful public engagement
- promote nation-to-nation, Inuit-Crown, and government-to-government partnerships with Indigenous Nations and communities
- ensure decisions are based on science, Indigenous knowledge and other sources of evidence
- assess cumulative effects within a region

The Impact Assessment Agency of Canada (IAAC) leads the conduct of impact assessments for all designated projects subject to this legislation and works in collaboration with the CNSC to review projects that are also subject to regulation under the NSCA. Nuclear projects to be assessed under the IAA are subject to an integrated impact assessment that is carried out by a review panel. An integrated impact assessment is a single assessment process meant to ensure that the requirements of the IAA and the NSCA are discharged as "one project, one assessment."

In 2019, IAAC and the CNSC signed a [memorandum of understanding \(MOU\)](#) that outlines the collaboration between the two partners.

Where projects link to regulators with responsibilities that cover the full lifecycle of a project, such as the CNSC for nuclear projects, the IAAC works collaboratively with these lifecycle regulators to draw upon their expert knowledge and ensure that safety, licensing requirements, international obligations and other key regulatory factors are considered as part of a single, integrated assessment. The MOU between the CNSC and IAAC confirms the commitment to work collaboratively to conduct integrated impact assessments under the IAA. The CNSC and IAAC are to ensure that the principle of “one project, one assessment” is followed when reviewing designated projects regulated by the CNSC, and that any reviews are conducted in an efficient and effective manner, without unnecessary delays or duplication of effort. The IAA stipulates that for designated projects, as identified in the *Physical Activities Regulations* that are also subject to lifecycle regulation by the CNSC, the assessment must be conducted by an integrated review panel whose members must include representatives from the regulator.

Projects with environmental assessments already initiated under *Canadian Environmental Assessment Act, 2012* (CEAA 2012) will continue under their current processes, as per the transition provision (section 182) of the IAA. This is the case for the environmental assessments of CNL's Near Surface Disposal Facility (NSDF) project, NPD Closure Project and *in situ* decommissioning of WR-1, all of which are led by the CNSC. For these projects, the CNSC is responsible for managing the environmental assessment process, including ensuring an environmental assessment report is prepared. In practice, the project proponent may be delegated to conduct technical studies for the environmental assessment or to ensure mitigation measures and/or a follow-up program are implemented; however, the Commission is the federal decision-maker when determining whether a project is likely to cause significant adverse environmental effects.

On October 13, 2023, the Supreme Court of Canada (SCC) rendered a decision relating to the constitutionality of the *Impact Assessment Act* (IAA). The SCC was asked to consider whether the IAA and one of its regulations went beyond the federal Parliament's legislative authority under the Constitution and encroached on provincial powers. The Court opined that portions of the IAA are beyond the powers conferred on the Federal Parliament and are therefore unconstitutional; however, as nuclear projects are regulated by the federal government and would have potential adverse effects within federal jurisdiction, and the parts of the IAA applicable to these projects were found to be constitutional, there is a limited impact on the designated nuclear projects that will require an impact assessment. The Government of Canada has signalled its intention to amend the IAA to better align the IAA with the SCC's ruling, even though the amendments have not yet been made.

E.2.1.6 *Canadian Environmental Protection Act*

The primary purpose of the CEPA is to contribute to sustainable development by preventing pollution. It provides the legislative basis for a range of federal environmental- and health-protection programs, including:

- the assessment and management of risks from chemicals, polymers and living organisms
- programs related to air and water pollution, hazardous waste, air pollutants and greenhouse gas emissions
- ocean disposal
- environmental emergencies

E.2.1.7 Fisheries Act

The *Fisheries Act* was one of the first laws enacted in Canada in 1868. Recognizing that healthy and productive fisheries require healthy fish habitat, legislators incorporated the habitat-protection and pollution-prevention provisions into the Act in the 1970s. In 2019, changes were made to the *Fisheries Act* to provide a framework for the conservation and protection of fish and fish habitats by:

- ensuring protection for fish and fish habitats, and incorporating tools to accomplish this
- providing certainty for industry, stakeholders and Indigenous Nations and communities
- promoting the long-term sustainability of aquatic resources

Since 2013, Fisheries and Oceans Canada (DFO) and the CNSC have had a MOU outlining areas for cooperation under the *Fisheries Act*. In 2023, the MOU was updated to place a greater focus on collaboration and information sharing between DFO and the CNSC.

The CNSC has always reviewed impacts to the environment, including impacts to fish and fish habitat, under the *Nuclear Safety and Control Act* and will continue to do so. Under the MOU, the CNSC will ensure that its reviews take into consideration the requirements of the revised *Fisheries Act*.

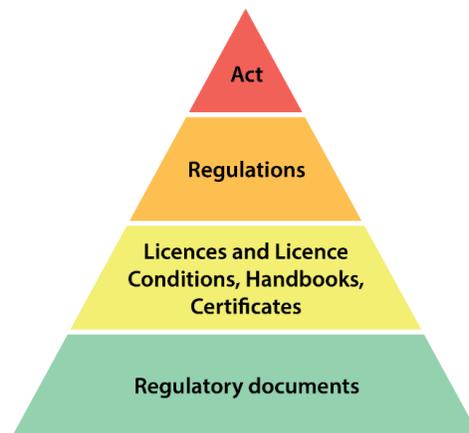
The Minister of Fisheries and Oceans remains accountable for decisions under the habitat provisions of the *Fisheries Act* and for protecting aquatic species listed under the *Species at Risk Act*. [Read the MOU](#).

E.2.2 National safety requirements and regulations

The Canadian Nuclear Safety Commission regulates the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. Established in 2000 under the *Nuclear Safety and Control Act* (NSCA), the CNSC reports to Parliament through the Minister of Natural Resources. To safely regulate an evolving nuclear sector, the CNSC maintains an effective and flexible regulatory framework.

The CNSC's regulatory framework, shown in Figure E.1, consists of [laws](#) passed by Parliament that govern the regulation of Canada's nuclear industry and associated [regulations](#), licences and certificates, and, regulatory [documents](#). The CNSC uses all elements shown in Figure E.1 to regulate the nuclear industry in Canada.

Figure E.1: Elements of the Canadian nuclear regulatory framework



As shown in figure E.2, the CNSC's regulatory framework applies to all nuclear industries, including, but not limited to, the following:

- nuclear power reactors
- non-power nuclear reactors, including research reactors
- nuclear substances and radiation devices used in industry, medicine and research
- the nuclear fuel cycle from uranium mining through to waste management

The CNSC regulatory framework also applies to the import and export of controlled nuclear and dual-use substances, equipment and technology identified as a proliferation risk. The CNSC also upholds and respects international commitments on the peaceful use of nuclear energy and materials.

Figure E.2: Nuclear industries regulated by the CNSC



E.2.2.2 Regulations issued under the *Nuclear Safety and Control Act*

A regulation, also referred to as “delegated legislation” or “subordinate legislation,” provides additional clarity on how the NSCA applies at the operational level and explains what must be done to comply with the NSCA. NSCA-associated regulations are made by the Commission with the approval of the Governor in Council.

Regulations set requirements for all types of licence applications and obligations, and provide for exemptions from licensing. By-laws are in place to govern the management and conduct of the Commission's affairs.

The following regulations have been issued under the NSCA:

- **General Nuclear Safety and Control Regulations**

Provide general regulations with respect to licence applications and renewals, exemptions, obligations of licensees, prescribed nuclear facilities and equipment and information, contamination, record-keeping, and inspections.

Apply to: All nuclear facilities and CNSC licensees and applicants

- **Administrative Monetary Penalties Regulations**

The *Administrative Monetary Penalties Regulations* (AMPR) sets out the list of violations that are subject to administrative monetary penalties under the NSCA, the method and criteria by which the penalty amounts will be determined, and the manner in which notices of violations must be served. These regulations apply to all persons subject to the NSCA.

Apply to: All persons subject to the NSCA

- **Radiation Protection Regulations**

The RPR define the ALARA principle and regulations for radiation dose limits, action levels, requirements for labelling and signage, and reports.

Apply to: All nuclear facilities and CNSC licensees and applicants

CNSC staff assess licensees' radiation protection programs to ensure that they meet the RPR requirements. Radiation protection programs are assessed at certain times in the lifecycle of a nuclear facility or regulated activity: during the initial application (site evaluation and preparation, construction, operation and decommissioning), and at the time of licence renewal and/or amendment. The radiation protection program forms part of the licensing basis for the nuclear facility or regulated activity.

The current regulations, last amended in 2020, are informed by international benchmarks such as the International Commission on Radiological Protection (ICRP) and the IAEA. The CNSC is committed to ensuring its radiation protection requirements are up to date to protect workers, the Canadian public and the environment. As a result of the discussion paper review, as well as focused consultation with interested parties, the amended RPR were published in November 2020 with additional transitional provisions coming into force in January 2021.

Some of the key amendments to the RPR made during the reporting period included:

- enhancing the requirements for licensees to provide information to nuclear energy workers (NEWs) including: information regarding the worker's responsibilities and associated risks during the control of an emergency, information regarding the risks to breastfed infants from intakes of nuclear substances, and information regarding the importance of informing the licensee when a female NEW is pregnant or breastfeeding
- removing the previous provision requiring a female NEW to disclose her pregnancy to the licensee
- adding a new requirement for a licensee to use a licensed dosimetry service to ascertain equivalent dose to the skin or to the hands and feet for NEWs that may receive greater than 50 mSv in a one-year dosimetry period

- revising the equivalent dose limit for the lens of an eye for a NEW from 150 mSv to 50 mSv in a one-year dosimetry period
- adding a specific record retention period for dose records
- adding a new requirement for licensees to ensure that radiation detection and measurement instrumentation is selected, tested, and calibrated for its intended use

To support licensees in the implementation of the amended RPR, during the reporting period the CNSC published three new regulatory documents:

- REGDOC-2.7.1, Radiation Protection
- REGDOC-2.7.2, Dosimetry, Volume I: Ascertaining Occupational Dose
- REGDOC-2.7.2, Dosimetry, Volume II: Technical and Management System Requirements for Dosimetry Services

These new regulatory documents supersede legacy regulatory guides and standards, providing new and updated guidance for radiation protection and dosimetry that is aligned with the revised RPR.

- **[Class I Nuclear Facilities Regulations](#)**

Provide requirements for site preparation licence applications, personnel certifications, record-keeping and sets timelines for regulatory reviews.

Apply to: Class 1A and Class 1B nuclear facilities including nuclear reactors, large particle accelerators, nuclear processing plants, fuel fabrication plants and waste disposal facilities

- **[Class II Nuclear Facilities and Prescribed Equipment Regulations](#)**

Provide requirements for licence applications, certification of prescribed equipment, radiation protection and record-keeping.

Apply to: Class II facilities and Class II prescribed equipment licensees and applicants

- **[Uranium Mines and Mills Regulations](#)**

Provide requirements for site preparation, construction, operation, decommissioning and abandonment of uranium mines and mills, including licensees' obligations with respect to operating procedures, codes of practice, ventilation systems, use of respirators, protection from gamma radiation, record-keeping, and set timelines for regulatory reviews.

Apply to: Uranium mine and mill licensees and applicants

- **[Nuclear Substances and Radiation Devices Regulations](#)**

Provide requirements for the licensing and certification of nuclear substances and radiation devices, use of radiation devices and record-keeping.

Apply to: All nuclear substances, sealed sources, radiation devices, licensees and applicants

- [**Packaging and Transport of Nuclear Substances Regulations, 2015**](#)

Provide requirements for licences to transport, transport of nuclear substances, record keeping as well as requirements for the design and certification of packages, special form radioactive material and other prescribed equipment.

Apply to: All persons transporting or offering for transport nuclear substances, including nuclear facilities and CNSC licensees and applicants

- [**Nuclear Security Regulations**](#)

Part I defines security-related information requirements and general obligations for application. It also includes information about security requirements for high-security sites. Part II provides security-related requirements for licensing and operation of lower-risk facilities.

Apply to: Any CNSC licensee and applicant with respect to Category I, II and III nuclear material and high-security sites

- [**Nuclear Non-proliferation Import and Export Control Regulations**](#)

Provide requirements for a licence application to import or export controlled nuclear substances, controlled nuclear equipment, or controlled nuclear information, in addition to exemptions from licensing for certain import and export activities.

Apply to: Any CNSC licensee and applicant with respect to import and export activities

- [**Canadian Nuclear Safety Commission Cost Recovery Fees Regulations**](#)

Set regulatory fees for the provision of information, products and services, and prescribe the method of calculating the fees that may be charged for a licence or class of licence.

Apply to: All nuclear facilities and CNSC licensees and applicants

- [**Canadian Nuclear Safety Commission Rules of Procedure**](#)

Define the procedures for CNSC public hearings and opportunities to be heard.

Apply to: The CNSC

- [**Canadian Nuclear Safety Commission By-laws**](#)

Define management and conduct of Commission's affairs (meetings).

Apply to: All nuclear facilities and CNSC licensees and applicants

E.2.2.3 Regulatory and guidance documents

The NSCA and its associated regulations set out legislative requirements, while regulatory documents provide clarity on the information necessary to meet those requirements. The CNSC develops regulatory documents under the authority of paragraphs 9(b) and 21(1)(e) of the NSCA.

Regulatory documents generally include two kinds of information: requirements and guidance. When included in the licensing basis, requirements are mandatory and must be met by any licensee wishing to obtain (or retain) a licence or certificate to use nuclear substances or to operate a nuclear facility. Guidance provides direction to licensees and applicants on how requirements could be met. It also provides more information about approaches used by CNSC staff to evaluate specific problems or data during the review of

licence applications. Licensees are expected to review and consider guidance; if these documents are not being followed, the licensees should explain how the alternate approach they have chosen still meets, or exceeds, regulatory requirements.

Each regulatory document aims to disseminate objective regulatory information to stakeholders, which include licensees, applicants, public interest groups, the public, and Indigenous Nations and communities. Regulatory documents also 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/eng/acts-and-regulations/regulatory-documents.

As outlined in REGDOC-3.5.3, *Regulatory Fundamentals*, the CNSC maintains an efficient and streamlined regulatory framework by making appropriate use of accredited domestic and international standards, including those of the IAEA. As of January 1, 2022, the Commission Secretariat was renamed the Commission Registry and the Commission Secretary became the Commission Registrar. Canada has actively helped the IAEA develop nuclear safety standards and create technical documents that outline more specific technical requirements and best practices for radioactive waste management and decommissioning. The CNSC also supports the development of domestic standards, such as those developed by the Canadian Standards Association Group, which can be cited in regulatory documents.

The CNSC maintains a five-year forward regulatory framework plan that is updated annually. A complete list of regulatory documents is available at <http://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/index.cfm>. Annex 1 includes a list of the CNSC's regulatory documents published since the Seventh Review Meeting.

The CNSC is committed to maintaining a waste management and decommissioning regulatory framework that is modern and aligned with national and international standards and best practices, that ensures effective oversight of waste management and decommissioning activities. The regulatory documents in the Waste Management series (i.e., 2.11) provide requirements and guidance to ensure that radioactive waste is safely managed and disposed of, and decommissioning is planned and executed safely. Meanwhile, REGDOC-3.3.1 describes how sufficient funds for decommissioning are established and maintained. These regulatory documents are complemented by CSA standards that are cited within each document, as appropriate.

The CNSC regulatory documents related to radioactive waste management and decommissioning are as follows:

- **REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*** – The CNSC published this regulatory document in March 2021. It provides information on the framework for radioactive waste management and decommissioning in Canada. It describes the philosophy that underlies the CNSC's approach to regulating the management of radioactive waste and the decommissioning of facilities, and explains the principles taken into account in CNSC regulatory decisions.
- **REGDOC-2.11.1, *Waste Management, Volume I: Management of Radioactive Waste*** – The CNSC published this regulatory document in January 2021. It provides requirements and guidance to CNSC licensees on the management of radioactive wastes and radioactive waste storage and disposal facilities.
- **REGDOC-2.11.1, *Waste Management, Volume II: Management of Uranium Mine Waste Rock and Mill Tailings*** – The CNSC published this regulatory document in November 2018. This regulatory document sets out the CNSC's requirements for the sound management of mine waste rock and mill tailings during the site preparation, construction, operation and decommissioning of new uranium mine or mill projects and/or new waste management facilities at existing uranium mines and mills in Canada to ensure the protection of the environment and the health and safety of people.

- **REGDOC-2.11.1, Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste, Version 2** – The CNSC published this regulatory document in January 2021. It provides requirements and guidance to CNSC licensees and applicants for developing a safety case and supporting safety assessment for activities pertaining to a disposal facility, location or site. The requirements and guidance in this regulatory document should also be adopted for the disposal of uranium mine and mill waste, as applicable.
- **REGDOC-2.11.2 Decommissioning** – The CNSC published this regulatory document in January 2021 and supersedes G-219, Decommissioning Planning for Licensed Activities, published in June 2000. This document sets out requirements and guidance regarding the planning and preparation for as well as the execution and completion of decommissioning.
- **REGDOC-1.2.3, Licence Application Guide: Licence to Prepare Site for a Deep Geological Repository** – The CNSC approved this regulatory document in February 2024. It provides clarity on the requirements and guidance for preparing an application for a licence to prepare a site for a DGR.
- **REGDOC-3.3.1, Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities** - The CNSC published this regulatory document in January 2021 and supersedes G-206, Financial Guarantees for the Decommissioning of Licensed Activities, published in June 2000. This document sets out requirements and guidance for applicants and licensees regarding the establishment and maintenance of funding for the decommissioning of facilities and termination of activities licensed by the Canadian Nuclear Safety Commission. It provides information on financial guarantees used to ensure a licensee will have sufficient funds to decommission a licensed location and dispose of any associated nuclear substances.

The process for developing a regulatory document follows five key steps:

1. Analyze the issue
2. Develop a draft of the document for public comment
3. Consult with stakeholders
4. Revise the draft document for Commission approval and publication
5. Publish the regulatory document

The consultation process for draft documents has two steps:

1. Consultation: The draft document is posted to the CNSC website. The public, licensees and interested organizations are invited to comment within a defined period.
2. Invitation to provide feedback on comments received: All comments received during the first consultation period are posted on the CNSC website. All the stakeholders have an opportunity to view these comments and provide additional feedback.

E.2.3 Comprehensive licensing system for spent fuel and radioactive waste management activities

As a best practice, the CNSC gets involved early in proposed new nuclear projects to ensure future licence applicants and affected communities have a comprehensive understanding of the CNSC's role in regulating Canada's nuclear sector.

Future applicants are provided with CNSC information and guidance on the regulatory requirements and licensing process prior to the submission of a licence application and the initiation of the environmental assessment process. The CNSC engages affected communities to provide factual and unbiased information about how its mandate is fulfilled to regulate the use of nuclear energy and materials, to protect health,

safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy. More information is available on the CNSC website at nuclearsafety.gc.ca/eng/waste.

E.2.3.1 Overview of the licensing process

The CNSC initiates the licensing process once it receives an application from an applicant. The *CNSC Rules of Procedure* require the application to be filed with the Commission Registry, along with the prescribed fee set out in the *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations*.

The licence application contains the identity of the applicant, a project description and a proposed schedule for completing the licensing process. Applicants are also encouraged to submit a schedule of submissions for all required information.

Section 3 of the *General Nuclear Safety and Control Regulations* (GNSCR) lists information that must be included in all licence applications. For example, applications must cover:

- management structure
- radiation protection
- security
- waste management

CNSC staff conduct technical assessments of the information submitted by an applicant to determine whether it meets the regulatory requirements of the NSCA and regulations, CNSC requirements and expectations, international and domestic standards, and the applicable international obligations. The CNSC's assessment includes input from other federal and provincial government departments, including those responsible for regulating health and safety, environmental protection, emergency preparedness and the transportation of dangerous goods.

Once the assessment of an applicant's information is complete, CNSC staff make recommendations on the licence application to the Commission or a designated officer. Each decision to licence is based on information that demonstrates that the activity or the operation of a given facility can be carried out safely and that the environment is protected.

A licence application may be subject to other legislation and regulations. For example, an impact assessment under the IAA may be required for a designated project regulated under the NSCA and described in the *Physical Activities Regulations*, or an environmental protection review may be carried out under the NSCA for projects not listed in the *Physical Activities Regulations*. Further information on environmental reviews can be found in section E.2.3.5.1.

Once a licence is issued, the CNSC carries out compliance activities to verify that the licensee is complying with the NSCA, associated regulations and its licence.

E.2.3.2 Licensing process for Class I nuclear facilities

The CNSC's licensing process for Class I nuclear facilities is described in [REGDOC-3.5.1, Information Dissemination: Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills, Version 2.1](#), and progresses through each stage in their lifecycle. The regulations list the information required to support a licence application to conduct the following activities:

- prepare a site
- construct

- operate
- decommission
- abandon

An applicant may, at their discretion, submit a licence application for multiple classes of licences (e.g., a licence to prepare site and construct, or a licence to construct and operate). A single licence may also be issued for multiple facilities, each at a different stage in their lifecycle.

CNSC staff conduct a comprehensive review of all licence applications to ensure regulatory requirements are met. Once the assessment of an applicant's information is complete, CNSC staff will make recommendations on the licence application to the Commission. A licensing hearing is held to take into account the views, concerns and opinions of interested parties and intervenors. These hearings are open to the public and webcast live. The Commission considers the entirety of an application and all information received in the course of the matter before making a decision. Following the hearing, the Commission members will deliberate and issue a decision, including reasons for the decision.

E.2.3.3 Licensing process for uranium mines and mills

The *Uranium Mines and Mills Regulations* (UMMR) list the required information to support an application to conduct the following activities:

- prepare a site and construct
- operate
- decommission

If the necessary applications are filed with the required information, the Commission may, at its discretion, issue a licence that includes multiple activities (e.g., one licence to prepare a site, construct, operate and decommission). A single licence may also be issued for multiple facilities, each at a different stage in their lifecycle.

Specific information regarding licence applications for each stage in the lifecycle of a uranium mine and mill can be found in REGDOC-3.5.1, *Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills*.

E.2.3.4 Involving stakeholders in the licensing process

E.2.3.4.1 Pre-licensing engagement

The CNSC gives applicants the option to engage in pre-licensing activities to facilitate discussion between stakeholders, the CNSC and any other relevant government bodies prior to submitting a licence application. These interactions may facilitate the understanding of regulatory requirements, the environmental review process, the licensing process and the information that must be included in a licence application. Pre-licensing and pre-certification activities can only inform a licensing or certification process; they do not result in the issuance of a licence or certificate under the NSCA and in no way fetter the Commission's decision-making authority.

Pre-licensing engagement can vary in complexity from process-related questions to technical assessments that provide feedback to a potential applicant. An example of a pre-licensing technical assessment is the CNSC review of a proposed facility design to identify issues and means to resolve them.

Early communication enables the CNSC to plan for consultation with various interested parties, including Indigenous peoples. Applicants are also encouraged to present the proposed projects as early as possible to local communities and Indigenous peoples in order to address any potential interests and concerns.

Early engagement in the planning and design stages of a proposed project can benefit all concerned by enhancing relationships, building trust and improving the understanding of the proposed project and its objectives.

E.2.3.4.2 Public participation in the licensing process

The NSCA establishes a legislative requirement for the Commission to hold public hearings, with respect to exercising its authority to licence. The *CNSC Rules of Procedure* allow the Commission to vary the public hearing requirement to ensure that a matter before it is dealt with as informally and expeditiously as the circumstances and the considerations of fairness permit. The NSCA also requires that applicants, licensees and anyone named in or subject to an order have the opportunity to be heard. The *CNSC Rules of Procedure* set out the requirements for matters, such as notifications of public hearings and the publication of decisions from public hearings.

Most Commission proceedings are open to the public. These proceedings allow affected parties and the public to learn about nuclear facilities and projects and give them an opportunity to be heard before the Commission. The Commission publishes on its website and sends advance notices of hearings or meetings to a list of more than 4,000 subscribers. In addition, the Commission may offer financial support through its Participant Funding Program (PFP) on a case-by-case basis to help members of the public offset the costs associated with participating in a hearing or meeting. In most cases, the notices posted online and sent to subscribers also provide information about the availability of PFP funding.

Documents submitted for a public hearing or meeting are available for download from the CNSC's website in advance of the proceedings. The Commission publishes records of decision, including detailed reasons for decision, to explain the basis for its licensing decisions. The Commission also publishes minutes to record the outcome of Commission meetings. During a public hearing, simultaneous interpretation in Canada's official languages (English and French) is provided. Complete written transcripts of all public proceedings are available upon request from the Registry within days of a hearing. These documents, along with other information about the Commission's proceedings and decisions, are available to the public at nuclearsafety.gc.ca/eng/the-commission/hearings/documents_browse.

In addition to attending a hearing in person, the public can watch and participate in Commission proceedings in other ways. The Commission offers live webcasts of all of its public proceedings on the CNSC's external website. Archived webcasts of past hearings and meetings are also available online for a minimum of three months following the end of the proceedings. In addition to following the live webcast, registered participants may use videoconferencing as a cost-effective way to make oral submissions.

Public hearings that include oral submissions usually take place in one or two parts; most decisions involving major nuclear facilities are made following the two-part public hearing process. For a one-part hearing, the Commission hears all of the evidence from the applicant, CNSC staff and interveners in a single hearing session, generally completed over one or more consecutive days. For a two-part hearing, the first part is reserved to hear the applicant and the CNSC staff submissions and recommendations. The second part is reserved to hear interventions and is typically held approximately 60 days after the first part to permit stakeholders to review the application and recommendations before the deadline for their submissions. Commission hearings are normally open to the public, but some parts of a public hearing may be held in a closed session to consider protected information. For example, certain protected security-related information cannot be discussed in a public forum.

A public hearing based only on written submissions may also be held for less significant licence amendments. They generally deal with applications to the Commission that are more administrative in nature and where little or no public interest is expected in the matter being considered. A notice of a public hearing in writing is published on the CNSC website and contains similar information to that contained in notices for other types of public hearings.

Following the deliberations of the Commission, a record of decision is published on the CNSC's website.

To encourage public participation, the Commission may also decide to hold licensing hearings and Commission meetings in the communities that will be most affected by the decision at hand. As an example, in June 2023, the CNSC held a public hearing in Saskatoon, Saskatchewan, on Cameco's licence renewals for one uranium mine, one uranium mill and one uranium mine and mill located in Northern Saskatchewan. This public hearing took place over two days during which the Commission considered oral and written submissions from a total of 35 interveners, 21 of which made oral presentations.

The total number of Commission hearing and meeting days is flexible to ensure that all interested intervenors have an opportunity to contribute. As long as the request to participate relates to the matter before the Commission, a request to intervene is generally accepted. From April 1, 2020, to March 31, 2024, the Commission held 24 public hearings over 42 hearing days, and it held 24 public hearings in writing. A total of 1185 intervenors participated in those hearings through written and oral submissions. In all, the Commission spent 204 days in local communities conducting public hearings and meetings.

E.2.3.4.3 Indigenous peoples' participation in the licensing process

The CNSC's approach to involving Indigenous peoples in the CNSC's life-cycle regulatory oversight of the nuclear sector in Canada includes commitments to uphold the honour of the Crown (federal, provincial and territorial governments) through consultation, engagement, relationship-building and information-sharing to build trust and advance reconciliation, and to meet the CNSC's legal obligations under section 35 of the *Constitution Act, 1982*. Since 2004, the Supreme Court of Canada has held that the Crown has a duty to consult and accommodate, where appropriate, when it contemplates conduct that might adversely impact potential or established Indigenous and/or treaty rights and related interests, including Indigenous title. The CNSC's approach to consultation and engagement aligns with best practices across the Government of Canada, as well as the principles of the United Nations Declaration on the Rights of Indigenous people.

The CNSC respects these commitments by informing Indigenous peoples of proposed projects, consulting with potentially impacted Indigenous Nations and communities and encouraging participation throughout the licensing and regulatory review process by offering funding and capacity support through the CNSC's Participant Funding Program and Indigenous and Stakeholder Capacity Fund. Indigenous peoples are also encouraged to bring their concerns to the Commission through intervening in public Commission proceedings. The CNSC ensures that all recommendations or decisions pertaining to licensing decisions under the NSCA and environmental reviews under the *Canadian Environmental Assessment Act, 2012* and the federal *Impact Assessment Act (IAA), 2019* consider the potential or established rights of Indigenous peoples, pursuant to the *Constitution Act, 1982*.

Beyond consultation obligations that arise from contemplated licensing and environmental review decisions, the CNSC is committed to building long-term relationships with Indigenous Nations and communities in order to build partnerships and trust. This is done by pursuing ongoing, informative and collaborative interactions with Indigenous Nations, communities and organizations who have interests regarding the regulation of nuclear activities and facilities within their traditional and/or treaty territories.

In June 2021, the *United Nations Declaration on the Rights of Indigenous Peoples Act* received Royal Assent. The CNSC actively participated in the development of the United Nations Declaration on the Rights of Indigenous Peoples Act Action Plan, 2023-2028. This Action Plan provides a roadmap of actions Canada needs to take in partnership with Indigenous peoples to implement the principles set out in the UN Declaration and to further advance reconciliation in a tangible way.

E.2.3.4.4 Funding Program

The CNSC administers its Participant Funding Program (PFP), which gives the public, Indigenous peoples and stakeholders an opportunity to request funding to participate in matters related to licensing for major nuclear facilities. The CNSC determines both whether to offer participant funding and the maximum amount available for each offering, based on the recommendations from an independent funding review committee. The objectives of the PFP are to:

- enhance Indigenous, public and stakeholder participation in the licensing and environmental review process
- help Indigenous Nations and communities, the public and stakeholders bring valuable information to the Commission through informed and topic-specific interventions related to aspects of licensing

The CNSC's Indigenous and Stakeholder Capacity Fund was launched in May 2023 and will help Indigenous Nations and communities, as well as stakeholders, gain the capacity necessary to engage in the CNSC's regulatory processes prior to and throughout the lifecycle of nuclear facilities and activities in Canada in a variety of ways.

The purpose of the Indigenous and Stakeholder Capacity Fund is to:

- develop and support organizational capacity of Indigenous Nations and communities and public stakeholders to participate in and contribute to the CNSC's regulatory processes, programs, policies and initiatives
- support building relationships and trust with the CNSC through collaboration with Indigenous Nations and communities and public stakeholders

The Indigenous and Stakeholder Capacity Fund has approved funding for five years (currently ending in fiscal year 2027–28) and includes three funding streams.

E.2.3.5 Application assessment by CNSC staff

When the CNSC receives a licence application, staff evaluate it to determine whether the proposed safety and control measures described in the application and the documents needed to support the application meet the applicable requirements.

The documents required to support the licence application are those that demonstrate that the applicant is qualified to carry out the licensed activity and that appropriate provisions will be made to protect worker and public health and safety, protect the environment, and maintain the national security and measures required to implement international obligations to which Canada has agreed. Examples include detailed documents that support the design, safety analyses and all aspects of operation to which the applicant submits reference, documents describing the conduct of operations and documents describing the conduct of maintenance.

Regulatory documents and industry standards may be referenced in the information supplied by the applicant in support of its licence application and are used by CNSC staff to evaluate the application. These regulatory documents and standards become part of the licensing basis when referenced in the licence application or its supporting documentation or when directly referenced in a licence.

Information submitted in support of an application must demonstrate that the proposed safety and control measures will meet or exceed CNSC expectations. All submissions must be supported by appropriate analytical, experimental or other suitable evidence. When deciding whether to renew an existing licence, the Commission also considers past performance by verifying compliance history.

Technical assessments are conducted by CNSC staff to support licensing, compliance, regulatory decision making and development of regulatory positions. CNSC staff perform these assessments based on the best available science (such as technical knowledge and analytical methods), taking into account operating experience. Technical assessments determine whether submitted documents and supporting evidence presented to the CNSC by any stakeholder have a sound technical basis as measured against the CNSC regulatory framework. These assessments address the completeness (coverage and adequacy), comprehensiveness (depth), and the validity of the rationale and technical justification provided in submissions, and are also used to verify licensee compliance with regulatory requirements. The expertise of CNSC staff covers a broad range of engineering and scientific disciplines.

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
- 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 the measures required to implement the international obligations to which Canada has agreed

If CNSC staff conclude that an application is not complete or satisfactory, the applicant is asked to submit additional information. Normally, a decision is not made until staff are satisfied with the application.

The comprehensive assessment that takes place during the licensing process may define additional programs and criteria as conditions of the licence. Once CNSC staff are satisfied that all requirements of the NSCA and its associated regulations have been met and that the applicant's documentation is complete and acceptable, they prepare a licence recommendation for submission to the Commission or designated officer for a decision. The recommended licence may include any conditions identified as necessary during the assessment, including the documentation references submitted in support of the application.

[E.2.3.5.1 Environmental review](#)

An application for a licence may be subject to other legislation and regulations. For example, an impact assessment under the IAA may be required for a designated project regulated under the NSCA and described in the *Physical Activities Regulations* or an environmental protection review may be carried out under the NSCA for projects not listed in the *Physical Activities Regulations*. For more information on impact assessments refer to section E.2.1.5. All types of environmental review evaluate potential interactions between projects or activities and the environment. In all cases, the CNSC ensures that the public has an opportunity to participate in the environmental review, and [Indigenous consultation and engagement](#) activities are integrated into the review process to the extent possible. Only after a positive decision is made on the environmental review (if one is required) can the Commission proceed with a licensing decision.

[E.2.3.6 Joint regulatory review process](#)

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

In recognition of this dual jurisdiction, the CNSC has established a joint regulatory process. As a lead agency, the CNSC invites other federal and provincial regulatory agencies to participate in the licensing process when their areas of responsibility could impact the proposed nuclear facility. Those that choose to participate become members of a site-specific joint regulatory group.

This process ensures that the legitimate concerns of federal, provincial and territorial 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 the Environment (MOE) and the Ministry of Labour Relations and Workplace Safety (Labour) in the administration of the CNSC's regulatory regime. The involvement of the MOE and Labour 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 to harmonize the CNSC, MOE and Labour regulatory requirements and regulatory activities.

E.2.3.7 Licensing decisions

Licensing decisions include the issuance, renewal, suspension, in whole or in part, amendment, revocation, replacement of a licence or authorization of its transfer. The Commission's decision-making independence and transparency are supported by fair, open, transparent and predictable regulatory processes. Commission hearings provide stakeholders with the opportunity to be heard, and the Commission takes stakeholder input into consideration in its decision-making processes. In addition, the Commission recognizes the role of professional judgement, particularly in areas where no objective standards exist.

The Commission is the overall decision-making authority for all licensing matters. Under section 37 of the NSCA, the Commission can delegate responsibility for issuing certain types of licences (other than Class I licences and licences for uranium mines and mills) to persons who have been identified as designated officers under the legislation. This can include issuing various types of licences, such as licences for radioactive WMFs not defined as Class I nuclear facilities. When a designated officer is delegated this responsibility, no public hearing occurs unless the officer refers the decision back to the Commission using a risk-informed approach. In this case, the Commission evaluates the need to conduct a public hearing as part of its decision-making process.

Before granting the licence, the Commission must be satisfied that the applicant is qualified to carry on the activity that the licence will authorize and that the applicant will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of Canada's national security and international obligations.

CNSC staff make recommendations to the Commission, and the Commission considers them along with input from external stakeholders (including the applicant or licensee, Indigenous Nations and communities, and members of the public) in its decision making. The Commission issues the licence, adding conditions as appropriate.

If the Commission deems it in the public interest to do so, the licensing decision involves public hearings before the Commission. Commission proceedings are open to the public and are webcast live on the CNSC website.

Once a licence is issued, CNSC staff are responsible for administering the Commission's decision, which includes developing and implementing a compliance verification program (see section E.2.5.2) to ensure that licensees continue to meet their legislative and licence obligations.

E.2.3.7.1 Public hearings

The NSCA requires that a public hearing be held before a major licensing decision is made or whenever it is in the public interest to do so. Public hearings, such as the one pictured in figure E.3, give organizations, Indigenous Nations and communities and interested members of the public a reasonable opportunity to comment on matters before the Commission. The *CNSC Rules of Procedure* apply to these proceedings and set forth the requirements for matters, such as notifying the public in advance of public hearings and publishing decisions after public hearings.

A public hearing may take place in one or two parts in a public hearing room, in-person or virtual attendance or by written submissions only (see section E.2.3.4.2). A two-part public hearing is often held for matters that are more complex and/or expected to generate significant intervenor interest. The hearing days in Part 1 and Part 2 are generally at least 60 days apart; they take place over two or more days and may be held in one or more locations. The time interval between Part 1 and Part 2 of the hearings gives intervenors time to review the application and the CNSC staff recommendations presented during Part 1 of the hearing and submit their interventions for Part 2 of the hearing. The objective, as set out in the NSCA, is to ensure that Commission proceedings are dealt with as informally and expeditiously as the circumstances and the considerations of fairness permit.

Figure E.3: Cameco licence renewal public Commission hearing 2023



E.2.3.7.2 Panels

The NSCA authorizes the President of the CNSC to establish panels of the Commission consisting of one or more members. The panel, as directed by the President, may exercise any or all of the powers, duties and functions of the Commission. The only exceptions are that a panel cannot make by-laws or regulations and it cannot review a decision or order of the Commission, because all members of the Commission are required for these actions. Other than these exceptions, an act of a panel is deemed to be an act of the Commission.

Figure E.4: Commission members at a public meeting in Kincardine, Ontario (2023)



E.2.3.8 Licence

Section 26 of the NSCA describes activities that no one may carry out, except in accordance with a licence. The NSCA gives the Commission the power to grant licences for these activities.

All applicable licence conditions are reflected in the respective licence, including conditions that require the licensee to ensure that qualified personnel carry out the licensed activities and that adequate provision is made for the protection of the environment, the health and safety of persons, and the maintenance of Canada's domestic and international arrangements.

The licence refers to the applicant's documentation, which legally compels the applicant to comply with its own procedures and programs, making it subject to the CNSC's compliance verification and enforcement program.

Licences or licence conditions handbooks 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 the controlled release of gaseous or liquid effluents or solid materials are adopted from complementary regulatory regimes (such as Ontario's *Provincial Water Quality Objectives* or *Metal Mining Limits for Liquid Effluent Releases*) or taken from specific licence conditions, such as the derived release limits. The CNSC may also adopt other standards that have been established by organizations like the CSA Group and the American Society of Mechanical Engineers.

E.2.3.8.1 Licensing basis

The licensing basis sets the boundary conditions for a regulated activity and establishes the basis for the CNSC's compliance program for that regulated activity.

All licensees are required to conduct their activities in accordance with the licensing basis, which is defined as a set of requirements and documents for a regulated activity comprising:

1. the regulatory requirements set out in the applicable laws and regulations
2. the conditions and safety and control measures described in the licence, and the documents directly referenced in that licence
3. the safety and control measures described in the licence application and the documents needed to support that licence application

The documents needed to support a licence application are those that demonstrate how the applicant is qualified to carry out the licensed activity and those that show how appropriate provisions are in place to: protect workers, public health and safety; protect the environment; and maintain national security and the measures required to fulfill the international obligations to which Canada has agreed. These include detailed documents that support design, safety analyses and all aspects of operation to which the licensee makes reference, documents describing the conduct of operations and documents describing the conduct of maintenance.

E.2.3.8.2 Licence periods

In Canada, the typical licence period for radioactive waste management facility (WMF) is 10 years. In 2023, the Commission renewed the Darlington WMF waste facility operating licence for a 10-year period (information on this facility can be found in annex 5.6). However, a licence may contain any term or condition that the Commission or designated officer considers necessary to meet the requirements of the NSCA, including the licence period granted.

In 2002, the CNSC introduced flexible licence periods to allow for the enhanced risk-informed regulation of spent fuel and radioactive WMFs. Factors that influence licence periods are licensee performance, facility risks, and compliance and verification findings. Short licence periods will continue to be an option in case of unsatisfactory licensee performance or other considerations. Along with the assignment of longer licence periods, CNSC staff report to the Commission in public meetings at a predetermined frequency (such as annually or biannually) on the facilities' operations and performance in regulatory oversight reports (RORs).

CNSC staff recommend licence periods based on a set of consistent factors. These factors include facility-related hazards, the development and implementation of safety programs, the implementation of an effective monitoring and maintenance program, licensee experience and performance, the *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations* and the facility's planning cycle.

E.2.3.9 Licence conditions handbook

The CNSC's licensing regime includes the licence conditions handbook (LCH), which is a companion piece needed to interpret a licence. The general purpose of the LCH is to clarify the regulatory requirements and other relevant parts of the licensing basis for each licence condition.

The LCH should be read in conjunction with the licence; it provides compliance verification criteria that the licensee must follow to comply with licence conditions, operational limits and information on delegation of authority and applicable versions of documents referenced in the licence. The LCH also provides non-mandatory recommendations and guidance on how to comply with licence conditions and criteria.

The LCH was developed as a tool that can more easily be updated as the licensees' programs are revised to align with operations. Amendments to the LCH, when delegated by the Commission, can be approved by CNSC staff.

E.2.4 System for prohibiting the operation of a spent fuel or radioactive waste facility without a licence

Under section 26 of the NSCA, no person shall, except in accordance with a licence:

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

E.2.5 System of institutional control, regulatory inspection, documentation and reporting

E.2.5.1 Graded approach to regulation

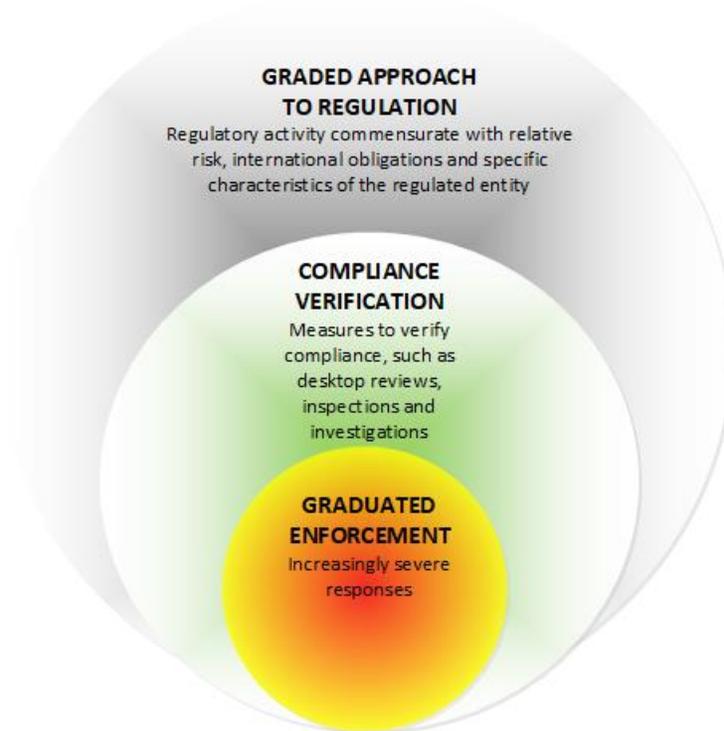
Assuring compliance with legislation, regulations and licensing requirements is one of the CNSC's core business processes, carried out through compliance verification and enforcement. Together, these activities enable the CNSC to make assurances to Canadians about the continuing compliance and safety performance of licensees.

The CNSC uses a systematic, risk-informed, graded approach when applying resources to oversee licensed activities and verify compliance with regulatory requirements. With the graded approach, elements like level of analysis, depth of documentation and scope of actions necessary to verify compliance are commensurate with:

- relative risks to health, safety, security and the environment
- any impact on Canada's international obligations
- particular characteristics of the given nuclear facility or licensed activity

Figure E.5 below illustrates the CNSC's graded approach to regulation.

Figure E.5: CNSC's graded approach to regulation



The licensee bears the primary responsibility for safety at all times, including compliance with regulatory requirements. The CNSC undertakes necessary and reasonable measures to ensure compliance. These measures include influencing compliance awareness, verification and enforcement.

The CNSC holds information sessions and communicates with licensees regularly to give licensees a better understanding of their responsibilities and to promote compliance.

E.2.5.2 Compliance verification

Verifying compliance is one of the CNSC's core regulatory oversight activities. It consists of processes and procedures established to confirm that all licensees and other individuals or corporations that are subject to the NSCA have an acceptable safety and security performance, and continuously comply with regulatory requirements.

There are four principal components to the CNSC's approach to verifying compliance:

- planning compliance verification activities
- influencing compliance awareness and verifying the extent of compliance
- responding to non-compliance
- reporting on compliance

The CNSC's compliance planning process ensures that compliance activities are carried out in a systematic and risk-informed manner.

The CNSC proactively influences compliance awareness through open communication with licensees. Doing so typically increases licensee's awareness and understanding of their responsibilities, leading to a better compliance performance.

The CNSC verifies compliance by regularly inspecting operational activities and reviewing licensee documentation. The CNSC requires licensees to report routine performance data and unusual occurrences. In addition, CNSC staff investigate unplanned events or accidents that involve nuclear materials or substances. CNSC staff also collect samples and subsequently analyzes them in the CNSC's own laboratory.

The frequency, scope, type and depth of these inspections and reviews are risk-informed. Where regulatory oversight overlaps with that of other regulatory bodies, the CNSC coordinates its verification activities to optimize efficiency. When responding to a non-compliance, the CNSC uses a graduated approach to enforcement to encourage and compel compliance and deter future non-compliance. The CNSC reports on the results of compliance verification and enforcement activities to the Commission, the public, licensees, the Government of Canada, the IAEA, and other stakeholders.

E.2.5.2.1 Regulatory inspection

Inspection is the process by which CNSC staff verify the performance of the licensed activities through direct, on-site or remote observation, measurement, records review, and interviews. Data gathered from inspections are analyzed to determine whether a licensee, individual or corporation is compliant with regulatory requirements.

Figure E.6: Compliance verification taking place at Chalk River in December 2023



CNSC inspections are led by designated inspectors under section 29 of the NSCA.

The main purposes of CNSC inspections (combined with enforcement) are to verify that:

- the licensee's activities, facilities, equipment and work performance meet regulatory requirements

- licensing basis documents are adhered to
- workers have the competencies needed to effectively perform their functions
- deficiencies and deviations are identified by the licensee and corrected or justified without undue delay
- any lessons learned are identified by the licensee and communicated to stakeholders
- the licensee is managing safety properly

Figure E.7: Compliance verification taking place at the Chalk River



CNSC inspections do not diminish the licensee's primary responsibility for safety and do not substitute the control, supervision, and verification activities that the licensee must carry out.

The fundamental principles of CNSC inspections are as follows:

- Inspections are consistent and transparent
- Inspection activities are open to formal scrutiny
- Inspections are planned, coordinated and controlled activities
- Inspection standards for performance and methodology are defined
- Inspections conducted follow approved inspection procedures
- Inspection objectives and criteria are defined and communicated to the licensee
- Inspections are conducted within the safety and control area framework
- Roles and responsibilities for conducting inspections are defined
- Inspections are documented in official and timely reports
- Inspection processes and procedures are subject to continuous improvement

Figure E.8: Compliance verification taking place at Western Waste Management Facility

Below is the process flow used to conduct CNSC inspections:

- Plan inspection and confirm scope
- Compile inspection criteria
- Notify licensee
- Start inspection
- Collect inspection facts
- Analyze inspection facts and develop preliminary findings
- Communicate preliminary summary of findings
- Conduct final analysis
- Prepare and issue final inspection report
- Follow-up

Inspections can be either Type I or Type II inspections, planned or reactive, and announced or unannounced. In a Type I inspection, the purpose is to verify the licensee's programs, processes or practices comply with the regulatory requirements. In a Type II inspection, the purpose is to verify the results of licensee's processes, not the processes themselves. For planned inspections, the inspection trigger will have been predetermined in the compliance plan. Reactive inspections can be triggered by desktop reviews, technical assessments, events or the occurrence of rare or unplanned regulated activities.

Figure E.9: Compliance verification taking place at the Pickering Waste Management Facility



E.2.5.2.2 Desktop reviews

Desktop reviews generally entail considering items like quarterly technical reports, annual compliance reports, special reports and documentation related to design, safety analysis, programs and procedures. Licensees are required to provide information to the CNSC through baseline reporting (scheduled) and event reporting. They are also expected to notify the CNSC of changes to operating processes, procedures or programs, and to submit written requests for these changes. In all cases, the CNSC assesses this information to ensure that operations remain within the licensing basis.

E.2.5.3 Documentation and reporting

CNSC staff report to the Commission, the public, licensees, the Government of Canada, the IAEA and other interested parties on the results of compliance verification and enforcement activities.

CNSC annual reports from 2006 through to 2023 can be found on the CNSC public website (<http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/annual-reports/index.cfm>). The CNSC annual reports provide an overview of Canada's nuclear industry and the regulatory activities that the CNSC undertakes to ensure the safety of Canadians. It highlights the organization's many accomplishments during the fiscal year at home and internationally, and explains how the CNSC is meeting its day-to-day responsibilities and positioning itself for the future. It reinforces the CNSC's commitment to become the world's best nuclear regulator.

Each year, the CNSC publishes regulatory oversight reports, which offer information on the safety performance of Canadian licensees who are authorized to use nuclear substances. The reports evaluate licensees based on their safety procedures and adherence to regulatory policy. Key issues and emerging changes in regulation are also highlighted. Licensees are categorized by sector, as follows:

- nuclear power generating sites (including on-site WMFs)
- uranium mines and mills
- use of nuclear substances
- uranium and nuclear substance processing facilities
- research reactors and particle accelerator facilities

E.2.6 Graduated enforcement

Under the NSCA and its Regulations, the CNSC can take various levels of regulatory action to correct a licensee's non-compliance and protect the health, safety and security of Canadians and the environment.

The CNSC's graduated enforcement strategy is built on the following fundamental principles:

- Flexibility - The effectiveness of the CNSC's graduated enforcement strategy relies on response flexibility based on a risk-informed approach, and on the application of expert judgement in selecting the most appropriate response(s) in a given situation.
- Timeliness – The CNSC manages compliance issues in a timely manner, taking regulatory significance into account.
- Transparency – In the spirit of its commitment to transparency, the CNSC maintains open and engaged communication and makes information on its enforcement activities available to the public, as appropriate.

The CNSC has established an integrated set of tools for influencing compliance awareness and responding to non-compliance. With this approach, CNSC staff are able to choose the appropriate instrument or combination of instruments to address the issues identified in any specific situation. Figure E.10 below illustrates how the components of the CNSC's graded enforcement strategy fit together.

Figure E.10: Components of the CNSC's graded enforcement strategy



Regulating requires consistent interaction with the regulated parties. Even before a licence or certificate is issued, the CNSC uses several measures to foster open communication with the applicant or proponent so that it can influence their understanding of the need to comply with all regulatory requirements. Regulated parties who engage in open communication with the CNSC from the outset typically have a clearer understanding of the regulatory requirements and a better compliance record. This proactive interaction continues after the licence or certificate is issued through outreach, regular interaction (in the form of discussions, meetings and letters), and recommendations.

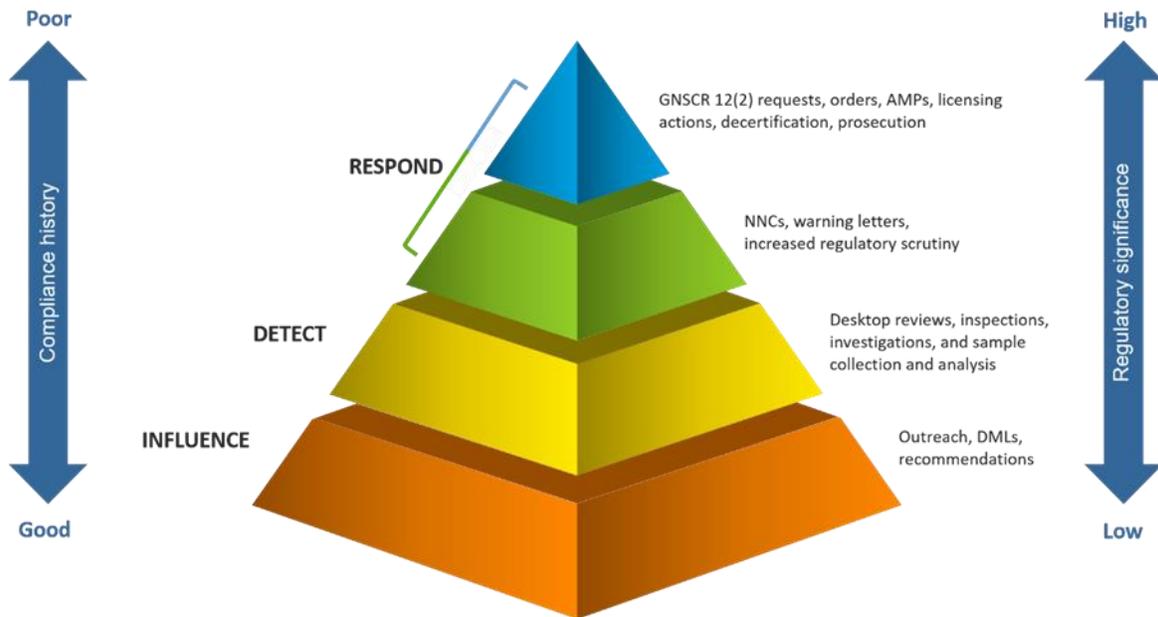
A regulatory response is required when non-compliance with regulatory requirements is confirmed through objective evidence obtained from reliable sources and based on verifiable facts.

The CNSC's graduated approach to enforcement provides a dynamic continuum of regulatory response options that begins with making the licensee aware of non-compliance and giving them the opportunity to correct it.

CNSC staff use regulatory judgement to determine the most appropriate response to a given situation. In all cases, the goal is to restore compliance, maintain continued safety and deter future non-compliance. All measures taken in response to non-compliance become part of the regulated party's compliance history.

In responding to non-compliance, the CNSC can use a progression of responses to restore compliance as quickly as possible. CNSC staff can select or recommend any of the available tools listed in figure E.11 at any time, as appropriate to the situation. The response or combination of responses that would likely be most effective in restoring compliance is determined by the person making the decision.

Figure E.11: CNSC toolbox continuum



When determining which response is most appropriate, the goal is to determine the response(s) that would most likely result in restoring compliance as quickly and effectively as possible, taking the following considerations into account:

- the regulatory significance of the non-compliance
- the circumstances that led to the non-compliance
- the entire compliance history of the regulated party
- any operational and legal constraints
- any industry-specific factors

E.2.7 Clear allocation of responsibilities

Canada is a confederation of 10 provinces and three territories, administered by the Government of Canada. The provinces and territories are self-governing in the areas of legislative power assigned to them in the Constitution of Canada, as expressed in the *Constitution Acts, 1867 to 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 that it declares 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 *NSCA* 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
- production, refinement or treatment of nuclear substances

This means that the Government of Canada is responsible for certain aspects of nuclear energy applications that would otherwise have been under provincial jurisdiction, including:

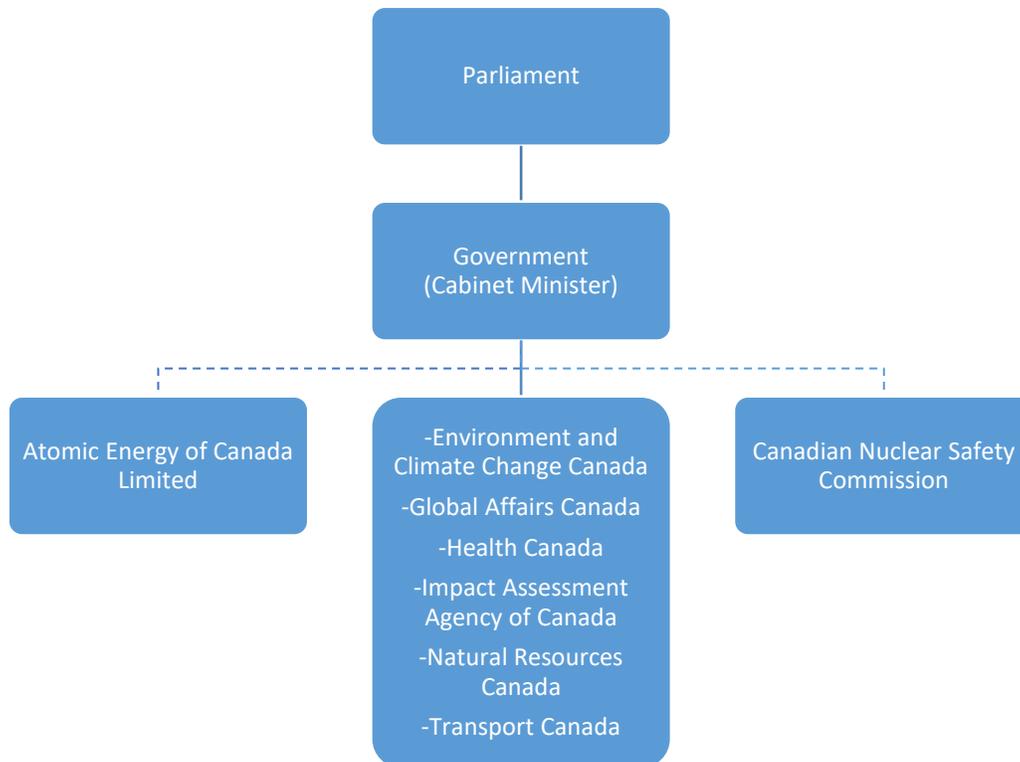
- occupational health and safety
- the regulation of boilers and pressure vessels
- coordination of the federal response to nuclear emergencies
- environmental protection

Under the Constitution of Canada, 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 has been to avoid redundancy 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 successfully led to 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 licences from the regulatory body – the CNSC – to perform any of the nuclear-related activities otherwise prohibited by the NSCA. In addition, the NSCA authorizes 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 departments and agencies of the Government of Canada involved in the Canadian nuclear sector are shown in figure E.12.

Figure E.12: Government departments and agencies responsible for the management of radioactive waste in Canada



E.2.7.1 Natural Resources Canada

Natural Resources Canada (NRCan) is the lead government department responsible for developing and implementing federal nuclear energy policy across the nuclear supply chain, from uranium mining to the final disposition of waste. This includes making uranium and radioactive waste policy, developing and implementing legislation, and the establishment and management of a nuclear civil liability and compensation regime. NRCan also provides expert technical, policy and economic information and advice to the Minister of Energy and Natural Resources and the Government of Canada on issues affecting:

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

NRCan administers, on behalf of the Minister of Energy and Natural Resources, the modernized *Policy for Radioactive Waste Management and Decommissioning*, released in March 2023, which reflects the values and principles of Indigenous peoples in Canada and all interested Canadians, and provides the basis for ensuring that the safe long-term management of radioactive waste continues to align with international standards and best practices. In Canada's approach to radioactive waste management, the 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, with oversight from the federal government.

NRCan's Uranium and Radioactive Waste Division is the organizational unit responsible for administering the *Nuclear Fuel Waste Act* (NFWA) and the *Nuclear Liability and Compensation Act* (NLCA). Part of the Division's mandate is to support the Minister of Energy and Natural Resources in discharging the Minister's responsibilities under the NFWA by overseeing, monitoring, reviewing and commenting on relevant activities of the NWMO and ensuring all NFWA requirements are met. The NLCA establishes a compensation and liability regime in the unlikely event of a nuclear accident resulting in civil injury and damages. Under the NLCA, the operator of a nuclear power plant is responsible to pay up to C\$1 billion for civil damages resulting from an accident at that plant.

E.2.7.2 Canadian Nuclear Safety Commission

The CNSC is Canada's independent nuclear regulatory body, created by Parliament in under the NSCA. The CNSC's mandate is to "regulate the use of nuclear energy and materials to protect health, safety, security, and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public." The CNSC reports to the Parliament of Canada through the Minister of Natural Resources. It is not part of NRCan; however, the Minister of Natural Resources can seek information from the CNSC about its activities. Under the NSCA, the Governor in Council may issue directives to the Commission that are of general application on broad policy matters. The Governor in Council cannot give direction to the Commission on specific licensing matters.

The CNSC is a federal regulatory agency and an independent administrative tribunal set up at arm's length from the government, with no ties to the nuclear industry. To serve Canadians, the ultimate outcome of the CNSC's work must be to establish safe and secure nuclear installations and processes solely for peaceful purposes and to instill public confidence in the nuclear regulatory regime's effectiveness. In keeping with the Government of Canada's Smart (specific, measurable, attainable, realistic and timely) Regulation Initiative to improve regulatory performance and reduce administrative burden on businesses, the CNSC engages in extensive consultation and information sharing 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 is an independent entity. This independence is critical so that the CNSC can maintain an arm's-length relationship with government when making legally-binding regulatory decisions. The CNSC is not an advocate for nuclear science or technology. Its mandate and responsibility is to regulate users of nuclear energy or materials to ensure that their operations will not pose unreasonable risks to Canadians. The people of Canada are the sole clients of the CNSC. The CNSC's regulatory decision process is fully independent of the Government of Canada.

The CNSC is responsible for working collaboratively with the Impact Assessment Agency of Canada to conduct integrated impact assessments for nuclear projects under the Impact Assessment Act (IAA). For ongoing projects initiated under the now repealed CEAA, 2012, the CNSC is also responsible for conducting and making decisions on environmental assessments. The IAA contains provisions to allow these projects to continue under their current processes. In some parts of northern Canada, environmental assessment processes are established under land claim agreements, and the IAA does not apply. In these cases, the CNSC acts as technical advisor throughout the environmental assessment process.

The CNSC's REGDOC-3.5.3, *Regulatory Fundamentals* states that persons and organizations subject to the NSCA 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 for assuring the public that these responsibilities are properly discharged.

E.2.7.3 Atomic Energy of Canada Limited

Atomic Energy of Canada Limited (AECL) is a Crown corporation whose sole shareholder is the Government of Canada. For more than 60 years, AECL has been a world leader in developing peaceful and innovative applications of nuclear technology. Its mandate is to enable nuclear science and technology, and manage the federal government's decommissioning and radioactive waste liabilities. Following a restructuring process that was completed in September 2015, AECL now delivers its mandate through a long-term contract with the private sector for the management and operation of its sites under a government owned – contractor operated (GoCo) model. CNL manages AECL's sites which includes operating the nuclear laboratories and delivering decommissioning and waste management activities. Activities related to decommissioning and waste management are necessary to address liabilities and reduce hazards that are the result of decades of nuclear research at AECL sites. AECL is also responsible for the cleanup and safe, long-term management of historic LLW at other sites across Canada for which the Government of Canada has accepted responsibility. This includes the PHAI and the activities associated with the Low-Level Radioactive Waste Management Office.

For its part, AECL was re-created as a small purpose-built Crown corporation with a view to ensuring it has the necessary expertise and capabilities to oversee the GoCo agreements. AECL's objective is to leverage the GoCo model to deliver on its mandate. Its role is to monitor and incentivize the performance of CNL to meet AECL's objectives. To help in its own transition to the GoCo model and in fulfilling its oversight role, AECL has retained the services of international experts who bring their significant experience in managing similar arrangements, from both a government and a contractor perspective.

AECL's efforts focus on overseeing CNL's activities in two main areas: decommissioning and waste management, and nuclear laboratory science and technology. With respect to decommissioning and waste management, the objective is to safely and efficiently reduce the Government of Canada's radioactive waste liabilities, including the associated risks to health, safety, security and the environment. The focus is on enabling CNL to significantly advance infrastructure decommissioning, site remediation and waste management for Canada.

E.2.7.4 Impact Assessment Agency of Canada

The IAAC is responsible for administering the IAA, the primary federal legislation that defines the requirements for assessing the positive and negative environmental, health, social and economic impacts of proposed projects (see section E.2.1.5 for a further description of the IAA). Under the IAA, the IAAC leads reviews of major projects and collaborates with the CNSC to review projects that are also subject to regulation under the NSCA. Nuclear projects to be assessed under the IAA are subject to an integrated impact assessment carried out by an integrated review panel.

E.2.7.5 Global Affairs Canada

Global Affairs Canada is the federal department responsible for promoting nuclear cooperation and safety, both bilaterally and multilaterally. It also implements key non-proliferation and disarmament agreements in Canada and abroad.

Implementing these agreements requires that Canadian domestic law be consistent with Canada's responsibilities under the agreements. It also requires the capacity to ensure effective monitoring to verify that treaty obligations and commitments are being honoured. Global Affairs Canada is responsible for

implementing the Chemical Weapons Convention and the Comprehensive Nuclear-Test-Ban Treaty. In addition, it oversees foreign policy, which includes global security issues, and is a required interlocutor in dealings with other governments.

E.2.7.6 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, Health Canada 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 by:

- maintaining the Canadian Radiological Monitoring Network (CRMN)
- developing guidelines for exposure to radioactivity in water, food and air following a nuclear emergency
- providing advice and assistance for environmental assessments and reviews, as required by the IAA and its regulations
- providing a full range of dosimetry services to workers through the National Dosimetry Services, National Dose Registry, 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*)
- administering the Federal Nuclear Emergency Plan

The CRMN is a national network that routinely collects samples of air particulate, precipitation, external gamma dose, drinking water, atmospheric water vapour and milk for radioactivity analysis. These surveillance activities of the network serve to establish background radiation levels in Canada.

Health Canada has complemented its CRMN with another monitoring system called the Fixed Point Surveillance (FPS) network. The FPS functions as a real-time radiation detection system designed to monitor the public dose from radioactive materials in the air, including atmospheric emissions associated with nuclear facilities and activities, nationally and internationally. The monitoring stations continuously measure gamma radioactivity levels from ground-deposited contaminants (groundshine) and airborne contaminants. More information can be found here: <https://www.canada.ca/en/health-canada/services/health-risk/safety/radiation/understanding/measurements.html>.

The National Dosimetry Services, operated through Health Canada, provide occupational monitoring for ionizing radiation to Canadians. The services offered include whole-body and extremity dosimetry services, as well as neutron dosimetry services and dosimetry. The National Dosimetry Services are licensed by the CNSC.

The National Dose Registry is a centralized radiation-dose record system managed by Health Canada. It contains occupational radiation dose records for all monitored radiation workers in Canada dating back to the 1940s.

E.2.7.7 Environment and Climate Change Canada

Environment and Climate Change Canada's mandate is to:

- preserve and enhance the quality of the natural environment, including water, air, soil, flora and fauna
- conserve Canada's renewable resources

- 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
- coordinate environmental policies and programs for the Government of Canada

Environment and Climate Change Canada administers the CEPA. It also runs the National Pollutant Release Inventory (NPRI). The NPRI is Canada's public inventory of releases, disposals and transfers. Facilities that meet the reporting thresholds must report releases from the facilities to air, water or land to the NPRI.

E.2.7.8 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 establishes policies, regulations and standards to protect the safety, security and efficiency of Canada's rail, marine, road and air transportation systems. Its oversight covers the transportation of dangerous goods, such as nuclear substances, and assurance that related developments can be sustained.

Transport Canada administers the *Transportation of Dangerous Goods Act*.

E.2.7.9 Province of Saskatchewan

Saskatchewan is the only province in Canada with operating uranium mines. In the past, mine and mill operators have requested harmonized action in areas like inspections and reporting requirements that involve the Saskatchewan Ministry of Environment, the Saskatchewan Ministry of Labour Relations and Workplace Safety, and the CNSC. The province and the CNSC continue to coordinate the regulation of the uranium mining and milling operations to encourage greater administrative efficiency in regulating the uranium industry. This lays the groundwork for the two groups to coordinate and harmonize their respective regulatory regimes.

E.2.8 Considerations when deciding whether or not to regulate radioactive material as radioactive waste

Section E.3.1 indicates that the CNSC is authorized under the NSCA to regulate nuclear substances in order to protect human health and the environment. REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada* defines radioactive waste as any material (liquid, gaseous or solid) that contains a radioactive nuclear substance, as defined in section 2 of the NSCA, and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive hazardous substances, as defined in section 1 of the GNSCR.

Subsection 5.1(1) of the *Nuclear Substances and Radiation Devices Regulations* (NSRDR) states that a person may, without a licence, abandon or dispose of a radioactive nuclear substance if the activity or the activity concentration of the substance does not exceed

- (a) its exemption quantity
- (b) its conditional clearance level or
- (c) its unconditional clearance level

Schedule 1 of the NSRDR sets out exemption quantities for radioactive nuclear substances. Schedule 2 of the NSRDR sets out unconditional clearance levels for radioactive nuclear substances. The NSRDR define conditional clearance levels as an activity concentration that does not result in an effective dose greater than 1 mSv in a year due to a low-probability event referred to in the IAEA Safety Standard RS-G-1.7 or greater than 10 µSv in a year.

E.3 Regulatory body (Article 20)

This section addresses the obligations under Article 20 of the Joint Convention.

ARTICLE 20. REGULATORY BODY

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfill its assigned responsibilities.
2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.

E.3.1 Establishment of the CNSC

E.3.1.1 Authority of the CNSC under the NSCA

Subsection 8(1) of the NSCA states: “there is hereby established a body corporate to be known as the Canadian Nuclear Safety Commission.” Section 9 of the NSCA states “the objects of the Commission are:

- (a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to
 - (i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,
 - (ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and
 - (iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and
- (b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph (a).”

The NSCA also sets out the responsibilities and powers of the Commission.

E.3.1.2 Canadian Nuclear Safety Commission in the government structure

In the Canadian system of parliamentary government, the decision to introduce government legislation like the NSCA into Parliament is made by the federal cabinet on the advice and recommendation of the appropriate minister. The NSCA establishes the CNSC as a departmental corporation, named in Schedule II of the Government of Canada's *Financial Administration Act*. The CNSC reports to the Parliament of Canada through a member of the King's Privy Council for Canada, designated by the Governor in Council as the minister for purposes of the NSCA. This designate is currently the Minister of Natural Resources. The CNSC is a departmental corporation, which is an independent agency, that is not part of any government department.

CNSC staff routinely interact with the 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 on this is provided in section E.2.7.1

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
- 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, including:

- AECL, the federal nuclear research and development company
- nuclear operators of provincially owned electrical utilities (OPG, NB Power and H-Q)
- Canadian universities
- hospitals and research institutions

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

E.3.1.3 Organizational structure

The CNSC consists of the president (who is also the chief executive officer of the CNSC), the federally appointed members of the Commission, and 1,044 staff members (as of March 31, 2024). As defined in the NSCA, the CNSC's organizational structure consists of two components:

- the Commission, which refers to the organization's tribunal component
- the CNSC, which refers to the organization and its staff

E.3.1.3.1 The Commission

The Commission is an independent quasi-judicial administrative tribunal and a court of record. It can consist of up to seven permanent members. Commission members are appointed by the Governor in Council of Canada for terms not exceeding five years and may be reappointed. In addition, the Governor in Council may appoint temporary members for a term not exceeding three years. A temporary member may be reappointed in the same or another capacity. Commission members are appointed "on good behaviour" and cannot be removed from the position except for just cause and in accordance with procedural fairness.

Commission members may not directly or indirectly engage in any activity, have any interest in a business, or engage in any employment that is inconsistent with their duties as Commission members. Each Commission member must be both independent of all possible influences and independent of each other.

Commission members commit to the highest ethical standards, guard against conflicts of interest and carry out their duties impartially. The president of the CNSC is a full-time Commission member. Other members generally serve on a part-time basis.

The Commission's key roles are to:

- establish regulatory policy on matters relating to health, safety, security and the environment
- establish classes of licences
- make legally binding regulations
- make independent decisions on licensing nuclear-related activities in Canada
- issue, renew, suspend in whole or in part, amend, revoke or replace a licence, or authorize its transfer
- require an applicant to provide a financial guarantee in a form that is acceptable to the Commission and authorize the application of the proceeds of any financial guarantee in a manner it considers appropriate

The Commission makes its decisions fairly and transparently, guided by clear rules of procedure. The Commission takes into account the views, concerns and recommendations of CNSC staff, interested parties, Indigenous Nations and communities and other intervenors when establishing regulatory policy, making licensing decisions and implementing programs. Decisions of the Commission cannot be appealed to the Executive Branch; they can only be challenged by way of an application for judicial review to the Federal Court of Canada.

The Commission administers the NSCA and its associated Regulations. Among these regulations are the *CNSC Rules of Procedure*, which outline the public hearing process, and the *CNSC By-laws*, which outline the Commission's meeting process. Decisions on the licensing of major nuclear facilities are made through public hearings.

Public hearings, both written only or with both oral and written submission, are the public's primary opportunity to participate in the licensing process. CNSC staff participate in all public hearings to make recommendations to and advise the Commission. The Commission operates independently of CNSC staff and the Commission Registry serves as liaison between CNSC staff and the Commission.

In addition to public hearings, the Commission also holds public meetings. Commission meetings consider a wide range of topics related to the nuclear regulatory process, and in certain cases, they serve as the vehicle for making legislative, policy or administrative decisions on matters of particular or general application. Meeting items may include subjects like annual industry reports, licensee performance reports, technical briefings, event reports and requests for approval of regulatory documents.

In advance of Commission meetings, the Commission publishes a notice inviting the public to attend. The opportunity for interventions on specific meeting items is determined by the Commission on a case by case basis. Meetings are webcast live, and archived webcast are posted on the CNSC's external website following the meeting. Written transcripts of the meeting are available upon request to the Commission Registry. Minutes of the meeting are approved by the Commission members and also posted on the CNSC's website.

The Commission Registry supports the Commission by planning its business, publishing notices, agendas, decisions and meeting minutes, and offering technical and administrative support to the President and Commission Members. As a court of record, the Commission Registry is also the official registrar of Commission documentation.

E.3.1.3.2 CNSC staff

The Commission employs the staff it considers necessary for the purposes of the implementation of the NSCA.

The CNSC has highly skilled scientific, technical, professional and administrative personnel who carry out the work necessary to fulfill the Commission's mandate. CNSC staff perform several functions, such as:

- conducting expert research and analysis
- verifying licensee compliance with regulatory requirements
- conducting activities to enforce licensee compliance, when necessary
- preparing material for the Commission known as Commission member documents, and appearing before the Commission at proceedings to answer questions
- carrying out a wide range of internal activities that enable the success of the CNSC's core operational work

The Commission may also enter into contracts for services to receive advice and assistance in the exercise or performance of any of its powers, duties or functions under the NSCA.

An office of the Uranium Mines and Mills Division is located in Saskatoon, Saskatchewan, close to Canada's major uranium mining and milling operations. CNSC satellite offices are located at each of the four operating NGSs in Canada and at CNL's Chalk River Laboratories. Staff at regional offices located in the provinces of 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.

In terms of organizational structure, the President's office provides administrative support services to the President and an Internal Audit, Evaluation and Ethics team.

There are five major branches of the CNSC: Regulatory Operations, Technical Support, Regulatory Affairs, Corporate Services and Legal and Commission Affairs. For more information about each of the five branches, see annex 2.

E.3.1.4 Financial resources

The CNSC is a departmental corporation listed in Schedules II and V of the *Financial Administration Act*. The NSCA stipulates that the CNSC reports 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. 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 primarily from fees collected from industry (licensees), pursuant to the *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations*, and secondarily through an annual appropriation from Parliament. The CNSC has revenue-spending authority, which means it uses the revenues collected to fund activities that are cost-recoverable under these Regulations. This authority provides a sustainable and timely funding regime to address rapid changes in the regulatory oversight workload associated with the Canadian nuclear industry.

E.3.1.5 Human resources and competent personnel

During the April 2020 to March 2024 reporting period, the CNSC's human resource management efforts continued to focus on maximizing organizational flexibility while maintaining a highly skilled and engaged workforce, supported by modern management practices and tools. Since the last report, the CNSC has continued to leverage its strategic and operational workforce planning capability. The CNSC put in place a Human Resources Management Plan 2020-2022 to ensure its workforce had the skills, knowledge, and abilities to effectively execute its mandate. CNSC has since developed a five-year Strategic Workforce Plan 2024-2029 to better understand and identify the core and emerging competencies to ensure the CNSC has the necessary skills to carry out its mandate to 2029 and beyond.

Given the changing landscape of the Canadian nuclear industry and its scientific, technical, math and engineering labour market, the greatest workforce risks that the CNSC faces between now and 2029 remains the retirement of experienced senior regulatory and technical employees, along with a labour market shortage of skilled workers. To mitigate this risk, the CNSC has initiated actions centered on organizational design, workforce recruitment and renewal, learning and leadership development, talent management, workplace wellness and employee engagement and retention. To this end, the CNSC's Human Resource Management (HRM) Plan and Strategic Workforce Plan (SWP) are focused on various strategies that deliver a workforce that is competent and agile, engaged and empowered, and respectful and inclusive.

As retirements continue and a new generation of workers enter the labour market, the expectations of employers will differ. The CNSC has had to evolve to remain relevant and compete for talent in a dwindling pool of STEM (Science, Technology, Engineering, Mathematics) resources. To manage these risks, the CNSC has identified and catalogued the core technical and emerging skills required to effectively deliver on our mandate and has established a risk-based EX (Executive) Talent Strategy that identifies future leadership needs and the health of the EX-pipeline. The CNSC continues to have success recruiting entry level talent and is taking steps to diversify ways in which it accesses mid-career talent, including non-traditional channels and approaches. A strong and well-articulated employment brand that speaks to the various talent segments is critical for the CNSC. To ensure career mobility and development across the organization, a Career Progression pilot has been launched in two key operational areas; with a plan to expand the progression program in the future.

To remain agile, the CNSC has had to modernize how work gets done by leveraging technology and designing work to maximize efficiency. This has been accomplished in part by the introduction of the CNSC Flexible Work Policy, giving employees more flexibility and autonomy over their work and has expanded the talent pool beyond the National Capital Region; as well as the CNSC's Digital Strategy, which provide the tools to modernize processes and workflows, the way employees communicate and collaborate, and supports and enables a hybrid workforce. The CNSC continues to leverage its knowledge management strategy and framework and has put greater emphasis on change management to encourage behavioural changes in this space.

The CNSC has focused on building a workforce that is engaged, empowered, respectful and inclusive, which is a cornerstone to its success. To this end, the CNSC has developed its Accessibility Plan 2022-25 and is in the process of updating its Diversity and Inclusion Strategy. The CNSC is also continuing with the practice of holding town-hall meetings and employee roundtables to give employees an opportunity to ask questions and share concerns with their senior leaders, and introduced other mechanisms, including regular pulse surveys, for employees to provide feedback and insights. Over the years, the CNSC has taken deliberate actions to build a respectful, collaborative workplace and a supportive culture for employees. Through different initiatives, the CNSC continues to raise awareness and provide tools to employees and managers to support mental health, reduce stigma and resolve conflicts in the workplace. The CNSC continues to monitor and assess internal and external drivers that may impact the work and workplace and build on strong Human Resource Management foundations.

E.3.1.6 Management system

The CNSC's management system integrates the key elements of the CNSC's work into the holistic framework of programs and activities through which the CNSC achieves its goals.

The CNSC's management system is aligned with the requirements and guidance set out in both the IAEA's general safety requirements for integrated management systems, *Leadership and Management for Safety* (GSR Part 2), and the Government of Canada's framework for management excellence, the Management Accountability Framework.

A robust management system allows the CNSC to deliver on key goals and objectives across all areas (such as safety, health, environment, quality, finance, human resources and security) in a balanced, harmonious and optimal manner. In defining and applying a common set of principles, practices and processes across the entire organization, the management system gives the CNSC an overarching and uniform management structure by:

- bringing together all of the organization's regulatory and business requirements in a coherent and consistent manner
- mapping out and managing processes as part of a larger, single integrated system to minimize both gaps in direction/guidance and duplication of effort
- providing support for approved and accessible processes and practices throughout the organization
- clarifying roles, responsibilities and authorities across all areas and all levels
- providing a consistent, robust platform for enabling continual improvements

The CNSC's regulatory philosophy describes safety as the primary responsibility of the person or organization responsible for a licensed facility or activity. At the same time, as a regulator, the CNSC remains mindful of the potential impact that CNSC decisions, actions and behaviours have on the safety of CNSC employees and on the CNSC's ability to ensure that all licensees maintain safety across their operations.

As the top-tier document, *How the CNSC Works: Our Navigator Manual* summarizes the integrated management system and provides a strong base for aligning management system-related documents like policies, processes, procedures, work instructions, criteria, forms and guides. These internal documents are developed on a priority basis and are driven by the need for additional guidance and direction for staff, management, licensees and other key stakeholders. This practical approach helps the CNSC to continually strengthen its management system so that it remains comprehensive, well-documented and seamlessly implemented.

E.3.1.7 The CNSC's regulatory approach

The CNSC regulates to prevent unreasonable risk to the environment, to the health and safety of persons, and to national security. The CNSC has established a licensing and compliance system to ensure that all persons who use or possess nuclear substances and radiation devices do so in accordance with a licence, and that regulated parties have safety and security provisions in place that ensure compliance with regulatory requirements.

E.3.1.7.1 Regulatory philosophy

The CNSC's regulatory philosophy is based on the following:

- licensees are directly responsible for managing regulated activities in a manner that protects health, safety, security and the environment, and that conforms with Canada's domestic and international obligations on the peaceful use of nuclear energy

- the CNSC is accountable to Parliament and to Canadians for assuring that these responsibilities are properly discharged

The CNSC therefore ensures that regulated parties are informed about requirements and provided with guidance on how to meet them, then verifies that all regulatory requirements have been and continue to be met.

E.3.1.7.2 Continuous improvement

The CNSC is committed to the continuous improvement of both its internal operations and its regulation of the Canadian nuclear industry. Consequently, the CNSC requires licensees to strive to further reduce the risks associated with their licensed activities, on an ongoing basis. It assesses how licensees manage risk during both normal operations and in response to potential accident conditions, applying concepts such as ALARA and defense in depth. In its assessments, the CNSC considers how licensees continuously evaluate, manage and further reduce uncertainties with respect to hazards and safety issues. This also includes assessing how licensees consider additional safety and mitigation options as techniques and technologies evolve.

E.3.1.7.3 International obligations

The CNSC participates in international forums to provide leadership in promoting and supporting global nuclear safety, security, and non-proliferation, and to benefit from international experience and best practices. It also participates in undertakings implemented by the IAEA (for example, IAEA peer reviews), the ICRP and other international organizations, as well as activities under certain treaties, such as the Joint Convention.

These international activities help inform the CNSC's decision-making processes to:

- understand and compare various ways of evaluating and mitigating risks
- share research and operational experience

E.3.1.8 CNSC research and support program

The CNSC funds an external research program to enhance the knowledge and information needed to support its regulatory mandate and to use the best available science in its decision making. The CNSC's research is often conducted with the support of independent third parties and/or in collaboration with national and international partners, providing access to valuable expertise, state-of-the-art facilities and the best available data. The outcome of these research activities supports the CNSC to understand and address new or emerging safety and security issues; gain third-party perspectives on nuclear science; and share scientific knowledge with the nuclear industry and the public at large. [Summaries of completed research are available on the CNSC's website](#) in support of its mandate to disseminate objective, scientific, technical and regulatory information to the public about the activities of the Commission and the industry it regulates.

Research is carried out on a wide range of topics, from [health studies](#) on nuclear workers and host communities, to research on the [long-term management of nuclear waste in geological repositories](#).

E.3.1.8.1 Geological repository research

Understanding the environmental, safety and security impacts of long-term solutions for the disposal of waste is an important area of interest for the CNSC. The CNSC has been performing research on geological repositories since 1978. In 2008, to support the review of Canadian DGR initiatives, the Coordinated Assessment and Research Program (CARP) was implemented. Through this program, the CNSC collaborated with different Canadian and international organizations to obtain experimental data and develop mathematical models, investigate properties of bentonite as a sealing material, and verify some aspects of

geosphere stability in order to assess the long-term performance of the host rock and the engineered barriers. In 2020, the CARP became the Strategic Research Agenda for Deep Geological Repositories (DGR-SRA). The DGR-SRA is integral to ensuring that the CNSC continues to build and maintain the independent scientific knowledge required to assess current and future licence applications and the ensuing safety case by proponents, and make science-based licensing recommendations to the Commission. The DGR-SRA continues to play an important role in CNSC staff preparation for the next licensing stages of geological disposal projects.

CNSC's research program consists of independent scientific research conducted by CNSC staff in collaboration with national and international institutions. It also includes monitoring and reviewing state-of-the-art scientific advancements and participating in international fora to exchange information and knowledge related to DGRs.

Areas of research include investigating the stability of the geosphere, understanding the long-term performance of the host rock and engineered barriers, building the CNSC's safety assessment modelling capabilities, and conducting a series of studies on natural analogues to investigate long-term processes and build confidence in the different components of the multi-barrier system for safety.

Areas of geological repository research interest include:

- **Geosphere characteristics:** Investigating the long-term evolution of a repository site requires a comprehensive understanding of the site geosphere, and identifying which of these characteristics are important for long-term DGR safety. Building knowledge of regional and site-specific geologies and the key relevant attributes for demonstrating long-term safety (e.g. geosphere stability, predictability, extents of various lithologies, known potential host rock characteristics) is relevant for the Canadian DGR initiative, which is at the stage of evaluating and characterizing 2 remaining potential sites. In the past this work included evaluating constraints on faulting at strategically chosen sites in Ontario by mapping brittle tectonic structures, assessing their deformation mechanisms and acquiring geochemical data and absolute ages of fracture-fill minerals. Current research is focussed on developing an understanding of the crystalline site that is being investigated as a potential DGR site in the Canadian Shield.
- **Long-term performance of the host rock and engineered barriers:** The long-term performance of barriers will be affected by many perturbations, including radiogenic heat, excavation of the repository and future geological events like seismicity and glaciation. These perturbations result in complex thermal-hydraulic-mechanical-chemical (THMC) processes that need to be understood through experimentation and mathematical modelling. The CNSC is collaborating with Canadian and international partners, especially those with access to underground research laboratories (URLs), to obtain experimental data for developing and validating models of coupled THMC processes in the geological and engineered barriers.
- **Safety assessment modelling capabilities:** Understanding the long-term interaction of various components of a DGR, as well as those features, events and processes (FEPs) pertinent to long-term safety is integral to reviewing a safety case for a DGR. The CNSC continues to build its long-term safety assessment modelling capabilities so that it can independently verify that acceptance criteria at proposed DGRs will be met, and gain further insight into the extent that safety significant FEPs will have on the overall system performance of a disposal facility.
- **Natural analogues:** Experiments conducted at research facilities or URLs are of short duration (hours to years), while the time frame of safety assessment is hundreds of thousands to millions of years. The spatial scale from those experiments (metres to tens of metres) is also small compared to the typical spatial scale in safety assessments (kilometres). This can be addressed by studying natural analogues, such as uranium deposits. Uraninite, the most abundant uranium-bearing mineral in most uranium deposits, is similar in many ways to the uranium dioxide in spent nuclear fuel. The use

of these deposits as natural analogues helps bridge the spatial-temporal gaps between laboratory experiments and the long-term safety assessment of DGRs, and it builds confidence in understanding the performance of the components of the multi-barrier system. Canada is uniquely positioned to complete a series of natural analogue studies on Canadian uranium-bearing formations deposited and existing under a wide range of geochemical and geological conditions.

E.3.1.8.2 International collaboration

The CNSC participates in several international cooperative programs that carry out research in geological repositories, including:

- DECOVALEX-2023 (development of coupled models and their validation against experiments) – This project challenges researchers to model the experimental behaviour of events that may occur in a geological repository. The CNSC is an active member of the DECOVALEX project, which is an international collaboration on research and model comparison initiated in 1992 to advance the understanding and modelling of coupled THMC processes in geological systems.
- TENOR – This project conducts URL experiments of water and/or gas transport in bentonite and fractured rock, and on interpretation by mathematical modelling. It is managed by the Institut de radioprotection et de sûreté nucléaire (IRSN) in France.
- SITEX Network – Coordinated by the IRSN, this initiative aims to sustain a network for independent technical expertise on radioactive waste disposal.

E.3.1.8.3 Mine waste

The most significant challenge for conventional mining is the long-term management of the uranium tailings produced from milling the ore. Safety cases associated with tailings are strongly linked to the mineralogical and leaching behaviour of tailings particles as they age. The presence of aged tailings in historical above-ground tailings facilities and the now 20-plus year history of operation for modern below-ground tailings facilities provides the opportunity to test the theoretical predictions associated with the long-term management of tailings, both empirically and mathematically.

Areas of mine waste research include:

- **evaluating original model predictions** – Using geochemical data accumulated from tailings monitoring programs over the last two decades, it is now possible to verify earlier predictions of contaminant behaviour. Predictions that differ from the actual outcome present an opportunity to determine what processes may be causing contaminants to mobilize.
- **investigating the mobility of contaminants in subaqueous uranium mine tailings** – Historic uranium mine sites have been remediated, depositing uranium tailings under permanent water cover to limit interaction with the surrounding environment. These sites provide ideal locations for hydrogeochemical and mineralogical studies to improve our understanding of speciation and mobility in saturated environments.

E.3.1.8.4 Spent fuel safety

In the wake of the Fukushima Daiichi accident, the CNSC assembled a group of experts to study the capability for modelling the behaviour of spent fuel held in a CANDU irradiated fuel bay, should the water held in the bay be partially or totally drained. The group made recommendations on how this severe accident scenario could be modelled. Based upon the recommendations of the study, the CNSC entered into a memorandum of understanding with AECL for CNL to develop a computer code modeling a fuel bay loss of cooling accident to support the CNSC's Emergency Operations Center's Reactor Safety Team. This computer model was completed by CNL in 2021 and is used predict timing and source terms which can be fed into the plume

model and support recommendations for protective actions. CNSC staff have also used it for independent verification of beyond-design-basis accidents (BDBA) submissions relating to accidents.

E.3.2 Independence of the CNSC

E.3.2.1 Separation of the CNSC and organizations that promote and use nuclear energy

The NSCA is distinct and comprehensive legislation for the regulation of nuclear activities and the separation of the regulatory body's functions from those of organizations that promote or use nuclear energy. The CNSC's mission (see section E.3.1.1) focuses clearly on the health and safety of persons and the protection of the environment, and it does not extend to economic matters. The CNSC operates at arm's length from, and reports directly to, the Parliament of Canada.

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." Any political directives given to agencies (such as the CNSC), however, must be of a general nature and cannot fetter the Commission's decision-making authority in specific cases. In addition, all directives must be published in the *Canada Gazette* and placed before each House of Parliament.

E.3.2.2 Values and ethics

The CNSC has a firmly-entrenched regime of values and ethics which serves to strengthen governance and support ethical leadership. The CNSC's Internal Audit Evaluation and Ethics Division (IAEED) administers five related programs, as follows:

- The Values and Ethics Program provides employees with counselling and techniques for strengthening relationships in the workplace and with stakeholders, as well as practical tools for ethical decision-making.
- The Internal Disclosure Program helps employees safely and constructively disclose wrongdoing and protects them from reprisal.
- The Conflict of Interest and Post-employment Program gives the CNSC and employees tools to prevent and avoid situations that could create the appearance of a conflict of interest or result in a potential or actual conflict of interest.
- The Political Activities Program offers guidance to employees who seek to participate in political campaigns and reviews requests to run for office in federal, provincial and municipal elections.
- The External Complaints Program offers members of the public and the industry an opportunity to voice their concerns to a neutral CNSC entity.

The External Complaints Program was established in September 2015. Its purpose is to ensure all external complaints are first reviewed by a neutral CNSC entity and to respond consistently to allegations and plaintiffs. It provides a single external complaints window, ensures that all files are monitored to closure and provides annual reporting.

Through this program, members of the public, licensees' employees and licensees' site contractors can make complaints concerning the following: power plant design, construction, operation and maintenance; radiation protection, safeguards and security; wrongdoing or harassment, intimidation, retaliation or discrimination related to raising safety concerns; concerns related to the CNSC's mandate; and misconduct associated with CNSC employees.

The external complaint process starts when a person contacts the CNSC by telephone, email or regular mail to make an allegation. The first staff member to receive the information completes the external complaint form.

The IAEED conducts a preliminary analysis of the nature of the allegation. The IAEED forwards complaints of a technical matter to the appropriate director general, but it keeps the file when allegations are associated with fraud, values and ethics, conflicts of interest or disclosures that involve CNSC management or staff. The following steps will then be carried out:

- The appropriate director general assesses the issue or the IAEED conducts a fact-finding mission.
- The appropriate director general determines the next steps (e.g., inspection, regulatory actions).
- The appropriate director general monitors file progression, responds to complainants and closes the file.

Subject to applicable legislation, regulations and policies, the External Complaints Program adheres to the principles of fairness and equity toward alleged wrongdoers and complainants, the protection of the complainant's identity and the confidentiality of information provided.

The process, the timing, and in some cases, the way complaints are handled are now being monitored by the appropriate director general and the IAEED. This provides assurance that files receive the appropriate attention, follow-up and closure.

SECTION F

Other
general
safety
provisions



Section F – Other General Safety Provisions

F.1 Responsibility of the licence holder (Article 21)

This section addresses the obligations under Article 21 of the Joint Convention.

ARTICLE 21. RESPONSIBILITY OF THE LICENCE HOLDER

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.
2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

In Canada, the primary responsibility for the safety of spent fuel and radioactive waste management is the licensee's under the NSCA and its associated Regulations, and may not be delegated by the licensee to other persons or organizations. This responsibility includes providing adequate human and financial resources (see section F.2).

In addition, REGDOC-3.5.3, *Regulatory Fundamentals* outlines the CNSC's regulatory philosophy and states that:

- licensees are directly responsible for managing regulated activities in a manner that protects health, safety, security and the environment and that conforms with Canada's domestic and international obligations on the peaceful use of energy
- the CNSC is accountable to Parliament and to Canadians for assuring that these responsibilities are properly discharged

Licensees are required to comply with regulatory requirements, including applicable acts and regulations, the licence and the licensing basis at all times. Licensees are expected to review and consider regulatory guidance; if they choose not to follow it, they should explain how their chosen alternate approach meets regulatory requirements.

F.2 Human and financial resources (Article 22)

This section addresses the obligations under Article 22 of the Joint Convention.

ARTICLE 22. HUMAN AND FINANCIAL RESOURCES

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;
- (ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;
- (iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.2.1 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. Paragraph 44(1)(k) of the NSCA provides the legislative basis for the qualification, training and examination of staff. Paragraphs 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.

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 staff, partly due to an aging Canadian population resulting in talent pressures in key Canadian labour sectors. The sections that follow outline the licensees' initiatives to develop sufficient human resources to ensure the long-term sustainability of the workforce.

F.2.1.1 University Network of Excellence in Nuclear Engineering

Established in 2002, 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, research and development capability in Canadian universities. 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 and university-based education, and by encouraging young people to choose a career in the nuclear sector. More information is available at unene.ca.

The alliance consists of a number of Canadian universities, government entities (NRCAN and the CNSC) and industry partners, including OPG, CANDU Owners Group (COG), Bruce Power, CNL, SNC Lavalin, Kinectrics and the NWMO.

UNENE funding creates industrial research chairs in specialized areas at these universities through which students in master's degree and PhD programs are trained. In addition, UNENE sponsors collaborative research of topical interest to industry. It also supports a master of nuclear engineering degree program, delivered jointly by participating universities and intended for the employees of industry partners, which can be taken on a part-time basis.

Some current projects undertaken by UNENE include work in high-temperature aqueous chemistry, corrosion and stress-corrosion research relating to reactor materials, nuclear safety analysis and thermalhydraulics.

F.2.1.2 CANTEACH

The CANTEACH program was established by AECL, OPG, COG, BP, McMaster University, École polytechnique de Montréal 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 educational and training documents. The CNSC and other industry members also contribute to the program. More information is available at canteach.candu.org.

F.2.1.3 Ontario Power Generation

OPG's Nuclear Sustainability Services (NSS) currently comprises approximately 270 full-time employees. Staffing demand fluctuates, depending mostly on attrition through retirements. OPG employs a "centre-led" model, in which support groups – including engineering, health and safety, and environment – are managed under a corporate reporting structure. Staff within each of those groups are dedicated to supporting the Nuclear Sustainability Services and are above and beyond the core employee count. Staff for skilled and semi-skilled trades are typically recruited from within OPG and acquired through the external labour marketplace, as required.

OPG's NSS uses the following recruitment and retention strategies, wherever possible:

- **succession management** – OPG assesses the leadership capabilities and succession/replacement planning for all leadership positions.
- **advance hiring** – Critical positions within the organization are identified in OPG's succession-management program, and advance hiring is applied where feasible. Pre-hiring is done to account for attrition and ensure that a fully trained and proficient workforce are in place.
- **development and co-op student program** – University and college students are recruited in technical and business streams for work terms ranging from 4 months to 15 months.
- **participation in workforce planning within OPG** – To ensure adequate recruitment in advance of hiring needs, staffing demand within the Division is often satisfied through OPG's internal selection and placement processes. The Division focuses on the skilled operator and maintenance positions with an induction process to provide core skills training. Centre-led functional groups review staffing demand, enabling integrated planning across all OPG nuclear facilities.
- **knowledge management** – Managing critical knowledge and the associated knowledge risk when people exit positions (or leave OPG) is a key focus given workforce demographics, impending retirements, role transitions and the training and development required for specialized roles. It is imperative that employees' critical knowledge and expertise are sustained to support ongoing operations.
- **Indigenous Opportunities Network** – A program dedicated to the recruitment of Indigenous people and, honouring OPG's Reconciliation Action Plan (RAP) and Equity, Diversity, and Inclusion (ED&I) Strategy. The program strives to create an engaging and inclusive workforce that reflects the broad diversity of Indigenous Nations and communities and peoples across our company. The program establishes a network of employers in the energy industry and develops approaches to Indigenous recruitment and build career pathways to OPG and across the industry.

NSS uses OPG's knowledge management toolkit and its strategies, tools and resources to identify and mitigate knowledge risks and sustain critical knowledge within NSS, culminating in the development of knowledge management plans.

With continued emphasis on succession management, knowledge management, workforce planning and staff development, OPG's Nuclear Sustainability Services is positively positioned to meet its qualified staffing requirements for both the short and long term.

F.2.1.4 Bruce Power

BP's integrated talent management framework is aligned with its corporate strategy and goals to ensure qualified staff are available as needed for safety-related activities during the operating lifetime of its spent fuel and radioactive waste management programs. BP is focused on ensuring it has the right skillsets and behaviours to achieve excellence and to make sure it achieves its vision: "Safe. Reliable. Securing Tomorrow."

This process involves completing calibrated talent reviews for employees at all management levels, including individual contributors, having robust succession plans for the positions of mid-manager and above, and establishing personalized development plans based on intensive leadership assessments, while leveraging career maps to drive next moves. Its talent management review process connects directly into its solid suite of leadership development programs, where talent data is used to identify the need for and develop leadership development programs and subsequently populate class rosters based on development needs. The integration of these programs and the commitment of the senior leadership team have allowed BP to maintain a focus on developing a strong pool of qualified candidates to meet its organizational priorities and continuously focus on driving business results.

F.2.1.5 Nuclear Waste Management Organization

After the Government of Canada selected the APM approach in 2007, the NWMO began its transition from a small study-based group to a sustainable corporation with full responsibility for implementing the approach.

On January 1, 2009, the NWMO became its own employer with the necessary supporting infrastructure, including finance, legal services and human resources. Staffing levels increased from 27 at the end of 2007, to 81 one year later, and to 250 by early 2024. The initial influx of staff was due to the transfer of OPG personnel who had been working on both the NWMO programs and OPG's Deep Geologic Repository project for its L&ILW. One significant benefit of this arrangement was acquiring the experience of an established radioactive waste management and repository team.

The NWMO continues to hire staff and contractors to support its site selection process. Increasingly, the NWMO has also hired staff to support its development from a technical organization to a nuclear organization capable of holding a CNSC licence. The NWMO also has local offices in the communities participating in site selection process.

NWMO employees are skilled professionals who regularly participate in development and training to complement their technical and professional backgrounds. All new staff are required to complete core business needs training. The organization has also developed succession plans to ensure that a sustainable senior management team is in place for the future.

Research also helps to shape development of the site preparation process and continues to support its implementation. The NWMO has contracts with more than 15 Canadian universities to support its research capability.

The organization works with an extended group of experts from across Canada and internationally to support its design, siting and confidence-building activities. The NWMO also has contacts with many international organizations and has co-operation agreements with national radioactive waste management organizations in Belgium, Sweden, Finland, Switzerland, France, Japan, the Republic of Korea, the United Kingdom and the United States. The NWMO also has a memorandum of understanding with their counterpart in Taiwan. This ensures that international best practices are observed.

The APM will be implemented over several generations and will continue to evolve. That means that as an organization, the NWMO also needs to adapt and transfer knowledge for different phases of work. An essential element of that culture is continuous learning. The NWMO has improved their ability to manage the learning and development process through enhanced governance and integrated scheduling and by creating a one-stop shop for learning through a platform for employees, called NWMO-University. The NWMO also ramped up the breadth and depth of their training. In 2022 alone, the NWMO delivered more than 100 training sessions to more than 250 staff, with each staff member attending 11 training sessions on average.

The NWMO seeks to maximize job opportunities in the local municipality and surrounding region, including First Nation and Métis communities, and to build capacity in communities through investments in training and education.

F.2.1.6 .1.1 Hydro-Québec

Hydro-Québec faced major challenges following the decision to permanently shut down the Gentilly-2 NGS in 2012. Those challenges included complete defueling of the reactor and final draining of both nuclear and conventional systems. Further, although several employees had to be relocated to other divisions, Hydro-Québec had to maintain adequate expertise at Gentilly-2 to continue early decommissioning activities safely, and then reach the SWS phase. A permanent organization was therefore put in place to ensure decommissioning activities are performed during the SWS preparation phase (2015–24). In the early years, this organization was composed of about 70 employees, 95% of whom worked at Gentilly-2 while it was in operation. Now, the number of employees is adjusted according to the tasks that remain to be assumed.

In 2019, Hydro-Québec formalized the organizational structure to carry out the activities during the SWS phase (2025–57). Since 2020, the organizational structure at Gentilly-2 facilities has been composed of a director, a main manager and around 20 employees to support and carry out the SWS phase of activities.

F.2.2 Financial resources

Canada applies the “polluter pays” principle to spent fuel and radioactive WMFs. The principle states that waste owners are financially responsible for managing their radioactive waste, and the Government of Canada has set in place mechanisms to ensure this financial responsibility does not fall on the Canadian public. This position was reaffirmed in the Government of Canada’s modernized *Policy for Radioactive Waste Management and Decommissioning*. In 2002, under the NFWA, the owners of spent fuel are specifically required to establish segregated funds to fully finance long-term spent fuel waste management activities.

F.2.2.1 Historic waste

In some instances, remedial actions are required to address historic radioactive waste liabilities that are on properties not owned by the federal government, but where the original waste owner or producer of the waste no longer exists and the current owner can not reasonably be held responsible. In these situations, AECL, in consultation with NRCAN, and on behalf of the federal government may make a determination to accept responsibility for managing the wastes on a case-by-case basis. In March 2001, the Government of Canada and the local municipalities in Ontario’s Port Hope area entered into an agreement on community-developed proposals to address the cleanup and long-term management of the bulk of Canada’s historic wastes, thereby launching the Port Hope Area Initiative (PHAI). In 2012, the Government of Canada announced \$1.28 billion in funding to implement the PHAI. The management of these wastes, as well as other designated historic wastes across Canada, are the responsibility of AECL and are being managed by CNL under a government-owned -contractor-operated model. See section K.2.1 for more information.

F.2.2.2 Financial guarantees

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

Subsection 24(5) of the NSCA provides the legislative basis for this requirement. Paragraph 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.” The CNSC’s REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*, covers the provision of financial guarantees for decommissioning activities. REGDOC-2.11.2, *Decommissioning*, sets out requirements and guidance regarding the planning for decommissioning, preparation for decommissioning, execution of decommissioning and completion of decommissioning. These guides can be found at cnsccsn.gc.ca/eng/acts-and-regulations/regulatory-documents.

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. To ensure that a licensee covers the costs of spent fuel only once, the money in the trust funds set up under the NFWA is considered part of that licensee’s total financial guarantee to the CNSC.

The CNSC must be assured that it (or its agents) can access adequate funding measures on demand if a licensee is not available to fulfill its decommissioning obligations. 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 (federal or provincial). The acceptability of any of the above measures will ultimately be determined by the CNSC on the basis of the following general criteria:

- **liquidity** – The proposed funding measures should be established so that the financial vehicle can be drawn upon only with the approval of the CNSC so 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 times, to fund the decommissioning plans for which they are intended.
- **continuity** – The funding measures required for decommissioning should be maintained continually. This may require the periodic renewal, revision and replacement of securities provided or issued for fixed terms. For example, during licence renewal, the preliminary decommissioning plan may be revised, and the financial guarantee updated accordingly. Where necessary, to ensure there is continuity of coverage, funding measures should include provisions for advance notice of termination or intent to not renew.

The CNSC has requirements for financial guarantees for all licensees, from large complex facilities to users of sealed sources and radiation devices (see section J.1.3.7).

F.3 Quality assurance (Article 23)

This section addresses the obligations under Article 23 of the Joint Convention.

ARTICLE 23. QUALITY ASSURANCE

1. Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.3.1 Management system requirements

The regulations made under the NSCA require licensees to prepare and implement a management system for activities, including measures to promote and support safety culture programs for nuclear facilities. The licensees of spent fuel and radioactive WMFs submit their management system manual and programs to the CNSC before they begin their planned activities. The organization responsible for a facility must establish and implement a management system for the items and services the facility supplies. The management system covers the licensed spent fuel and radioactive waste management activities for more than one site. After a licence is granted, the licensee implements, assesses and continually improves the management system. The licensee must demonstrate the effectiveness of the management system.

CSA standard N286-12, *Management system requirements for nuclear facilities* integrates the requirements from other management system standards, such as quality, health and safety, environment, economics and security. The standard applies to top management with overall accountability for the nuclear facility. CSA standard N286-12 applies to all nuclear facilities, including spent fuel and radioactive WMFs at NPPs and uranium mines and mills. The requirement for a management system to meet this standard emphasizes the paramount importance of safety in guiding decisions and actions. This standard, in addition to generic requirements, also lists specific requirements for the lifecycle activities of radioactive WMFs.

The licence application describes how the main features of the applicant's management system are compliant with the relevant requirements in CSA standard N286-12 and how the management system will be implemented. The licence application is reviewed by CNSC staff. Specific waste management activities are performed under specific programs accepted by the CNSC.

F.3.2 Management system assessments

CNSC staff review the licensee's program documentation against the criteria established in the requirement documents and standards that are referenced in the licence and LCH to assess the effectiveness of the licensee's management system. CNSC staff also examine the results of the licensee's internal reviews and assessments. After the management system documentation is accepted, the CNSC plans and carries out a compliance verification to ensure the licensee is complying with its provisions. When deficiencies are detected, the CNSC produces detailed reports of the findings and forwards them to the licensee for its response and corrective actions. Based on the no-surprise approach that CNSC staff practice, the preliminary findings are presented to the licensees to take immediate corrective actions, as necessary. It is the responsibility of the CNSC to verify and enforce compliance. The CNSC uses a graduated enforcement strategy that is built on three fundamental principles: flexibility, timeliness and transparency. Enforcement includes all activities conducted to compel a licensee to return to compliance and to deter further non-compliance with the NSCA and its Regulations, and any licences, decisions, certificates and orders issued by the CNSC.

F.4 Operational radiation protection (Article 24)

This section addresses the obligations under Article 24 of the Joint Convention.

ARTICLE 24. OPERATIONAL RADIATION PROTECTION

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:
 - (i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;
 - (ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and
 - (iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.
2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:
 - (i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and
 - (ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.
3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.4.1 Keeping radiation exposures and doses as low as reasonably achievable

Operations at Canada's spent fuel and radioactive WMFs must be carried out in a manner that ensures radiation exposures and doses to workers, the public and the environment are below the CNSC regulatory dose limits and kept as low as reasonably achievable (ALARA), with social and economic factors taken into account. This approach is legislated through the NSCA and the RPR. Radiation exposures and doses are kept ALARA by implementing a radiation protection program with the following elements:

- management control over work practices
- personnel qualification and training
- control of occupational and public exposure to radiation
- planning for unusual situations
- ascertaining the quantity and concentration of any nuclear substance released as a result of a licensed activity

Note that the ALARA principle takes into account social and economic factors. Licensees are responsible for assessing and documenting the justification and rationale for how they will take these factors into account in the application of ALARA.

To ensure that licensees consistently apply the ALARA requirement, the CNSC has issued regulatory document REGDOC-2.7.1, *Radiation Protection*, published in July 2021, to provide further details on regulatory expectations.

F.4.2 Dose limitation

The CNSC establishes effective and equivalent dose limits in the *Radiation Protection Regulations* (RPR) for a nuclear energy worker, a pregnant nuclear energy worker and non-nuclear energy workers.

Section 13 of the RPR requires that every licensee ensure that the following effective dose limits are not exceeded:

- 50 mSv in a year and 100 mSv in a five-year dosimetry period for a nuclear energy worker
- 4 mSv for a pregnant nuclear energy worker who has informed the licensee in writing that they are pregnant (balance of the pregnancy starting from the date on which the licensee has been informed of the pregnancy)
- 1 mSv per calendar year for a person who is not a nuclear energy worker

Section 14 of the RPR requires that every licensee ensure the following equivalent dose limits are not exceeded:

- 50 mSv in a one-year dosimetry period for the lens of an eye of a nuclear energy worker, and 15 mSv in a calendar year for the lens of an eye of any other person
- 500 mSv in a one-year dosimetry period for the skin and for the hands and feet of a nuclear energy worker, and 50 mSv in a calendar year for the skin, hands and feet of any other person

Section 15 of the RPR details regulatory requirements related to exposures of persons who have been requested by the licensee to participate in the control of an emergency.

F.4.3 Action levels

In terms of occupational radiation protection, paragraph 3(1)(e) of the GNSCR requires a licence application to include the measures proposed for ensuring compliance with the RPR. Paragraph 3(1)(f) of the GNSCR also requires any proposed action level for the purpose of section 6 of the RPR to be included with the application.

Section 6 of the RPR defines an action level as “a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee’s radiation protection program and triggers a requirement for specific action to be taken.” When an action level is reached, the licensee must take the following actions:

- Conduct an investigation to establish the cause for reaching the action level

- Identify and take action to restore the effectiveness of the radiation protection program, and
- Notify the Commission within the period specified in the licence.

Action levels are designed to alert licensees before regulatory dose limits are reached; they are established as part of licensees' radiation protection programs. Licensees are responsible for identifying the parameters of their program that serve as timely indicators of potential losses of control of their program. For this reason, action levels are specific to the facility or activity and may change over time, depending on operational and radiological conditions. By definition, if an action level is reached, a loss of control of some part of the associated radiation protection program may have occurred, and specific action is required. The CNSC's REGDOC-2.7.1, *Radiation Protection* provides further details on regulatory expectations.

F.4.4 Dosimetry

The CNSC requires that every licensee ascertain and record the magnitude of radiation exposure to workers by direct measurement or monitoring, or where this is not possible, by estimation. The RPR stipulate that when a nuclear energy worker has a reasonable probability of receiving an effective dose of greater than 5 mSv in a one-year dosimetry period or an equivalent dose to the skin or to the hands and feet greater than 50 mSv in a one-year dosimetry period, the licensee is required to use a CNSC-licensed dosimetry service. Standards for licensed dosimetry services in Canada are found in REGDOC-2.7.2, *Dosimetry, Volume II: Technical and Management System Requirements for Dosimetry Services*, published in August 2020. Licensed dosimetry services must report the dose results of each nuclear energy worker in Health Canada's National Dose Registry.

F.4.5 Preventing unplanned releases

The nuclear sector reduces the risk of unplanned effluent releases of radioactive material into the environment by, but not limited to installing multiple barriers; having competent staff and reliable, systems and components; and detecting failures and correcting them.

Due to the robust design of the storage facilities that house high-risk materials like spent fuel, the potential for a significant release is present mainly when materials are handled. Such operations are closely monitored by the licensee, who would be available to immediately respond 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 transporting the spent fuel at extremely low speeds on dedicated transit routes which are physically controlled during transfer and prohibiting the transfer of spent fuel during inclement weather, including high winds and periods of rain or snow. Packages used in the transport of radioactive materials are designed to withstand accidents during transportation to ensure containment and are inspected and tested routinely to confirm their integrity.

In the event of an uncontrolled release into the environment, competent licensee staff are available for an initial cleanup and containment exercise to prevent the further spread of radioactive contaminants. If necessary, the stored radioactive waste may be retrieved and held in a more secure manner. Depending on the magnitude and severity of the release, emergency procedures and emergency preparedness plans may be activated.

F.4.6 Protection of the environment

Environmental protection is one of the 14 safety and control areas (SCA) (see annex 3 for a description of all 14 SCAs) that the CNSC considers when evaluating how well its licensees meet regulatory requirements and expectations to prevent unreasonable risk to the environment in a manner consistent with Canadian environmental policies, laws and regulations, and Canada's international obligations. The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances. There are requirements that ensure effluent and emissions preventive and control measures are established on the basis of best industry practice, incorporating the application of best available technology and techniques economically achievable (BATEA), ALARA, process optimization, continuous improvement and

the results of an environmental risk assessment (ERA). It incorporates the key concepts of pollution prevention, sustainable development and adaptive management. It also covers the effects on the environment and human and non-human biota from facilities or as the result of licensed activities.

REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, version 1.2 (published in September 2020), sets out the CNSC's regulatory requirements for and expectations of programs related to environmental protection. More precisely, REGDOC-2.9.1 describes:

- the CNSC's principles for environmental protection for all nuclear facilities or activities that interact with the environment
- for all nuclear facilities or activities that interact with the environment, the scope of an environmental review, including the roles and responsibilities associated with this review
- the CNSC's requirements and guidance to applicants and licensees for developing environmental protection measures, including an ERA where required, for both new and existing facilities or activities

REGDOC-2.9.1 clarifies the CNSC's expectations of applicants and licensees for the entire nuclear fuel cycle and provides guidance for the environmental protection measures licensees should have in place to ensure the protection of persons and the environment. The necessary measures for environmental protection are determined on a facility- or activity-specific basis. Not every facility or activity is required to have every environmental protection measure described in this regulatory document. The CNSC allows the applicant or licensee to address certain requirements by demonstrating that a particular measure is not necessary or does not apply to that facility or activity. In this scenario, a licence application that describes the nature of the proposed licensed activities is considered sufficient for ensuring protection of the environment, provided CNSC staff conclude the facility or activities do not have significant interactions with the environment.

F.4.6.1 Environmental management system

An environmental management system (EMS) refers to the management of an organization's environmental policies, measures and procedures in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection and continuous improvement by:

- identifying and managing environmental risks associated with a facility or activity
- identifying, implementing and maintaining pollution control activities and technologies
- monitoring releases
- monitoring contaminants and their potential effects in the environment

The EMS serves as the management tool for integrating all of the applicant's or licensee's environmental protection measures in a documented, managed and auditable process by:

- identifying and managing non-compliance and corrective actions within the activities, through internal and external inspections and audits
- summarizing and reporting the performance of these activities, both internally (licensee's management structure) and externally (to the Commission and the public)
- training the personnel involved in these activities
- ensuring the availability of resources (such as qualified personnel, organizational infrastructure, technology and financial resources)
- defining and delegating roles, responsibilities and authorities essential to effective environmental management

The EMS may be implemented within the licensee's integrated management system. CAN/CSA ISO 14001, *Environmental management systems – Requirements with guidance for use* (2004 edition or successor editions), specifies the requirements for an EMS that licensees can use to enhance environmental performance. Licensees are required to ensure that the scope of the EMS is consistent with the definition of environment, environmental effects and pollution prevention. They must conduct internal audits and an annual management review.

Within the EMS, the licensee should address reporting requirements for potential or real emergency situations. In addition, the EMS should address environmental emergency preparedness and response in terms of:

- the proposed measures to prevent accidental releases of nuclear and hazardous substances or mitigate the effects of any releases on the environment
- the proposed measures to ensure that environmental monitoring instruments are available and accessible during emergencies
- environmental monitoring instruments and equipment layouts included in emergency plans

F.4.6.2 Environmental risk assessment

Under REGDOC 2.9.1, licensees must conduct an environmental risk assessment (ERA). An ERA is a systematic process that identifies, quantifies, and characterizes the risk posed by releases of nuclear and hazardous substances and physical disturbances (stressors) on representative human and non-human biota in the environment. It is a practice or methodology that provides science-based information to support decision making and to prioritize the implementation of mitigation measures. CSA standard N288.6, *Environmental risk assessments at nuclear facilities and uranium mines and mills* addresses the design, implementation and management of an ERA program.

The ERA provides the basis for the scope and complexity of monitoring programs, including effluent and environmental monitoring programs. An ERA can help inform an effluent monitoring program by identifying and prioritizing specific radioactive and non-radioactive contaminants, physical stressors, and the sources or release points from the nuclear facility or licensed activity.

An ERA is an evergreen tool that is reviewed (i.e., minimum every 5 years) and updated periodically as new information is gathered. If an ERA indicates that the nature and/or extent of potential environmental exposures have changed, several actions may be taken, including re-evaluating the significance of environmental effects, investigating mitigation measures as necessary, and updating the effluent and environmental monitoring programs accordingly.

F.4.6.3 Protection of people

Under the NSCA and associated regulations, the licensee must demonstrate that the health and safety of the public are protected from exposures to nuclear and hazardous substances released from the nuclear facility. REGDOC-2.9.1 states that a human health risk assessment is completed as a sub-element of an ERA; it estimates the nature and probability of adverse human health effects as a result of releases of nuclear and hazardous substances from the nuclear facility and other physical stressors, such as noise.

In addition, releases of nuclear and hazardous substances are controlled and monitored by the effluent and emissions control and monitoring program and the environmental monitoring program. Licensees are required to report to the appropriate authorities, including the CNSC, any releases above regulatory limits and any unauthorized releases of nuclear or hazardous substances to the environment (for example, spills). Licensees are also required to submit a follow-up report detailing the results of the investigation and any corrective actions taken to prevent a reoccurrence.

F.4.6.3.1 Estimated dose to the public

Licensees are required to demonstrate in their ERA that the estimated dose to the public from their licensed activities is below the regulatory limit of 1 mSv per calendar year. Some licensees achieve this by entering the results of their effluent monitoring and control activities into an environmental transport model, as described in CSA standard N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities*; they use this model to calculate the estimated dose to the public as a result of the licensed activity. Other licensees conduct fence-line monitoring using thermoluminescent dosimeters (TLDs) or active monitoring during the execution of licensed activities. Every year, licensees are required to report to the CNSC the estimated dose to public as a result of their licensed activities.

F.4.6.3.2 Studies on health effects from exposures to ionizing radiation

The health effects from exposure to ionizing radiation have been studied for decades.¹ There are two broad categories of health effects from exposure to radiation: tissue reactions and stochastic effects. The current understanding of tissue reactions and stochastic effects is based on the life span studies (LSS) of the atomic bomb survivors.² Numerous studies published in Canada³⁻¹⁶ and abroad support the findings of the LSS studies. These studies include: studies of medical patients, nuclear energy workers (including medical workers), and people living in the vicinity of nuclear facilities. Together, these studies confirm that at current environmental or occupational exposure levels, no adverse health effects are expected.

In Canada, spent fuel and radioactive waste are contained in interim storage facilities. As currently managed, all radioactive waste inventories contribute to less than 1 μ Sv of dose each year to the public (1,000 times lower than the public dose limit), and less than a few mSv each year to those who work with such wastes. At these operational levels, there is no significant health risk.¹⁷

Given that there are no geological repositories in Canada, and few in the world, limited information exists about public radiation exposures resulting from the operation of this type of facility. However, public exposure during existing (or normal) and emergency situations have been modelled, and the doses are expected to be lower than the public dose limit of 1 mSv per year for normal operations and lower than 1 mSv per year for emergency situations that are considered very unlikely events.¹⁸

Human health risk assessments have generally focused on the risk of cancer, the primary health effect associated with low dose radiation exposures. However, lessons learned from past nuclear accidents and other types of disasters have shown that psychosocial impacts are an important health factor. Although there is no widely agreed definition, psychosocial describes the interaction between social aspects (such as interpersonal relationships and social connections, social resources, social norms, social values, social roles, community life, spiritual and religious life) and psychological aspects (such as emotions, thoughts, behaviours, knowledge and coping strategies) that contribute to overall well-being. To support the planning in advance for management of psychosocial impacts, the World Health Organization (WHO) published a framework for mental health and psychosocial support in radiological and nuclear emergencies as an initial step toward integrating mental health support and radiation protection.¹⁹ An example in which psychosocial impacts were considered in Canada was described in the Seventh National Report for the Joint Convention.

Through continued research and collaboration with domestic partners and international bodies, the CNSC will remain abreast of new developments in radiation health research. The CNSC will ensure that all wastes as currently managed and any proposed future operations meet all regulatory standards and requirements, thereby protecting the health and safety of all Canadians.

F.4.6.4 Effluent and emissions control and monitoring

The CNSC regulates releases to the environment through licensed release limits which are values that, if exceeded, indicate that the licensee is operating outside of its licensing basis during normal operation, which is a point of non-compliance. The objectives of a licensed release limit are to:

- protect human health and the environment
- ensure that pollution prevention and control technologies are implemented
- drive continuous improvement
- ensure that the licensee is operating within their approved licensing basis

Licensees establish controls on environmental releases to protect the environment and abide by the principles of sustainable development and pollution prevention. Licensees are encouraged to set action levels to provide assurance that the licensed release limits will not be exceeded. This is done by providing an early indication of a potential loss of control of part of the environmental protection program. Action levels are also used to ensure licensees demonstrate adequate control of their facility based on their approved facility design, environmental protection programs and radiation protection programs. Action levels are site-specific and are derived using operating data from the facility during normal operations. CSA standard N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities* (published in 2017 and updated in 2023) provides guidance on developing and implementing action levels for releases from nuclear facilities.

In conjunction with specific regulatory monitoring requirements, the ERA provides the technical foundation and structure to identify the need for effluent and emissions monitoring and its details. The design of the site-specific effluent and emissions monitoring program is based on the characterization of the locations, the anticipated volume, chemistry and flow rate of releases, and the proposed maximum quantities and concentrations of nuclear and hazardous substances (including their physical, chemical and radiological characteristics). CSA standard N288.5, *Effluent and emissions monitoring programs at nuclear facilities* (published in 2011 and updated in 2022) addresses the design, implementation and management of an effluent monitoring program that meets legal and business requirements.

Effluent and emissions monitoring may not be required for facilities and activities with no significant measurable releases to the environment. In such cases, the licensee should demonstrate (through engineering or scientific methods) that appropriate barriers and practices are implemented, monitored and maintained to prevent releases to the environment.

Monitoring may also not be required for facilities and activities where the releases are of low risk, as identified in the ERA, or the quantities are too low or too difficult to measure using industry best practices and/or equipment. If measuring is not feasible or is too difficult, the licensee may estimate emissions based on site-specific process chemistry and engineering principles.

F.4.6.4.1 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 one or more pathways, such as:

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

Currently, for nuclear substances, the CNSC's licensed release limits are known as derived release limits (DRLs). A DRL is a sub-type of a licence limit that is derived using the methodology in CSA standard N288.1, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities*. For most facilities, a DRL is based on achieving a radiological dose equal to the regulatory annual dose limit of 1 mSv/yr to a potential critical receptor from the airborne and liquid releases

of a facility during normal operations. Instead of using the regulatory dose limit, some facilities calculate their DRLs so that they achieve a lower dose constraint. The nuclear sector sets operating targets or administrative limits that are typically a small percentage of the DRLs. These targets are based on the ALARA principle; they are unique to each facility and depend 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. This person is determined from site-specific surveys and can be based on an actual or hypothetical person.

Doses received by members of the public through routine releases from Canadian nuclear facilities are very low and constitute a small fraction of the CNSC regulatory dose limits. REGDOC-2.9.2, *Controlling Releases to the Environment*, formally describes the process for establishing and implementing licensed release limits for releases to the environment and sets expectations for using CSA standard N288.8 to derive environmental action levels.

F.4.6.4.2 Conditional clearance levels

Some licensees have generic conditional clearance levels for releases to the atmosphere and to the municipal sewer system that are derived using the methodology in IAEA-TECDOC-1000, *Clearance of Materials Resulting from the Use of Radionuclides in Medicine, Industry and Research*, which was published in 1998.

The licensed release limits for the release of radionuclides to the atmosphere assume that the release is from a vent from the side of a building. The receptor is assumed to reside in a building 20 metres away from the source. In addition, the receptor is assumed to consume all vegetables and other crops from a location 100 m away from the source of the atmospheric releases, and that meat and milk that are consumed are from a location 800 m from the source of the releases. The licensed release limits consider the following exposure pathways:

- inhalation of radionuclides released to air
- external dose from the cloud (immersion)
- external dose from material deposited on the ground
- ingestion of radionuclides in food

The licensed release limits for sewer releases are based on two main groups of pathways: those resulting from the retention of radionuclides in sewage sludge at the waste water treatment plant (WTP), and those from the waste water treatment plant effluent discharged to a river. Discharge limits are calculated separately for both groups of pathways; namely those resulting from the retention of radionuclides in sewage sludge and those from the WTP effluent discharged to a river. The limits are calculated so that the annual effective dose to the receptor is 10 μSv from each of the two groups of pathways. The smaller of the two limits calculated in this manner is rounded to the nearest multiple of 10 and selected as the discharge limit for the radionuclide. These limits are found in appendix A of REGDOC-2.9.2.

F.4.6.5 Environmental monitoring

Under REGDOC-2.9.1, and in keeping with regulatory monitoring requirements and the ERA, the environmental monitoring measures that licensees establish and implement are in line with CSA standard N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*. This standard addresses the monitoring of both nuclear and hazardous substances, and their potential effects on human and non-human biota. CNSC staff evaluate and assess the results of these monitoring programs to determine compliance with the applicable requirements and limits, as set out in the regulations that govern Canada's nuclear industry. Data from the environmental monitoring program is used to inform future revisions of the ERA.

Environmental monitoring consists of a risk-informed set of integrated and documented activities to sample, measure, analyze, interpret and report one or all of:

- the concentration of nuclear and hazardous substances in environmental media to assess the exposure of receptors to those substances and/or the potential effects on human health, safety and the environment
- the intensity of physical stressors and/or their potential effect on human health and the environment
- the physical, chemical and biological parameters of the environment normally considered when determining what environmental monitoring is needed to help interpret the results, for example, data for transport (such as wind velocity), or toxicity assessment (such as organic carbon or hardness), or measurements at reference stations (where incorporated in the monitoring)

The CNSC's Independent Environmental Monitoring Program (IEMP) is an independent from licensee, technical environmental sampling program in publicly accessible areas around nuclear facilities. The CNSC continues to strive to build Indigenous and public trust in the CNSC's regulation of the nuclear industry, and thus implements an IEMP as one tool to confirm the effectiveness of a licensee's monitoring program and to promote greater awareness and information sharing about the CNSC's work in the protection of people and the environment. The IEMP is a regulatory tool that complements and informs the CNSC's ongoing compliance verification program. The IEMP does not rely on licensees to provide samples. CNSC staff or independent contractors obtain samples from publicly accessible areas around nuclear facilities, then measure and report the amounts of radiological and hazardous substances present in these samples to the Commission, Indigenous Nations and communities, and the public. A summary of the results is available on the CNSC's IEMP website at [Independent Environmental Monitoring Program \(IEMP\) \(cnsccsn.gc.ca\)](https://www.cnsccsn.gc.ca/iemp).

Figure F.1: CNSC staff taking food samples at a local garden



F.4.6.6 Groundwater protection and monitoring

Under the NSCA and its Regulations, licensees are required to ensure that groundwater is protected through an inter-related system of initiatives, processes, and activities that seeks to protect the quality and quantity of groundwater. This system minimizes interactions between the environment and activities associated with a nuclear facility to help manage groundwater resources effectively. Groundwater protection is a specialized element of the overall environmental protection measures. As groundwater flow and associated contaminant transport can be more difficult to detect and delineate than those of surface water, specific requirements and guidance are provided in REGDOC-2.9.1 and CSA standard N288.7, *Groundwater protection and monitoring programs for nuclear facilities and uranium mines and mills*.

F.5 Emergency preparedness (Article 25)

This section addresses the obligations under Article 25 of the Joint Convention.

ARTICLE 25. EMERGENCY PREPAREDNESS

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.
2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F.5.1 Nuclear emergency preparedness and response in Canada

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

In keeping with IAEA guidance, responsibilities for nuclear emergency response are subdivided into two basic areas: on-site and off-site. The response activities and strategies in these two areas may involve and require different stakeholders; however, they are not independent of each other. Therefore, an effective and efficient response to a nuclear emergency must be coordinated between all levels of government, the CNSC and the licensee.

All organizations that play a role in nuclear emergency response, including the CNSC and its licensees, must have a nuclear emergency response plan in place, as well as operational facilities that are equipped and appropriately staffed to coordinate and direct their responses to the nuclear emergency.

From June 3 to 13, 2019, the IAEA carried out an Emergency Preparedness Review (EPREV) at the Government of Canada's request, making Canada the first G7 country to conduct an EPREV mission, highlighting its commitment to protecting the health and safety of Canadians. The mission focused on preparedness for emergencies originating from events at Emergency Preparedness Category I facilities, as defined in IAEA Safety Standards Series No. GSR Part 7, *Preparedness and Response for a Nuclear or Radiological Emergency* which includes emergencies taking place at NPPs, irrespective of their initiating events. The IAEA's 2019 report, *Peer Appraisal of the Arrangements in Canada Regarding Preparedness and Response for a Nuclear or Radiological Emergency*, highlighted 5 good practices and provided 6 suggestions and 6 recommendations. In June 2023, the Government of Canada hosted the EPREV follow-up mission, which consisted of interviews and the review

of reference materials provided by Canada. During the follow-up mission, the IAEA review team interacted with government officials and representatives of response organizations at all levels, as well as with staff from NB Power and OPG. The IAEA review team identified that all the recommendations and suggestions formulated in 2019 are addressed and closed. In addition, the IAEA review team acknowledged the amount of work that Canada had completed since the 2019 EPREV mission even while managing the COVID-19 pandemic and the conflict situation in Ukraine. For further information on the EPREV mission in 2019 and the 2023 follow-up mission, see section K.5.2.

F.5.2 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** – events that occur within the physical boundaries of a CNSC-licensed nuclear facility. The operators of those nuclear facilities are responsible for their on-site emergency planning, preparedness and response, but must also have plans and procedures in place to assist with any potential off-site consequences of an on-site emergency at their facility
- **off-site nuclear emergencies** – events that occur outside licensed facilities but may originate from or be associated with a licensed facility or activity, and may even originate outside Canada. Events of this type may require intervention from provincial, territorial or municipal authorities operating outside of the licensed facility or activity, likely requiring support from the licensee and possibly the Government of Canada through the Federal Nuclear Emergency Plan (FNEP)

The licensees' nuclear emergency plans include measures to address on-site emergencies (including emergencies at the spent fuel facilities and WMFs), as well as measures that support planning, preparedness and response for off-site emergencies. The response to off-site emergencies takes a hierarchical approach that involves the licensee, the local municipal government, the provincial/territorial government and the federal government.

F.5.3 Responsibilities in the event of a nuclear emergency

In the event of a nuclear site or facility accident with potential off-site consequences, the off-site response would follow a tiered process that involves:

- the licensee
- municipal government
- provincial/territorial governments
- federal government

The provincial governments are responsible for:

- overseeing public health and safety, and the protection of property and the environment
- enacting legislation to fulfill the province's lead responsibility for public safety
- preparing emergency plans and procedures and providing direction to the municipalities they designate to do the same
- managing the off-site response by supporting and coordinating the efforts of organizations that have responsibility in a nuclear emergency
- coordinating support from the nuclear site or facility licensee and the Government of Canada during preparedness activities and during the response in a nuclear emergency

Federal government support and response for potential off-site impacts are required for addressing areas of federal responsibility, including the effects of an incident that extend beyond provincial or national borders. Likewise, federal assistance, when requested by an affected province, needs to be coordinated. Some provinces have agreements with the federal government for the provision of specific types of technical support. Federal responsibility also encompasses a wide range of contingency and response measures to prevent, correct or eliminate accidents, spills, abnormal situations and emergencies, and to support provinces and territories in their responses to a nuclear emergency. The Government of Canada is also responsible for:

- 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

Public Safety Canada was created in 2003 to ensure coordination across all federal departments and agencies responsible for national security and the safety of Canadians. It is responsible for coordinating the overall federal government response to emergencies in support of provinces, including nuclear emergencies. The *Emergency Management Act* (EMA), which entered into force in 2007, replacing the former *Emergency Preparedness Act*, recognizes the roles that all stakeholders must play in Canada's emergency management system. It sets out the leadership role and responsibilities of the Minister of Public Safety and Emergency Preparedness, including coordinating emergency management activities among government institutions and in cooperation with the provinces and other entities. The responsibilities of other federal ministers are also set out in the EMA.

Canada's federal government is dedicated to working collaboratively with provinces and territories to support communities when disasters strike. To this end, *An Emergency Management Framework for Canada* was revised and approved by federal, provincial and territorial ministers in 2011. The framework establishes a common approach for a range of collaborative emergency management initiatives in support of safe and resilient communities. It can be viewed at publicsafety.gc.ca/cnt/rsrscs/pblctns/mrgnc-mngmnt-frmwrk/index-eng.aspx.

Public Safety Canada is the lead authority for the Federal Emergency Response Plan (FERP). On behalf of Public Safety Canada, Health Canada is the lead authority for the FNEP, which is a subsection of the FERP, and also has responsibilities related to radiation protection. Health Canada administers both a federal interdepartmental and a federal-provincial nuclear emergency management committee.

Other federal organizations with responsibilities in nuclear emergency preparedness and response include the CNSC, Transport Canada, Environment and Climate Change Canada (ECCC), NRCAN and the Public Health Agency of Canada (PHAC):

- NRCAN is responsible for providing emergency radiation mapping and surveying services, providing policy advice and coordinating federal actions in relation to nuclear liability, including administering the NLCA.
- Transport Canada is responsible for the Canadian Transport Emergency Centre (CANUTEC).
- Internationally, Health Canada and the CNSC serve as national competent authorities to the IAEA.
- ECCC operates a regional specialized meteorological centre under the auspices of the World Meteorological Organization and provides atmospheric modelling services to the IAEA as part of its emergency response functions.
- PHAC is the national authority for reporting to the World Health Organization under the *International Health Regulations*.

The Government of Canada is also responsible for establishing and 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 NLCA. Operators of nuclear installations designated under the NLCA are absolutely and exclusively liable for any civil damages caused by an incident at that installation, and are required to have financial security in place to cover their liability. In the event of a serious incident, the NLCA provides special compensation measures that may be imposed by government to replace the normal court process. NRCan is the lead department responsible for ensuring that the process of compensation is well coordinated and administered in Canada.

The CNSC has a dual role in nuclear emergency response. Under the mandate established by the NSCA, the CNSC maintains regulatory oversight of the on-site nuclear emergency response activities of its licensees. As a federal agency, the CNSC also participates in the whole-of-government response to a nuclear emergency in accordance with the requirements of both the FERP and the FNEP.

The CNSC requires licence applicants to assess the impacts their proposed activities have on health, safety, security and the environment. It also requires that they propose and implement measures to prevent or mitigate the effects of accidental releases of nuclear or hazardous substances. Once the CNSC has reviewed and accepted the application, then issued a licence, these measures become binding upon the licensee. Due to the variety of risk among CNSC-licensed facilities in Canada, some facilities require detailed emergency preparedness and response plans that must be coordinated with mutual aid organizations, while others may require only internal emergency procedures (i.e., for some low risk WMFs). Following the events in Fukushima, all major radiological and nuclear facilities in Canada were required to review their emergency planning basis, taking into account severe accidents and multi-event scenarios (e.g., loss of power coinciding with a release of radioactive material) to determine whether their current preparedness measures were still appropriate and whether additional measures needed to be incorporated into their plans.

The CNSC maintains its regulatory role and responsibilities during emergencies through direct oversight of the licensees' response actions, providing technical and advisory support to the provincial, territorial and federal authorities through the Government of Canada's FERP and FNEP. These responsibilities encompass a wide range of contingency and response measures to prevent, correct or mitigate accidents, spills, abnormal situations and emergencies.

Health Canada coordinates federal operations with provincial and territorial operations as required. The FNEP includes provincial annexes for Ontario, Quebec, and New Brunswick, as they have nuclear power stations, and for Nova Scotia and British Columbia, as they have ports which are visited by nuclear-powered vessels. The FNEP also supports the provinces and territories without specific annexes, as required.

F.5.4 CNSC assessment of licensee emergency management programs

Applicants, including those for spent fuel and radioactive WMFs, must submit their emergency plans as part of their licence application. CNSC staff review and evaluate those plans according to regulatory criteria and guidance documents, such as REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response, Version 2* (2016) and CSA standard N393, *Fire protection for facilities that process, handle, or store nuclear substances*. Once an applicant has been issued its licence, CNSC staff regularly review and perform audits of that licensee's emergency plans.

NGS and WMF licensees have emergency preparedness programs that identify the concepts, structures, roles and resources needed to implement effective nuclear emergency response capabilities and maintain them. The programs establish how nuclear facilities and other concerned organizations prepare for and plan to respond to emergencies (including nuclear or radiological emergencies, both on-site and off-site), in order to protect workers, the public and the environment. An effective emergency preparedness program contains arrangements to ensure a timely, coordinated and effective response to any emergency.

Each licensee's response capability is captured in its nuclear emergency plan, which encompasses both emergency preparedness and emergency response measures. The plan ensures that the appropriate emergency response capabilities have been developed and are being maintained so that the licensee can

respond effectively in the event of a nuclear emergency. It is based upon the licensee's planning basis for both design-basis and beyond-design-basis events. Note that OPG has a single Consolidated Nuclear Emergency Plan that governs both the Darlington and Pickering sites and includes the WMFs.

The licensees' nuclear emergency plans include measures to address on-site emergencies, as well as measures that support planning, preparedness and response for off-site emergencies. The response to off-site emergencies takes a hierarchical approach that involves the licensee, the local municipal government, the provincial/territorial government and the federal government.

As part of their emergency preparedness programs, the licensees conduct emergency preparedness training, drills and exercises annually to ensure that their sites have adequate and robust emergency notification and response capability from their own staff and/or nearby emergency services with which they have memoranda of understanding or agreements. The following full-scale exercises were conducted within the review period:

- From October 18 to 21, 2020, OPG held a full-scale exercise (Exercise Unified Control) at the Pickering NGS, which tested the preparedness and response capabilities and capacities of more than 30 organizations, including the CNSC and some non-government agencies. The CNSC participated at its Emergency Operations Centre at headquarters, the Site Management Centre at OPG and the Provincial Operations Centre at the Office of the Fire Marshall and Emergency Management in Toronto.
- On October 6 and 7, 2021, NB Power conducted a full-scale exercise (Exercise Synergy Challenge) at Point Lepreau, which tested the preparedness, response and recovery capabilities and capacities of more than 35 organizations, including the CNSC and some non-government agencies. This exercise also has a security component.
- On February 23 and 24, 2022, OPG conducted a full-scale exercise (Exercise Unified Command) at the Darlington NGS, which tested the preparedness and response capabilities and capacities of the various response organizations, including the CNSC and some non-government agencies. The CNSC participated at its Emergency Operations Centre at headquarters, the Site Management Centre at OPG and the Provincial Operations Centre at the Office of the Fire Marshall and Emergency Management in Toronto.
- From October 4 to 6, 2022, BP held a full-scale exercise (Exercise Huron Endeavour) at BP. This exercise tested and validated emergency preparedness, response capabilities and the collaborative and consultative processes of BP and its stakeholders. The initiating event was a plane crash into the Bruce NGS.
- From September 27 to 29, 2023, OPG held a full-scale exercise (Exercise Unified Command) at the Pickering NGS, which tested the preparedness and response capabilities and capacities of more than 30 organizations, including the CNSC and some non-government agencies. The CNSC participated at its Emergency Operations Centre at headquarters, the Site Management Centre at OPG and the Provincial Operations Centre at the Office of the Fire Marshall and Emergency Management in Toronto. The final day of the exercise focused on the recovery phase, which the CNSC observed, even though these proceedings were not formerly evaluated.

F.5.5 International arrangements

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

- *Canada–United States 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 cooperative measures for dealing with peacetime radiological events that involve Canada, the U.S. or both countries. The 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, developed under the auspices of the IAEA, promotes

cooperation between signatories and facilitates prompt assistance in the event of a nuclear accident or radiological emergency. Its purpose is to minimize the consequences of such an accident. Practical steps include taking measures to protect life, property and the environment. The agreement sets out how assistance is requested, provided, directed, controlled and terminated.

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

F.6 Decommissioning (Article 26)

This section addresses the obligations under Article 26 of the Joint Convention.

ARTICLE 26. DECOMMISSIONING

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

- (i) qualified staff and adequate financial resources are available;
- (ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;
- (iii) the provisions of Article 25 with respect to emergency preparedness are applied; and
- (iv) records of information important to decommissioning are kept.

F.6.1 Decommissioning in Canada

REGDOC-2.11.2, *Decommissioning*, provides requirements and guidance for all phases of decommissioning from planning for to the completion of decommissioning. REGDOC-2.11.2 applies to Class I and Class II nuclear facilities, uranium mines and mills and nuclear substances and radiation devices licensees that are required to have decommissioning plans or strategies as a result of a regulatory requirement or a condition of their licence. In accordance with REGDOC-2.11.2, licensees are required to keep decommissioning plans up to date throughout the lifecycle of a licensed activity. The CNSC also requires licensees to prepare a preliminary decommissioning plan (PDP) and a detailed decommissioning plan (DDP) for approval.

The PDP must be filed with the CNSC as early as possible in the lifecycle of the activity or facility, and must be reviewed and updated:

- every five years
- when operational experience is gained or technological advancements are made
- when requested by the Commission or person authorized by the Commission

The PDP documents the selected decommissioning strategy, main decontamination, dismantling and/or clean-up activities; end-state objectives; an overview of the principal hazards and protection strategies; a waste management strategy; a cost estimate; and financial guarantee arrangements. The PDP is progressively updated, where needed, to reflect the appropriate level of detail required for the respective licensed activity.

The DDP is filed with the CNSC prior to decommissioning activities and is required for appropriate licensing action (i.e., licence to authorize decommissioning). The DDP refines and adds details to the PDP.

CSA standard N294, *Decommissioning of facilities containing nuclear substances* complements CNSC REGDOC-2.11.2 by providing direction on decommissioning that is consistent with Canadian and international recommendations. The standard incorporates current best practices and existing regulatory requirements, and it draws on the decommissioning experience of the Canadian nuclear industry. The second edition, CSA

standard N294-19, *Decommissioning of facilities containing nuclear substances*, was published in 2019. CSA standard N294-19 is currently being updated with a revised version expected to be published in 2025.

The applicable regulations and regulatory guide can be viewed on the CNSC website at nuclearsafety.gc.ca.

Current decommissioning activities in Canada are listed in table D.12 and annex 8.

F.6.1.1 Operational radiation protection, discharges, unplanned and uncontrolled releases

Throughout the entire lifecycle of a facility, including decommissioning, the licensee is required to implement and maintain a radiation protection program to ensure that radiation exposures and doses to persons are below CNSC regulatory dose limits and kept as low as reasonably achievable (ALARA) by implementing:

- management control over work practices
- personnel qualification and training
- control of occupational and public exposure to radiation
- planning for unusual situations

Additionally, licensees are required to ascertain the quantity and concentration of any nuclear substance released as a result of a licensed activity and implement measures to protect the environment and prevent or mitigate the effects of unplanned releases.

F.6.1.2 Emergency preparedness

An emergency response plan is still required for nuclear emergency management during the decommissioning phase. However, the extent of the plan will be commensurate with the risks associated with the facility at the time of decommissioning. Section F.5 provides further details on Emergency Preparedness in Canada.

F.6.1.3 Records

As part of the decommissioning planning process, records are reviewed, and relevant aspects are incorporated into the documentation required to obtain formal approval of both the PDP and DDP. A PDP serves as the basis for the decommissioning financial guarantees provided by the licensee. The CNSC requires that the PDP and financial guarantee be in place before construction and operations begin. A detailed decommissioning plan must be developed as operations near completion; this serves as the basis for subsequently licensing the decommissioning activities. The DDP must include a description of the records and information that will be permanently retained and of the reports that are to be submitted to the CNSC.

The CNSC's REGDOC-2.11.1, *Waste Management Volume I: Management of Radioactive Waste*, provides requirements and guidance for the types of records to be produced and/or maintained for each of the steps in the management of radioactive waste and REGDOC-2.11.2, *Decommissioning*, also provides licensees with requirements and guidance for the types of records to be maintained during all phases of decommissioning.

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 Facilities Regulations (CINFR) require that every licensee who operates a nuclear facility keep a record of the following:

- operating and maintenance procedures
- results of the commissioning program
- results of the inspection and maintenance programs

- nature and amount of radiation, nuclear substances and hazardous substances within the nuclear facility
- status of each worker's qualifications, re-qualifications and training

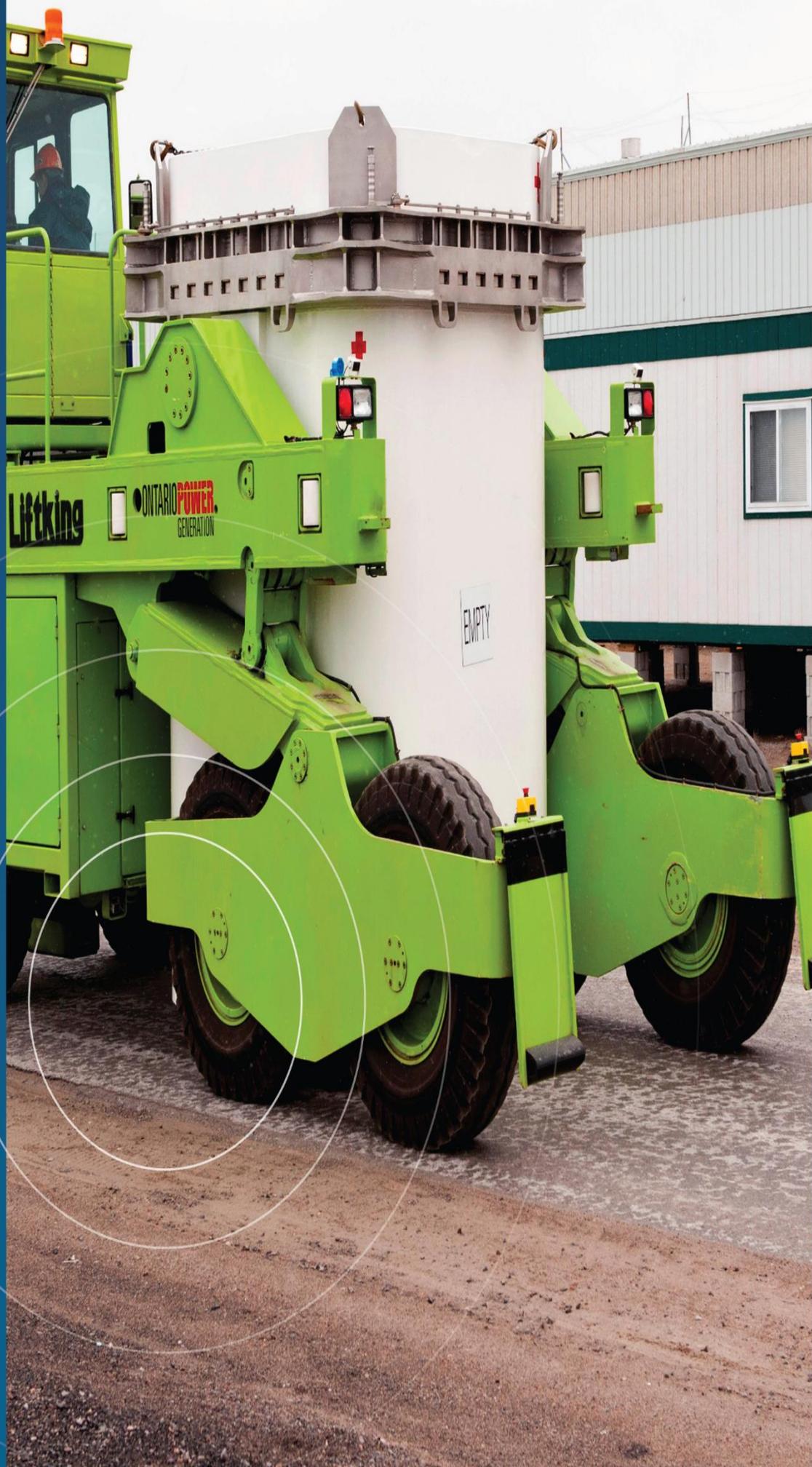
Also, every licensee who decommissions a Class I nuclear facility must keep a record of the following:

- progress achieved in meeting the schedule
- implementation of the decommissioning and results
- how and where any nuclear or hazardous waste is managed, stored, disposed of or transferred
- name and quantities of any radioactive nuclear substances, hazardous substances and radiation that remain at the nuclear facility after decommissioning is complete
- status of each worker's qualifications, re-qualifications and training

The CINFR can be viewed on the CNSC's website at nuclearsafety.gc.ca/eng/acts-and-regulations.

SECTION G

Safety of spent fuel management



Section G – Safety of Spent Fuel Management

G.1 General safety requirements (Article 4)

This section addresses the obligations under Article 4 of the Joint Convention.

ARTICLE 4. GENERAL SAFETY REQUIREMENTS

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

- (i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;
- (ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;
- (iii) take into account interdependencies among the different steps in spent fuel management;
- (iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
- (v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;
- (vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generations;
- (vii) aim to avoid imposing undue burdens on future generations.

G.1.1 Criticality and removal of residual heat

There are several requirements in the Canadian regulatory framework that address the subject of criticality safety in the management of spent fuel. Licensees conducting activities that involve the management of spent fuel are required to implement these documents. Under REGDOC-2.4.3, *Nuclear Criticality Safety*, criticality safety requirements must address both normal and abnormal conditions. This document clarifies the minimum physical constraints and limits on fissionable materials in order to ensure nuclear criticality safety during the construction, operation, decommissioning or abandonment of the licensed facility, and with respect to the handling, storing, processing and transport of certain fissionable materials. This document also provides guidance on how requirements for nuclear criticality safety may be met. The information set out in this document applies to operations with fissionable materials outside nuclear reactors, except for the assembly of these materials under controlled conditions (such as in critical experiments). A criticality safety analysis must be performed when "large quantities of fissionable materials" are stored or handled. The analysis must clearly demonstrate that the storage and handling of the radioactive waste is safe, and that 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 it must demonstrate that the consequences of these events do not encroach upon the public evacuation criteria established in international standards and the *Canadian Guidelines for Intervention during a Nuclear Emergency*.

G.1.2 Radioactive waste management principles

As stated in Section B.1.2, REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*, outlines the policy and principles that the CNSC considers when making regulatory decisions about the management of radioactive waste including spent fuel.

G.1.2.1 Waste minimization

Canada's Policy for Radioactive Waste Management and Decommissioning section 1.7, states that the waste generators and owners will prevent and minimize the generation, volumes and activity levels of their radioactive wastes, to optimize waste management, through appropriate facility design measures and through operating and decommissioning practices, including the recycling and reuse of materials, while taking into account health, safety, security, nuclear non-proliferation, environmental and socio-economic considerations.

The CNSC's REGDOC-2.11.1, volume I, provides requirements and guidance in steps in the management of radioactive waste. Licensees waste management programs must consider the waste hierarchy, including minimization, and consider measures to control the generation of radioactive waste in terms of both volume and radioactivity content as early as possible prior to the commencement of licensed activities and on an ongoing basis.

Complementary to REGDOC 2.11.1 volume I, CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* contains requirements for waste management programs regarding the minimization of radioactive waste including strategies to minimize production of wastes and to reduce the overall volume of waste requiring long-term management, while taking into consideration the health and safety of workers.

Further, CSA standard N294, *Decommissioning of facilities containing nuclear substances* contains requirements to consider the waste hierarchy, specifically, the minimization of radioactive waste.

G.1.2.2 Security

Security requirements for Canadian licensees are based primarily on the IAEA's Nuclear Security Series guidance documents. The CNSC monitors and assesses the effectiveness of the security of nuclear facilities, nuclear material and other radioactive material. Spent fuel storage and radioactive waste systems must conform to the requirements identified in the Nuclear Security Regulations (NSR). Additionally, licensees must meet security requirements defined in the GNSCR and further described in the following regulatory documents:

- REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2* (2018) (Classified)
- REGDOC-2.12.1, *High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices* (2018) (Classified)
- REGDOC-2.12.2, *Site Access Security Clearance* (2013)
- REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1* (2020)

Some waste facilities must also overcome the threat characteristics of adversaries, as defined in Canada's document on design basis threats for high-security nuclear facilities.

G.1.2.3 Safeguards

The CNSC is the designated safeguards regulatory authority for Canada responsible for implementing the requirements of the Canada/IAEA safeguards agreements within the regulatory framework established through the NSCA and its regulations. As a result of these agreements, all nuclear material (generally

uranium, thorium, and plutonium-239, excluding ores) and all facilities possessing such nuclear material are subject to routine verification by the IAEA. This includes all spent fuel and any waste that contains these nuclear materials. Under the NSCA, licensees must meet the safeguards requirement defined in the GNSCR and further described in REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy* and their licence conditions.

G.1.3 Protection and safety fundamentals

The main objective in regulating spent fuel and radioactive waste management is to ensure 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 three parts:

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

G.1.3.1 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 (e.g., dose limits, ALARA principle).
- The applicant must assure or demonstrate compliance with tests, analyses, monitoring programs, records, data and relevant reports.

G.1.3.2 Generic design and operational principles

There are two main principles for generic design and operations:

- Multiple engineered barriers are used to ensure spent fuel and radioactive waste are adequately contained and isolated from humans and the environment during normal and abnormal conditions.
- Administrative controls and procedures are used to augment and monitor the performance of the engineered barriers.

G.1.3.3 Performance criteria

The performance criteria accepted by the CNSC are as follows:

- Structural integrity must 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.
- The physical security systems of the contents and facility components must be maintained.

G.1.4 Interdependencies

Under CNSC REGDOC-2.11.1 Volume I, all licensees that manage radioactive waste must take into account interdependencies among all steps in radioactive waste management, as appropriate; each step shall be evaluated as an individual step in the process and as part of an integrated radioactive waste management system.

Furthermore, CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* states that the different steps in the management of radioactive waste are often interdependent, and that consequently, in order to achieve an appropriate level of safety, each step should be evaluated both as an individual step in the process and as part of an integrated system. In addition, the interfaces of the various organizations involved should be considered.

G.2 Existing facilities (Article 5)

This section addresses the obligations under Article 5 of the Joint Convention.

ARTICLE 5. EXISTING FACILITIES

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

The NSCA and its regulations ensure the safety of the spent fuel management facilities that existed when the Joint Convention came into force for Canada, as all facilities were under a CNSC licence. The design, construction, operation, decommissioning and abandonment of spent fuel management facilities must be conducted in accordance with the NSCA and its regulations, and the licence conditions.

See Section H.2.1.

G.3 Siting of proposed facilities (Article 6)

This section addresses the obligations under Article 6 of the Joint Convention.

ARTICLE 6. SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:
 - (i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
 - (ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
 - (iii) to make information on the safety of such a facility available to members of the public;
 - (iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

In Canada, spent fuel management facilities are considered to be Class I nuclear facilities in accordance with the definition provided in the CINFR.

The objective of the site preparation stage is to determine whether the site is suitable for the construction and operation of a nuclear facility. An application for a licence to prepare a site does not require detailed design information or specifications, but it must provide enough information to demonstrate that releases of radioactive and hazardous substances are within the limits claimed in the impact assessment, and they meet all applicable regulatory requirements.

In some cases, the IAAC and the CNSC work collaboratively to conduct an integrated impact assessment under the *Impact Assessment Act* (IAA) before the Commission can make a licensing decision on site preparation and the construction of a new nuclear facility to manage spent fuel. See section E.2.1.5 for information on the IAA.

Section 4 of the CINFR, Licence to Prepare Site, states that an application for a licence to prepare a site for a Class I nuclear facility shall contain the following information in addition to the information required by section 3:

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

Other requirements are stipulated in section 3 of the GNSCR.

The review of the application focuses on determining whether the site characteristics that have an impact on health, safety, security and the environment have been identified; it also looks at whether these characteristics have been taken into account and ensure that they will also be considered in the design, operation and decommissioning of the proposed facility. The technical information gleaned from external events, site-specific characteristics and supporting assessments provides input into the design of the facility for the chosen site, which is submitted in the construction licence application.

Before issuing a licence to prepare a site, the Commission must be satisfied that the site preparation activities will be carried out in a manner that will satisfy all health, safety, security and environmental protection requirements.

CSA standard N292.4, *Storage of radioactive waste and irradiated fuel*, published in August 2023, states that the licensee shall perform site evaluation during the lifecycle of a facility to address safety and security aspects in site evaluation. The site for a storage facility shall be characterized to support the understanding of the site and the evolution of the site overtime. The licensee shall characterize the site for the biosphere, geosphere, population, land use and Indigenous people. This site characterization data is also used to support facility safety assessments.

G.3.1 Public information program

Paragraph 3(j) of the CINFR states that a licence application must contain details about the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed.

REGDOC-3.2.1, *Public Information and Disclosure*, sets out the CNSC's requirements for protocols on public information and disclosure and the associated documentation as they relate to licensed activities. A program for public information includes a public disclosure protocol for events and developments that involve their facilities and/or activities. The document also provides guidance for licensees and licence applicants on fulfilling the regulatory requirements; it provides explanatory information, process and procedural guidance, and examples of good practices currently in use in the nuclear sector. This regulatory document applies to all uranium mines and mills and Class I nuclear facilities. It also applies to a Class II facility that is required to develop and implement a public information and disclosure program as a condition of its licence.

The primary goal of a public information program, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public. As a component, where the public has indicated an interest to know, the program must include a commitment to and protocol for the ongoing, timely communication of information about the licensed facility during the licence period.

The CNSC expects a licensee's public information program and disclosure protocol to be commensurate with the public's perception of risk and the level of public interest in the licensed activities, which may be influenced by the complexity of the nuclear facility's lifecycle and activities, and the risks to public health, safety and the environment perceived to be associated with the facility and activities.

REGDOC-3.2.2, *Indigenous Engagement*, identifies requirements for CNSC licensees with respect to Indigenous engagement and provides guidance and information on conducting Indigenous engagement activities. This document applies to Class I nuclear facilities and uranium mines and mills when a licensee's application has the potential to raise the Crown's duty to consult.

REGDOC-3.2.1 and REGDOC-3.2.2 are in the preliminary phase of review to modernize the regulatory documents to reflect the evolving expectations, policies and legal requirements in Canada in relation to consultation, engagement, communications and transparency.

The CNSC published a new regulatory document, REGDOC-1.2.3, *Licence Application Guide: Licence to Prepare Site for a Deep Geological Repository*. This document, in conjunction with REGDOC-3.2.2 and REGDOC-3.2.1, provides additional information on the CNSC's expectations on public and Indigenous engagement for proponents who intend to initiate the licensing process for a potential deep geological repository in Canada.

In addition, Canada's IAA recognizes the importance of meaningful public participation; it requires that opportunities be provided through the assessment process, in accordance with legislation, regulations, policies and guidance established by the agency (please refer to section E.2.1.15 for more information).

Every three years, the NWMO, which is responsible for implementing Canada's plan for the long-term management of its spent fuel, publishes a five-year strategic plan and welcomes public input to help shape its future work. The implementation plan is a living document that is regularly assessed and strengthened through public feedback, advances in science and technology, insight from Indigenous Knowledge, changes in societal values and evolving public policy. At this time, the NWMO does not have a CNSC licence. Should they be granted a CNSC licence to prepare a site, the NWMO (as the licensee) would be required to develop and maintain a public information and disclosure protocol.

G.3.2 International arrangements with other Contracting Parties

While the Canadian regulatory regime does not obligate the proponents of domestic nuclear facilities that may affect the U.S. to consult with foreign jurisdictions or with their public about the proposed siting of such facilities, there are numerous arrangements in place to ensure cooperation.

The CNSC and the U.S. Nuclear Regulatory Commission have practised cooperation and consultation since the 1950s, and have entered into a bilateral MOU for cooperation and the exchange of information on nuclear regulatory matters. As part of this agreement, both countries committed to exchanging certain

technical information related to regulating 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 or the U.S.

Canada and the U.S. are signatories to the *International Convention on Environmental Impact Assessment in a Transboundary Context* (Espoo, Finland, February 25, 1991). The Convention, which came into force on September 10, 1997, obliges signatories to:

- take all appropriate and effective measures to prevent, reduce and control significant adverse transboundary environmental impacts of proposed activities (including site preparation, construction and operation of nuclear installations)
- ensure that affected parties are notified of the proposed installation
- give the public in areas likely to be affected an opportunity to participate in relevant environmental impact assessment procedures for the proposed activities, and ensure the opportunity provided to the public of the affected party is equivalent to that provided to the public of the party of origin
- include in the notification information on the proposed activity, including any information available about its possible transboundary impact

The Impact Assessment Agency of Canada is responsible for providing tri-annual reports to the Secretary of the Espoo Convention. Reports submitted by Espoo Convention signatories are used as the basis to prepare the Review of Implementation report. The Canadian Review of Implementation reports can be found at the [UNECE's website](#).

Of note, the governments of Canada and the U.S., in cooperation with state and provincial governments, are also obligated to have programs in place 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 set out in the *Great Lakes Water Quality Agreement* (1978), as amended by the protocol signed on September 7, 2012.

G.4 Design and construction of facilities (Article 7)

This section addresses the obligations under Article 7 of the Joint Convention.

ARTICLE 7. DESIGN AND CONSTRUCTION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;
- at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;
- the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

A licence to construct allows a licensee to construct, commission and operate some components of the facility (e.g., security systems). Some commissioning activities may be allowed in order to demonstrate that the facility has been constructed in accordance with the approved design and that the structures, systems and components important to safety are functioning as intended.

An application for a licence to construct contains detailed information about the design of the facility and the supporting safety case. The applicant must demonstrate that the proposed design of the facility conforms to regulatory requirements and that it will allow for safe operation on the designated site over the proposed life of the facility.

The applicant is expected to address all follow-up activities identified during the environmental review, including those relevant to the design, construction and commissioning stages, and verify that any outstanding issues from the site preparation stage have been resolved.

Section 5 of the CINFR, Licence to Construct, states that an application for a licence to construct a Class I nuclear facility shall contain the following information in addition to the information required by section 3:

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

Other information is required, as stipulated in section 3 of the GNSCR, including paragraph 3(d), "the proposed management system for the activity to be licensed, including measures to promote and support safety culture."

The review of the application focuses on determining whether the proposed design, the safety analysis and other required information meet regulatory requirements. The evaluation involves rigorous engineering and scientific analysis, taking into consideration national and international standards and best practices in nuclear facility design and operation. The CNSC also verifies that any outstanding issues from the site preparation stage have been resolved. The protective zone established for the licence to prepare the site is also confirmed during the review of the licence to construct.

For the latter part of construction, regulatory attention focuses on the commissioning program and associated activities to demonstrate to the extent practicable that all the structures, systems and components have been built and function as intended.

Sometimes, a single application for a licence to prepare site and to construct is submitted to the CNSC for combined approval.

G.5 Assessment of safety of facilities (Article 8)

This section addresses the obligations under Article 8 of the Joint Convention.

ARTICLE 8. ASSESSMENT OF SAFETY OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;
- before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

See sections G.3, G.4 and G.6 for the regulatory requirements for conducting a safety analysis in the siting, design, and operation phases of a Class I nuclear facility. See section E.2.1.5 for information the IAA.

In 2022, the CNSC published REGDOC-2.4.4, *Safety Analysis for Class 1B Nuclear Facilities*. This document applies to spent fuel and radioactive waste management facilities in accordance with the definitions provided in CINFR. This regulatory document clarifies requirements and provides guidance for applicants and licensees on how to demonstrate the safety of a Class IB nuclear facility, including information relating to:

- the safety analysis program (the managed process that governs the conduct of a safety analysis)
- the conduct of a safety analysis (the systematic evaluation of the potential hazards)
- safety analysis documents, records and reporting

Complementary to REGDOC-2.4.4, CSA standard N292.4 *Storage of radioactive waste and irradiated fuel* also provides requirement and guidance for the development and conduct of safety assessments.

G.6 Operation of facilities (Article 9)

This section addresses the obligations under Article 9 of the Joint Convention.

ARTICLE 9. OPERATION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;
- operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;
- operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;
- engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;
- incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;
- programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;
- decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

A licence to operate will enable a licensee to complete final commissioning activities and to operate the facility. Commissioning activities provide assurance that the facility has been properly designed and constructed, and it is ready for safe operation.

Section 6 of the CINFR, Licence to Operate, states that an application for a licence to operate a Class I nuclear facility shall contain the following information, in addition to the information required in section 3:

- (a) a description of the structures at the nuclear facility, including their design and their design operating conditions
- (b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions
- (c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility
- (d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility
- (e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances
- (f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement
- (g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility
- (h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects
- (i) the proposed locations of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics

- (j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment
- (k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to
 - (i) assist off-site authorities in planning and preparing to limit the effects of an accidental release
 - (ii) notify off-site authorities of an accidental release or the imminence of an accidental release
 - (iii) report information to off-site authorities during and after an accidental release
 - (iv) assist off-site authorities in dealing with the effects of an accidental release
 - (v) test the implementation of the measures to prevent or mitigate the effects of an accidental release
- (l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts
- (m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers
- (n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility

Other requirements are stipulated in section 3 of the GNSCR.

The first licence to operate the facility is typically issued with conditions (hold points). All of the relevant commissioning tests completed must be deemed satisfactory before the hold points can be removed.

G.6.1 Maintenance, testing, examination and inspection

CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* states that the WMF shall be designed to facilitate the inspection and maintenance of the structures, systems and components of the facility with the minimum radiation exposure to the workers in accordance with the ALARA principle (clause 7.12.1). Further, this standard states that the design of the WMF shall allow for the monitoring of interior cavities within structures (clause 7.12.2).

CSA standard N292.1, *Wet storage of irradiated fuel and other radioactive materials* states that a maintenance program for the wet storage bay shall be prepared, implemented, and maintained to address predictive and preventative elements, including: cleaning requirements for the wet storage bay floors and walls; and examining, inspecting, and testing the wet storage system (clause 6.3.3.1). Further, this standard states that for Nuclear Power Plants (NPPs), in-service examination of the civil structures of the wet storage systems of NPPs shall be in accordance with the requirements of CSA standard N291, *Requirements for nuclear safety-related structures*. Finally, clause 6.3.3.3 states that the frequency of maintenance, testing, examination, and inspection of safety-related systems and components shall be such that the level of reliability and effectiveness remains in accordance with the requirements throughout the operating life of the wet storage system (clause 6.3.3.3).

CSA standard N292.2, *Interim dry storage of irradiated fuel* states that the licensee shall prepare a program of periodic maintenance, post maintenance testing, examination, and inspection of the dry storage system to prevent the degradation of its structures, equipment, systems, and related components (clause 6.5.2.1). Further, this standard states that the frequency of maintenance, testing, examination, and inspection of safety systems and safety-related systems and components shall be such that the level of reliability and effectiveness remains in accordance with the design assumptions and intent throughout the life of the storage system (Clause 6.5.2.2).

In 2023, CSA Group streamlined the requirements in CSA standard N292.1 and N292.2 into CSA standard N292.4, *Storage of radioactive waste and irradiated fuel*. CSA standard N292.4 Storage of radioactive waste and irradiated fuel states that the licensee shall establish a program for maintenance, periodic testing and inspection to ensure and confirm that structures, systems, and components (SSCs) are able to function in accordance with the requirements for safety and that they are as described in the safety assessment. During the next reporting period, licensees will be required to address any gaps and implement this standard.

G.6.2 Reportable events

Regulatory requirements regarding reportable events and the submission of immediate preliminary reports and 21-day full reports, including what situations require reporting and the information that shall be contained in the reports, are set out in the following sections of the NSCA and its associated Regulations:

- section 45 of the NSCA
- sections 29 and 30 of the GNSCR
- section 38 of the NSRDR
- sections 32, 37, 38, 40 and 41 of the (*Packaging and Transport of Nuclear Substances Regulations* (PTNSR), 2015)
- section 16 of the RPR

REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants, Version 2*, incorporates and expands upon requirements found in the NSCA and the Regulations made under the NSCA for reports, notifications and filing of specific records to the CNSC by licensees of NPPs (which includes the spent fuel bays).

REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills, Version 1.1*, published in July 2022, incorporates and clarifies requirements found in the NSCA and the Regulations made under the NSCA for reporting. This document presents the types of reports and the applicable time frame for reporting. Licensees are required to report to the CNSC regarding situations, events and dangerous occurrences that may require short-term action by the CNSC.

G.6.3 Operating experience

CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* states that processes should be put in place to allow for the feedback from and analysis of operating experience, including: initiating events, accident precursors, near misses, accidents and unauthorized acts (clause 4.10.1.5). Further, in order to continually improve and learn from ongoing research and development activities, gathering research and operating experience should be done on an ongoing basis (clause 7.4.6).

CSA standard N292.1, *Wet storage of irradiated fuel and other radioactive materials* states that accident prevention and mitigation shall be achieved through the use of operating experience (clause 5.2.2.21).

In 2023, CSA Group moved the requirement in CSA N292.1 into a new standard CSA N292.4, *Storage of radioactive waste and irradiated fuel*, which states that safety assessment updates shall be informed by operating experience, including the results from the analysis of operational occurrences and accidents (clause 9.1.2.3 (d)).

G.6.4 Decommissioning plans

The regulatory requirement to maintain a decommissioning plan is a specific licence condition that is in all licences for operational facilities that manage spent fuel.

The CNSC requires that the planning for decommissioning take place throughout the lifecycle of a nuclear facility, location or site or for the duration of a licensed activity.

A PDP is developed during the siting phase and is progressively updated where needed, to reflect the appropriate level of detail required for the respective licensed activities.

The PDP is filed with the CNSC as early as possible in the lifecycle of the activity or facility. Specific requirements for planning the decommissioning of Class I nuclear facilities are set out in the CINFR. The preliminary plan documents: the preferred decommissioning strategy and end-state objectives, as appropriate; the major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; an overview of the principal hazards and protection strategies; a cost estimate; and the method(s) used to guarantee financing for the decommissioning activities.

The initial PDP is based largely on predicted types and quantities of contamination that are expected to accumulate in different parts of a facility under normal operating conditions. During the operations phase, these predictions should be monitored and revised as necessary using actual survey data. Periodic inspections and sampling should be conducted in known or potentially contaminated areas. Similarly, all unplanned events and accidents that could lead to contamination should be thoroughly investigated and sample analyses carefully documented. The PDP should be reviewed and updated in light of operational experience and technological advances. During the facility operation stage, the CNSC may inspect the facility's operational records and PDP to ensure that the plan and financial guarantee program remain consistent with the projected scale of the decommissioning effort.

The DDP is filed with the CNSC for appropriate licensing action before decommissioning activities begin. It normally refines the preliminary plan by adding procedural and organizational details. Once approved by the CNSC, the detailed plan is incorporated into a licence authorizing the decommissioning.

Section 6.1 of REGDOC-2.11.2 provides requirements regarding the PDP, and section 6.1 provides requirements on the DDP.

REGDOC 2.11.2, *Decommissioning*, is complemented by the requirements and guidance in CSA standard N294, *Decommissioning of facilities containing nuclear substances*, which was developed to consolidate and incorporate into one document the principles of decommissioning, the Canadian and international decommissioning experience and international guidance that could be applied to the decommissioning of all facilities and sites where nuclear substances have been used or stored. The standard is consistent with and supplements current Canadian policy and regulatory guidance. This standard applies to the decommissioning of nuclear facilities and other locations where nuclear substances are managed, possessed or stored.

G.7 Disposal of spent fuel (Article 10)

This section addresses the obligations under Article 10 of the Joint Convention.

ARTICLE 10. DISPOSAL OF SPENT FUEL

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

At the end of the useful life of a facility, the licensee may decide to apply for a licence to decommission. Section 7 of the CINFR, Licence to Decommission, states that an application for a licence to decommission a Class I nuclear facility shall contain the following information, in addition to the information required by section 3:

- (a) a description of and the proposed schedule for the decommissioning, including the proposed starting date and the expected completion date of the decommissioning and the rationale for the schedule

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

Other requirements are stipulated in section 3 of the GNSCR.

The licensee's responsibility can be terminated when long-term monitoring confirms the successful completion of decommissioning. The Commission may issue a licence to abandon, under which the site would be released unconditionally, or an exemption from licensing which would end the licensee's responsibility for the site and transfer responsibility for regulatory oversight or institutional control from the CNSC to the province or territory, if applicable. Information required to support the transfer agreement includes:

- the results of decommissioning work
- the results of environmental monitoring programs
- a description of requirements for long-term institutional controls
- a program to inform the public about the effects the transfer of responsibility has on the health and safety of the public and on the environment

REGDOC-1.2.3, *Licence Application Guide: Licence to Prepare Site for a Deep Geological Repository*, provides clarity on the requirements and guidance for preparing an application for a licence to prepare site for a deep geological repository (DGR). Licensing of a DGR begins after site selection, starting with site preparation and ending with decommissioning. The safety case for disposal is the main tool used to assess the safety of a DGR facility over its lifecycle.

REGDOC-1.2.3 is complemented by CSA standard N292.7, *Deep geological disposal of radioactive waste and irradiated fuel*. CSA N292.7 provides requirements and guidance for licensees and licence applicants regarding the lifecycle of a deep geological repository for radioactive waste and irradiated fuel. The standard includes requirements for activities such as siting-related aspects during indigenous and public engagement, site evaluation, design and safety assessments.

Canada does not currently have a disposal facility for spent fuel. Any proposal for the site preparation, construction, operation, decommissioning (closure and post-closure) and abandonment (i.e., release from CNSC licensing) of a disposal facility, such as a DGR, must satisfy the requirements of the *Impact Assessment*

Act and Nuclear Safety and Control Act and its regulations. The CNSC can make a DGR licensing decision only after a positive decision is made on the impact assessment.

G.7.1 History of the disposal of spent fuel in Canada

Since the early days of the CANDU program, several concepts for the long-term management of spent fuel 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 the responsibility of developing a concept for placing spent fuel in a deep underground repository within the plutonic rock of the Canadian Shield. Ontario Hydro (now OPG) was assigned the responsibility of studying and developing technology to store and transport spent fuel. It was also designated as a source of 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 on the DGR concept for review by the Seaborn Panel, a federal environmental assessment panel. This review included input from government agencies, non-governmental organizations and the general public. Public hearings were conducted by the Seaborn Panel in 1996 and 1997. The report of the *Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel* was submitted to the Government of Canada in 1998. It concluded that a DGR in crystalline rock was technically feasible, but "until broad public acceptance of a nuclear fuel waste management approach has been achieved, the search for a specific site should not proceed."

It also made recommendations to help the Government of Canada 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 in Canada, as set out in the CEAA, 1998.

The Government of Canada responded to the Seaborn Panel report later in 1998. It explained the steps it would require the producers and owners of spent fuel in Canada to take, and it announced the formation of a waste management organization, to be funded by the nuclear utilities. In 2002, the Parliament of Canada adopted the *Nuclear Fuel Waste Act* (NFWA).

Under the NFWA, the nuclear energy corporations were to establish a waste management organization, the purpose of which would be to study and propose approaches for managing spent fuel, recommend an approach and 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 as well as the ethical, social and economic considerations associated with each approach. It was also to include specific economic regions where implementation would take place and plans for implementing each approach in the study. The waste management organization was to consult the general public, and in particular Indigenous peoples, on each approach.

The waste management organization was also required to create an advisory council whose members would bring a broad range of scientific and technical disciplines. The council's expertise should include public affairs, other social sciences as needed, traditional Indigenous knowledge and representatives of the local and regional governments and Indigenous Nations and communities affected by the selected approach because of their geographic locations.

Within three years after the NFWA came into force, the waste management organization was to submit a study setting out proposed approaches for managing spent fuel and its final recommendation. The study would include approaches based on the following methods:

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

Under the NFWA, the Government of Canada was tasked with reviewing the study prepared by the waste management organization, selecting a long-term management option from those proposed and providing oversight during implementation. NRCan was tasked with overseeing how the waste management organization implements the management approach and ensuring compliance with the NFWA. The waste management organization was to report annually to the Minister of Natural Resources, then, every third year, following the selection of an approach by the Governor in Council. This report would include a summary of activities and a strategic plan for the five subsequent years. Canada's plan has now moved forward within this legislative framework.

Pursuant to the NFWA, the NWMO was established in 2002 by the nuclear energy corporations of OPG, H-Q and NB Power. Upon its establishment, the NWMO's first mandate was to work collaboratively with Canadians to study management approaches for the long-term care of Canada's spent fuel and recommend an approach 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 and consulted extensively across the country.

In 2005, the NWMO submitted their study of options, *Choosing a Way Forward*, to the Minister of Natural Resources, which recommended that Canada adopt the Adaptive Phased Management (APM) approach. APM includes a technical method based on an end point of centralized containment and isolation of the spent fuel in a DGR built in a suitable rock formation. It provides for the continuous monitoring of spent fuel and offers the potential to retrieve the fuel 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 spent fuel before the repository is ready.

Implementing the project at a flexible pace and manner allows for phased decision making, each step supported by continuous learning, research and development, and public engagement. An informed, willing community will be sought to host the centralized facilities. The 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, Indigenous Nations and communities, non-governmental organizations, industry and others.

On June 14, 2007, following a review of the NWMO's study *Choosing a Way Forward*, the Government of Canada announced it had selected the APM approach for the long-term management of spent fuel in Canada. Based on this government decision and as required by the NFWA, the NWMO assumed responsibility for implementing the APM approach. Information about the current status of the APM initiative can be found in section K.2.2. 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 the NWMO issues its reports annually to the Minister of Energy and Natural Resources (formerly referred to as the Minister of Natural Resources) and to the public. The NWMO is required under the NFWA to submit their annual/triennial report to the Minister by March 31 of each fiscal year and publish the report publicly. The Minister must then table the report in both houses of Parliament and publish a public annual statement.

To support financing of the plan, waste owners continue to make regular deposits into 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; this funding formula was later approved in 2009. The NWMO anticipates new market entrants and emerging technologies. The NFWA considers the potential for new market entrants such as small modular reactors, and the government-approved formula used to determine funding for APM anticipated this eventuality. For emerging technologies, the NWMO would provide a fee for service at fair and reasonable costs and determine the long-term management requirements and associated costs for the resulting fuel wastes.

The NWMO will be required to obtain licences from the CNSC for the site preparation, construction, operation, decommissioning and abandonment (release from CNSC licensing) of the repository facilities.

SECTION H
Safety of
radioactive
waste
management



Section H – Safety of Radioactive Waste Management

H.1 General safety requirements (Article 11)

This section addresses the obligations under Article 11 of the Joint Convention.

ARTICLE 11. GENERAL SAFETY REQUIREMENTS

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management, individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

- (i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;
- (ii) ensure that the generation of radioactive waste is kept to the minimum practicable;
- (iii) take into account interdependencies among the different steps in radioactive waste management;
- (iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
- (v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;
- (vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generations;
- (vii) aim to avoid imposing undue burdens on future generations.

See section G.1.

H.2 Existing facilities and past practices (Article 12)

This section addresses the obligations under Article 12 of the Joint Convention.

ARTICLE 12. EXISTING FACILITIES AND PAST PRACTICES

Each Contracting Party shall in due course take the appropriate steps to review:

- (i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;
- (ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

The NSCA and its Regulations ensured the safety of the radioactive WMFs, locations and sites that existed when the Joint Convention entered into force in Canada, as all facilities, locations and sites were under a CNSC licence.

H.2.1 Past practices

Legacy radioactive wastes at AECL sites (which are managed by CNL) 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 CNL on behalf of AECL. The liabilities include spent research reactor fuel and intermediate-level liquid waste from the production of medical isotopes and fuel processing experiments conducted in the Cold War era. In 2006, the Government of Canada initiated the Nuclear Legacy Liabilities Program to deal with liabilities at AECL sites.

In 1982, the Government of Canada established the Low-Level Radioactive Waste Management Office within AECL as the federal agent for the cleanup and management of historic LLW in Canada. Canada's historic LLW 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. In March 2001, the Government of Canada and the local municipalities partnered on community-developed proposals to address the cleanup and long-term management of these wastes. This partnership launched the Port Hope Area Initiative (PHAI).

Upon implementation of the GoCo model in 2015, federal responsibility for managing and discharging the Government of Canada's radioactive waste liabilities (including legacy and historic LLW) was transferred from NRCAN to AECL. As a result, the Nuclear Legacy Liabilities Program came to an end and the activities associated with the program were included as part of CNL's scope of work under the GoCo arrangement.

When remedial actions are required at uranium mine and mill tailings facilities where the owner no longer exists, the federal and/or provincial governments ensure the sites are safely decommissioned. In Ontario, the governments of Canada and Ontario signed a memorandum of agreement in 1996 that outlined their respective roles and responsibilities for the decommissioning of uranium mine and mill sites for instances in which the owner no longer exists or is not financially solvent. To date, these arrangements have not been necessary, as all legacy mining sites in Ontario have owners who have successfully decommissioned their sites and are complying with their obligations, including providing financial guarantees for long-term monitoring and maintenance.

H.3 Siting of proposed facilities (Article 13)

This section addresses the obligations under Article 13 of the Joint Convention.

ARTICLE 13. SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:
 - (i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;
 - (ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;
 - (iii) to make information on the safety of such a facility available to members of the public;
 - (iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

For information regarding Class I radioactive WMFs, see section G.3.

H.4 Design and construction of facilities (Article 14)

This section addresses the obligations under Article 14 of the Joint Convention.

ARTICLE 14. DESIGN AND CONSTRUCTION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;
- (ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;
- (iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;
- (iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

For information regarding Class I radioactive WMFs, see section G.4.

H.5 Assessment of safety of facilities (Article 15)

This section addresses the obligations under Article 15 of the Joint Convention.

ARTICLE 15. ASSESSMENT OF SAFETY OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;
- (ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;
- (iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

For information regarding Class I radioactive WMFs, see section G.5.

REGDOC-2.11.1, *Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste, Version 2* provides requirements and guidance for the development of a safety case and supporting safety assessment for the post-closure phase of disposal facilities, locations or sites for all classes of radioactive wastes. This document also applies to long-term radioactive waste management facilities where there is no intention to retrieve the wastes. The safety case is a structured framework for documenting and presenting all of the safety-related information for a disposal facility in a consolidated manner.

H.6 Operation of facilities (Article 16)

This section addresses the obligations under Article 16 of the Joint Convention.

ARTICLE 16. OPERATION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

- (i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;
- (ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;
- (iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;
- (iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;
- (v) procedures for characterization and segregation of radioactive waste are applied;
- (vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;
- (vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;
- (viii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;
- (ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

For information regarding Class I radioactive WMFs, see section G.6.

H.6.1 Maintenance, testing, examination and inspection

For information regarding maintenance, testing examination and inspection, see section G.1

H.6.2 Reportable events

Regulatory requirements regarding reportable events and the submission of immediate preliminary reports and 21-day full reports, including what situations need to be reported and what information needs to be contained in the reports, are set out in the following sections of the NSCA and its regulations:

- Section 45 of the NSCA
- Sections 29 and 30 of the GNSCR
- Section 38 of the NSRDR
- Sections 32, 37, 38, 40 and 41 of the PTNSR, 2015
- Section 16 of the PRP

H.6.3 Operating experience

CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* states that processes should be put in place to allow for the feedback from and analysis of operating experience, including initiating events, accident precursors, near misses, accidents and unauthorized acts (clause 4.10.1.5). Further, in order to continually improve and learn from ongoing research and development activities, gathering research and operating experience should be done on an ongoing basis (clause 7.4.6).

H.6.4 Decommissioning plans

For information regarding Class I radioactive WMFs, see section G.6.4

H.7 Institutional measures after closure (Article 17)

This section addresses the obligations under Article 17 of the Joint Convention.

ARTICLE 17. INSTITUTIONAL MEASURES AFTER CLOSURE

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

- records of the location, design and inventory of that facility required by the regulatory body are preserved;
- active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and
- if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

There are currently no disposal facilities for radioactive waste in Canada; however, decommissioned tailings management facilities (TMFs) require long-term institutional controls. These will vary from minimal (after the current generation of in-pit TMFs, designed for future decommissioning, are closed) to ongoing monitoring and maintenance programs at older sites where tailings have been deposited in surface facilities.

Release from CNSC regulatory control occurs when the licensee has successfully decommissioned the facility and restored the site to a state that is suitable for future use (e.g., green field or brown field [industrial]). If unrestricted release has yet to be achieved (i.e., due to long-term presence of nuclear substances, contaminated systems, components or structures), perpetual licensing from the CNSC may be required, unless the risks are very minimal and oversight by another regulatory or governmental body allows the Commission to exempt the site indefinitely from CNSC licensing (this is determined case by case).

The CNSC requires licensees to apply for a licence to abandon or an exemption from licensing, after successful decommissioning. This submission must be supported by reports on the results of the decommissioning and site restoration activities, as well as the results of the radiological and environmental monitoring to demonstrate that the site no longer needs to be licensed under the NSCA.

H.7.1 Exemption

In order to be granted an exemption from licensing, the licensee must present a safety case that demonstrates long-term safety. The safety case must cite engineering design and barriers and/or the proposed 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, the costs and consequences of failure of the institutional controls, and the reliability of the institutional controls. REGDOC-2.11.1, *Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste*, and REGDOC-2.11.1, *Volume I: Management of Radioactive Waste* provide requirements and guidance to licensees and applicants for developing a safety case and supporting safety assessment for the post closure phase of disposal facilities, and location or sites for all classes of radioactive waste, including institutional controls.

H.7.2 Licence to abandon

In reviewing a submission for a licence to abandon, the CNSC must be satisfied that abandoning the site, nuclear substance, prescribed equipment or information does not pose an unreasonable risk to the environment, the health and safety of persons or national security. The abandonment must also not result in a failure to comply with Canada's international obligations.

Section 8 of the CINFR, Licence to Abandon, states that an application for a licence to abandon a Class I nuclear facility shall contain the following information:

- (a) the results of the decommissioning
- (b) the results of the environmental monitoring programs

Other requirements are stipulated in sections 3 and 4 of the GNSCR.

H.7.3 Records

Section 27 of the GNSCR states, "every licensee shall keep a record of all information relating to the licence that is submitted by the licensee to the Commission." Subsection 28(1) states, "every person who is required to keep a record by the Act, the regulations made under the Act or a licence shall retain the record for the period specified in the applicable regulations made under the Act, or if no period is specified in the regulations, for the period ending one year after the expiry of the licence that authorized the activity in respect of which the records are kept."

Under subsection 28(2), no person shall dispose of a record referred to in the Act, the regulations made under the Act or a licence unless the person is no longer required to keep the record by the Act, the regulations made under the Act or the licence and has notified the Commission of the date of disposal and the nature of the record at least 90 days before the date of disposal. Finally, subsection 28(3) states, "a person who notifies the Commission in accordance with subsection (2) shall file the record, or a copy of the record, with the Commission at its request."

H.7.4 Active and passive institutional controls

REGDOC-3.6, *Glossary of CNSC Terminology* defines institutional controls as the control of residual risks at a site after it has been decommissioned. Institutional controls can include active measures (those requiring activities on the site such as water treatment, monitoring, surveillance and maintenance) and passive measures (those not requiring activities on the site, such as land use restrictions or markers).

REGDOC-2.11.1, *Waste Management Volume I and Volume III, Safety Case for the Disposal of Radioactive Waste*, provide requirements and guidance to licensees and applicants for developing a safety case and supporting safety assessment for the long-term management of radioactive waste. A submission from a licence applicant must include plans to address the period following closure of the radioactive waste disposal facility to address institutional controls. These plans shall be consistent with passive safety features that form part of the safety case for the disposal facility.

The following actions must be taken during the post-closure period:

- implementation of a visual inspection plan for periodic examination of the site to look for signs of deterioration of the facility (e.g., slumping of the ground) or erosion of the surface;
- implementation and maintenance of a monitoring and surveillance plan to ensure that the post-closure objectives set out in the safety case continue to be met;
- implementation of active controls, where required, to prevent unauthorized access to the site.

Long-term management options should not rely on long-term institutional controls as a safety feature unless they are absolutely necessary. However, for some waste types in certain site-specific situations, there may be no realistic alternative to long-term institutional controls as a safety feature, even after optimizing the facility design.

As a result of the uncertainties associated with future human activities and the evolution and stability of societies, current international best practice generally limits the reliance on institutional controls as a safety feature to a few hundred years. However, it is recognized that in spite of design optimization, some facilities, such as surface impoundments for tailings, may need to rely on institutional controls for a more extended period of time. Any intention of relying on institutional controls to ensure long-term safety should be documented and justified in the long-term assessment.

SECTION I

Transboundary
movement



Section I – Transboundary Movement**I.1 Transboundary movement (Article 27)**

This section addresses the obligations under Article 27 of the Joint Convention.

ARTICLE 27. TRANSBOUNDARY MOVEMENT

- Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments:
In so doing:
 - a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;
 - transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;
 - a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;
 - a Contracting Party which is a State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement;
 - a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.
- A Contracting party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.
- Nothing in this Convention prejudices or affects:
 - The exercise, by ships and aircrafts of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;
 - Rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;
 - The right of a Contracting Party to export its spent fuel for reprocessing;
 - Rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

I.1.1 Introduction

The following Canadian laws and regulations are used to control the import and export of nuclear substances in accordance with Canada's bilateral and multilateral agreements:

- NSCA and the associated NNIECR and GNSCR
- CEPA and the associated *Export and Import of Hazardous Wastes Regulations*
- *Export and Import Permits Act*
- *United Nations Act*

The export of Category 1 and Category 2 radioactive sources (as identified in table 1, annex 1 of the IAEA *Code of Conduct on the Safety and Security of Radioactive Sealed Sources*) requires a transaction-specific authorization issued pursuant to the NSCA. For authorization to export Category 3 and below radioactive sealed sources and authorization to import, use, abandon, produce, manage, store or dispose of a radioactive sealed source, applicants must provide the information required under section 3 of the GNSCR and section 3 of the NSRDR. To import and export controlled nuclear substances, separate licence requirements are prescribed under the NNIECR. Additional requirements for persons wishing to apply for a licence to transport nuclear substances are prescribed in the PTNSR, 2015.

Canada's modernized Policy for Radioactive Waste Management and Decommissioning, released in March 2023, sets out that the federal government is committed to the principle that radioactive waste generated in other countries are not to be disposed of in Canada and radioactive waste generated in Canada will be disposed of in Canada, with the exception of certain radioactive wastes subject to return arrangements (see Section J.1.3.4 on import and export of radioactive sealed sources).

I.1.2 Nuclear substances

Under the NSCA, the CNSC regulates the import and export of nuclear substances (as well as prescribed equipment and prescribed information). The schedule to the NNIECR identifies the "controlled nuclear substances" that require export and import authorization from the CNSC.

The following are considered controlled nuclear substances and require transaction-specific risk assessments and export authorizations from the CNSC:

- plutonium
- uranium
- thorium
- deuterium
- tritium
- radium-226 (greater than 370 MBq)
- 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)

Global Affairs Canada regulates the export of certain types of nuclear substances under the *Export and Import Permits Act*.

The export of a radioactive sealed source of the first 16 radionuclides identified by the IAEA as a Category 1 or Category 2 radioactive sealed source (table 1, annex 1 of the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources*) requires authorization by the CNSC under the NSCA and the GNSCR.

I.1.3 Exporting state

As stated above, the CNSC and Global Affairs Canada both regulate the export of the controlled nuclear substances listed in section I.1.2. Although the regulations that both organizations use are based on the Nuclear Suppliers Group guidelines (parts 1 and 2), the regulations administered by the CNSC are slightly broader in scope and coverage, pursuant to its mandate.

In keeping with Canadian nuclear non-proliferation policy, exports of nuclear substances, equipment and information for nuclear use can go forward only to countries with which Canada has established a nuclear cooperation agreement (NCA). These treaty level agreements establish reciprocal obligations to ensure, among other things, that nuclear items will only be used for peaceful, non-explosive purposes. Exports of nuclear substances may still go forward to countries with which Canada does not have an NCA, provided they are of small quantities and/or for non-nuclear use. Canada may also import nuclear substances from countries with which it does not currently have an NCA.

I.1.4 State of destination

Possession licences issued by the CNSC specify the nuclear substances that the licensee is authorized to hold. These possession licences may also authorize certain types and maximum quantities of nuclear substances to be imported without further authorization. When substances (as defined in subsection I.1.2) are imported, transaction-specific authorization must be obtained. This authorization verifies 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 is notified of the requirements for holding the substance shown in the application.

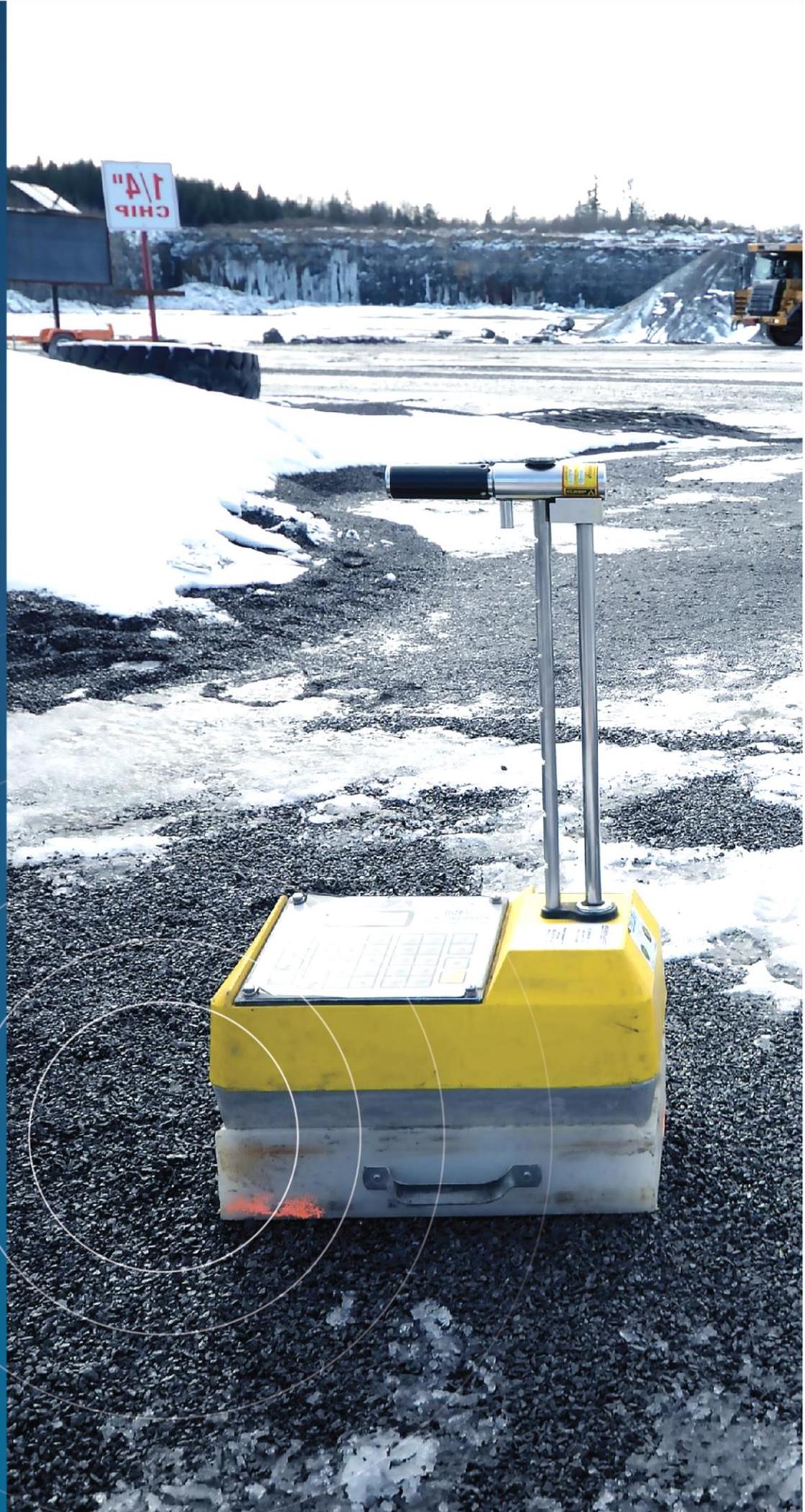
The Canada Border Services Agency assists the CNSC in administering export and import controls under the NSCA. An importer/exporter must present a valid CNSC licence to a customs officer when importing or exporting a nuclear substance. If a valid licence is not presented upon import or export, the licence holder may be in violation of the conditions of the import/export licence or of the licensing controls under the NSCA.

I.1.5 Destinations 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 into Canadian federal law through the CEPA.

SECTION J

Disused
sealed
sources



Section J – Disused Sealed Sources

J.1 Disused sealed sources (Article 28)

This section addresses the obligations under Article 28 of the Joint Convention.

ARTICLE 28. DISUSED SEALED SOURCES

1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.
2. A Contracting Party shall allow for reentry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

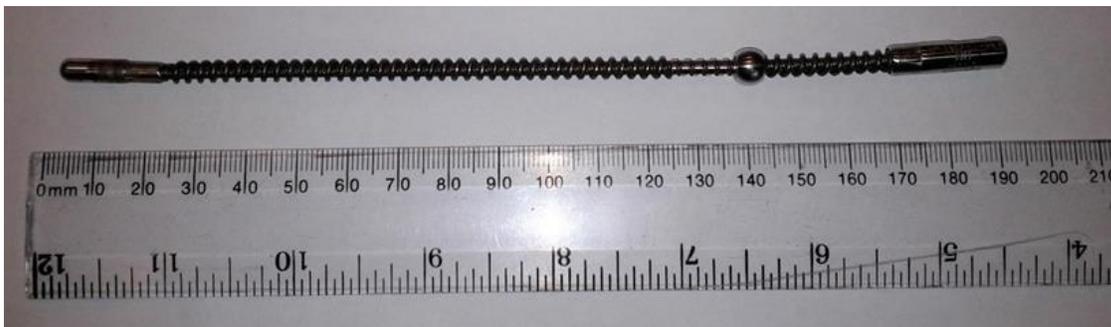
J.1.1 Introduction

Radioactive nuclear substances in sealed or unsealed source form have many industrial, medical, commercial, academic and research applications. A wide variety of organizations make use of nuclear substances, including universities, hospitals, industrial facilities and government departments.

Although most radioactive sealed sources are physically small (see figure J.1), their radioactivity may range from tens to billions of becquerels. When radioactive sealed sources are no longer in active use or have decayed beyond their useful life and are not intended to be used for the practice for which authorizations have been granted, they become disused radioactive sealed sources. These sources may then be returned to their manufacturer, in Canada or to their country of origin, if not Canada. They may also be sent to a licensed waste management facility (WMF). If a radioactive sealed source has decayed below its exemption quantity or its clearance level as defined in the NSRDR, it may be released from CNSC regulatory control, pursuant to subsection 5.1 of the NSRDR. Nuclear substances that remain within regulatory control must be managed with consideration for all existing regulations.

Note that in September 2018, Canada made a political commitment to the IAEA *Guidance on the Management of Disused Radioactive Sources* (the Guidance). The CNSC conducted an analysis of the Guidance and decided not to integrate the term “disused sealed sources” into its regulatory framework based on the fact that the framework already provides for a safe and secure management of all sealed sources throughout their lifecycle, regardless of whether they are in active use or not. In July 2023, the CNSC published the document *Policy and Strategy on Meeting the IAEA Guidance on the Management of Disused Radioactive Sources*, to describe its long-term commitment to the safe and secure management of disused sealed sources.

Figure J.1: Sealed source assembly used for industrial radiography



J.1.2 Regulatory framework for radioactive sealed sources

Under section 26 of the NSCA, and subject to regulatory requirements, no person shall possess, transfer, import, export, use, abandon, produce or service a sealed source, except in accordance with a licence. Section 5 of the NSRDR provides a list of general exempted activities for which a licence is not required.

As defined in the NSRDR, “sealed source” means a radioactive nuclear substance in a sealed capsule or bonded to a cover. The capsule or cover must be strong enough to prevent contact with or dispersion of the substance under the conditions for which the capsule or cover is designed.

Sealed sources may be remanufactured or reprocessed by licensees for future use if doing so is within the scope of their licensed activities.

J.1.3 Radioactive sealed sources used in Canada

Through Canada's regulatory oversight program, the CNSC regulates activities involving radioactive sealed sources. Each licence specifies the isotope, the maximum activity per sealed source and the regulated activities the licensee can conduct under that licence.

J.1.3.1 Safety of radioactive sealed sources

In Canada, radioactive sealed sources are referenced in a licence (pursuant to the NSRDR) to ensure that throughout its lifecycle, a radioactive sealed source is possessed, transferred, imported, exported, used, abandoned, produced or serviced in accordance with regulatory requirements.

Licensees are required to report their inventory of sealed sources and radiation devices to the CNSC annually for Category 3, 4 and 5 sources, and more frequently for Category 1 and 2 sources. Furthermore, CNSC inspectors physically verify a licensee's inventory of sealed sources during inspections to ensure it is keeping accurate records of the sources in its possession and that it knows the whereabouts of all sources in its possession.

Canada's regulatory framework holds licensees responsible for the recovery and safety of lost, stolen and found radioactive sources. Radioactive sources that become disused while under regulatory control must be managed in consideration of all existing regulatory requirements and may be returned to the manufacturer in Canada or in the country of origin. They may also be sent to a licensed WMF.

The responsibility for the safe recovery of sealed sources found outside of regulatory control lies with the licensee-owner. When a sealed source is found outside of regulatory control, the CNSC can and does intervene to identify the licensee-owner. For cases where this identification cannot be achieved, the CNSC has a procedure in place and allocates financial and human resources to ensure that the source is brought back under regulatory control. In these cases, the CNSC may intervene in the recovery and will not penalize the entity that has found the radioactive sealed source(s). Any expenses incurred during the recovery operations may be recovered under the CNSC's financial guarantee program via an insurance policy claim. The CNSC's internal procedures cover all steps in the management of a source, from discovery to disposal.

According to the regulations, sealed sources that are lost or found must be reported to the CNSC. Licensees that become bankrupt must also report this to the CNSC. All reports are kept in the Events Information Tracking System, an internal events management database, so that the CNSC can respond appropriately. REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices* clarifies the reporting requirements, provides details on the events, situations and dangerous occurrences that must be reported to the CNSC, and provides guidance on the information that must be submitted with the different report types.

The 2019 IRRS Mission to Canada observed the following: “The CNSC, in partnership with other organisations, has established a comprehensive programme for radium luminous devices, including a graded approach to their regulation, public outreach and a programme to support safe disposal.” The Historic Artefact Recovery Program, operated by CNL, provides technical advice and assistance. It helps identify radioactive artefacts found on private and public properties across Canada. When required, the artefacts are transported to a CNSC-licensed long-term waste management storage facility. The IRRS Mission identified this program as a good practice as Canada “has established a comprehensive programme for dealing with historic radium devices in the public domain.”

J.1.3.2 Disposal of radioactive sealed sources in Canada

A radioactive sealed source may only be transferred in accordance with the conditions of a licence issued by the CNSC. For their long-term management, radioactive sealed sources may be returned to their manufacturer in Canada or to their country of origin, if not Canada.

In Canada, certain source manufacturers are recycling radioactive sealed sources as part of end-of-life management by either reusing decayed sources for other applications, re-encapsulating them or reprocessing them for other useful applications.

The radioactive sealed sources may also be sent to a licensed radioactive WMF (such as the facility operated by CNL in Chalk River, Ontario) or transferred to a person licensed by the CNSC to possess the radioactive sealed sources.

If a radioactive sealed source has decayed below its exemption quantity or its clearance levels (as identified in Schedule 1 and Schedule 2 of the NSRDR), it may also be released from CNSC regulatory control, pursuant to subsection 5.1 of the NSRDR. Even though the radioactive sealed sources may no longer be under CNSC regulatory control, persons possessing them must still follow the applicable federal, provincial and/or municipal regulations.

See section K 2.6 for information on the ISRW as it pertains to the disposal of ILW and non-fuel HLW, and LLW, which is inclusive of waste from disused sealed sources.

J.1.3.3 National Sealed Source Registry and Sealed Source Tracking System

In 2006, the CNSC implemented the Sealed Source Tracking System (SSTS) and the National Sealed Source Registry (NSSR) as components of the CNSC's efforts in implementing the IAEA's *Code of Conduct on the Safety and Security of Radioactive Sources*. The SSTS is a secure web-based system that keeps track of inventories of high-risk radioactive sealed sources by allowing licensees to conduct online reporting of source creation, transfer, receipt, import, and export and source exchanges in radiation devices. The NSSR, which is populated by the SSTS, enables the CNSC to maintain an accurate and secure inventory of Category 1 and 2 sealed sources in Canada. For sealed sources used in industrial radiography, licensees are required to report transfer of all sources, regardless of their category.

The information contained in the NSSR reflects the reporting timeframes required by the licence (e.g., reporting within 2 days of receipt, 24 hours in advance of a domestic transfer and 7 days in advance of an export). Data related to exported sources, such as their serial number, activity, and reference date as well as details related to the export transaction remains available in the NSSR. Each year, over 90% of the source transactions are done via the web interface demonstrating successful adoption of the system by Canadian licensees. The remaining transactions are conducted by fax and email and processed by a CNSC staff member directly in the NSSR.

In order to verify the accuracy of the data in the system, CNSC inspectors physically cross-reference SSTS data against licensees' actual inventory of sealed sources. Routine CNSC compliance inspections include verification of sealed source tracking information.

Licensees are also obligated to submit their inventory for all their sealed sources via their annual compliance report. The CNSC consolidates these inventories into a separate searchable file.

By the end of December 2023, the NSSR contained information regarding 179,591 radioactive sealed sources of all categories in Canada. This is a 33.4% increase over the number of sources in the NSSR at the end of December 2019. As of December 2023, the SSTS was tracking 5,888 Category 1 sources and 75,674 Category 2 sources. The remaining 98,029 sources in the NSSR were of Category 3, 4 and 5, which are subject to mandatory annual reporting.

In 2017, the CNSC began posting data from the SSTS in machine readable format, online, as part of the Government of Canada's Open Government initiative.

As part of efforts related to continuous improvement, the CNSC initiated an improvement project for the SSTS and the NSSR in 2018. This project was subsequently incorporated into the CNSC's Digital Program, aimed at modernizing the full scope of the CNSC's systems. Under this Digital Program, the CNSC is currently focused on upgrading its fundamental information technology infrastructure. A subsequent phase of the strategy will include the delivery of a new information management system and the replacement of legacy applications, including the national registry and source tracking system, with modern applications.

J.1.3.4 Import and export of radioactive sealed sources

The enhancement of Canada's import and export control program for radioactive 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 supplementary *Guidance on the Import and Export of Radioactive Sources*. Under the leadership of the IAEA, these documents were developed to improve the safety and security of radioactive sealed sources around the world. To support the IAEA and its efforts to develop a global regime to control and securely manage Category 1 and 2 radioactive sealed sources, the Government of Canada committed to meeting the provisions contained in the Code of Conduct and implementing an import and export control program, as outlined in the guidance.

As Canada's nuclear regulatory authority, the CNSC is responsible for controlling the import and export of radioactive sealed sources under the NSCA. Category 1 and 2 radioactive sealed sources are consistent with IAEA safety standard RS-G-1.9, *Categorization of Radioactive Sources*, which is based on the D-values that define how dangerous a source is. Category 1 and 2 radioactive sealed sources are defined as risk-significant radioactive sealed sources for the purpose of the CNSC import and export control program.

By implementing import and export control measures as outlined in the IAEA Code and guidance, the CNSC is enhancing national and international safety and security. These measures ensure that only authorized persons can receive Category 1 and 2 radioactive sealed sources. The CNSC's import and export control program is consistent with that of the IAEA and aims to:

- achieve a high level of safety and security regarding Category 1 and 2 radioactive sealed sources
- reduce the likelihood of accidental harmful exposure to Category 1 and 2 radioactive sealed sources or the malicious use of such sources with intent to harm individuals, society and the environment
- mitigate or minimize the radiological consequences of any accident or malicious act involving Category 1 and 2 radioactive sources

When considering an application to export Category 1 and 2 radioactive sealed sources, the CNSC must be satisfied that the importing state meets the expectations specified in paragraph 7 of the guidance regarding Category 1 sources, and paragraph 11 with respect to Category 2 sources. Where such assurances cannot be obtained and the CNSC determines that the importing state lacks the appropriate regulatory infrastructure to effectively manage the source in a safe and secure manner, the CNSC may consider denying the authorization of the export.

The CNSC import and export control program for Category 1 and 2 radioactive sealed sources is fully consistent with the provisions of the IAEA Code and Guidance. Canadian exporters are required to apply for and obtain an export licence from the CNSC prior to exporting Category 1 or 2 radioactive sealed sources. The program encompasses licensing, compliance, prior shipment notifications to importing states, post-shipment verifications, state-to-state requests for import consent to import Category 1 radioactive sealed sources, the establishment of bilateral administrative arrangements and the confirmation of receipt of radioactive sources as negotiated in several bilateral administrative arrangements.

To assist licensees and other states, the CNSC published REGDOC-2.13.2, *Import and Export, Version 2*, which provides information on the CNSC import and export control program for Category 1 and 2 radioactive sealed sources. An application form and accompanying instructions for obtaining a licence to export Category 1 and 2 radioactive sealed sources are also available at nuclearsafety.gc.ca.

Since the program was implemented on April 1, 2007, the CNSC has received more than 2,820 applications to export Category 1 and 2 radioactive sealed sources to 100 countries and has controlled the export of more than 20.4 million TBq. Canada remains a global leader in the production and export of Category 1 cobalt-60 radioactive sealed sources, supplying approximately 95% of the global demand.

Canada's modernized Policy for Radioactive Waste Management and Decommissioning, released in March 2023, addresses Canada's commitment to the principle that radioactive waste generated in other countries are not to be disposed of in Canada and radioactive waste generated in Canada will be disposed of in Canada, with the exception of certain radioactive wastes subject to return arrangements. For radioactive sources manufactured in Canada that are sold abroad for industrial irradiation, medical, agricultural, and other beneficial uses, it will permit the repatriation of disused sources to Canada for management or disposal under the return-to-manufacturer principle or prior arrangement between Canada and the other country. It also recognizes that under exceptional circumstances, radioactive sources that were not from Canada may be brought to Canada for the purpose of protecting the health, safety and security of people and the environment and with the agreement of the federal government.

J.1.3.4.1 International harmonization through bilateral administrative arrangements

To assist in a harmonized international implementation of the IAEA Code and guidance, the CNSC has developed a model bilateral administrative arrangement with a core set of terms, definitions and procedures. The CNSC has established 12 bilateral administrative arrangements with its international counterparts to ensure that imports and exports of Category 1 and 2 radioactive sealed sources between Canada and these countries are conducted in a manner consistent with the Code and guidance. These arrangements assist in harmonizing regulatory approaches for authorizing imports and exports and facilitate the sharing of regulatory information related to such imports and exports.

Placing importance on bilateral arrangements to better harmonize controls internationally was regarded as a good practice in the IRRS review of the CNSC regulatory program in June 2009. The practice is also highly regarded internationally, as it helps other states implement the IAEA Code and guidance. The CNSC encourages the establishment and use of bilateral arrangements to assist in harmonizing regulatory approaches for authorizing imports and exports.

J.1.3.5 Radioactive sealed sources in the international community

The re-entry of previously exported radioactive sealed sources is permitted with an import licence (for controlled nuclear substances) or under a general import authorization licence issued by the CNSC. Manufacturers of sources in Canada continue to import sealed sources from other countries as part of the return-to-manufacturer principle.

J.1.3.6 Records

Paragraph 36(1)(a) of the NSRDR requires every licensee to keep a record of any nuclear substance in their possession. Records must include:

- the name, quantity, form and location of the nuclear substance
- the model and serial number of the source if the nuclear substance is a sealed source
- the model and serial number of the device if the nuclear substance is contained in a radiation device
- the quantity of the nuclear substance used
- the manner in which the nuclear substance was used

Paragraph 36(1)(c) of the NSRDR requires every licensee to keep a record of any transfer, receipt, disposal or abandonment of a nuclear substance. Records must 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 radioactive sealed source, the model and serial number of the source
- when the nuclear substance is contained in a radiation device, the model and serial number of the device

J.1.3.7 Financial guarantee program for users of sealed sources and radiation devices

In 2015, the CNSC established a financial guarantee program for users of sealed sources and radiation devices. The CNSC has put in place an insurance program through contract with a private institution. Under the program, the CNSC is the sole insured party and licensees pay an annual premium, a variable percentage of their total liability (up to a maximum liability of \$1 million). The premium is revised on an annual basis. Licensees that choose not to participate or are excluded from the program are required to establish an alternate financial guarantee that is acceptable to the Commission. The establishment of this financial guarantee regime ensures adequate funds will be available for the safe termination of licensed activities in the event of licensee default or for cases when a source is found outside of regulatory control and for which the licensee-owner cannot be identified.

The financial guarantee program does not absolve the licensee of their obligations for safe termination of licensed activities. Since its inception, the CNSC has made a number of claims under this program, both in the context of bankruptcies and recovery of sealed sources found outside of regulatory control. In addition, the CNSC is actively participating in recent initiatives by the IAEA to develop guidance on financial provisions associated with the management of disused radioactive sealed sources.

SECTION K

General efforts
to improve
safety



Section K – General Efforts to Improve Safety

K.1 Scope of the section

This section addresses the following:

- a summary of safety issues and planned future actions on those issues, and the challenges and suggestions identified at the sixth and seventh review meetings (K.2)
- overarching issues identified at the Seventh Review Meeting (K.3)
- measures of international cooperation (K.4)
- international peer reviews (K.5)
- actions taken to enhance openness and transparency in implementing the obligations under the Joint Convention (K.6)

K.2 Safety issues and planned future actions

The Seventh Review Meeting did not identify any new challenges for Canada. While progress had been made on challenges made during the Sixth Review Meeting, Canada proposed that these challenges remain open to be reported on at the Eighth Review Meeting. These are the three challenges that remained open:

1. decommissioning and remediation of AECL sites (under the management of CNL) and continued licensing process for CNL accelerated decommissioning and remediation projects (K.2.1)
2. long-term management of spent fuel and the identification of an acceptable site in a willing host community for a spent fuel repository (K.2.2)
3. development of Canada's integrated Radioactive Waste Management Strategy (K.2.3)

Canada received two suggestions at the Seventh Review Meeting:

1. Completion of Canada's commitment from the 2019 IRRS Mission with regards to Canada's Radioactive Waste Policy (K.2.4)
2. Undertaking an ARTEMIS Mission (integrated Review Service for Radioactive Waste Management and Spent Fuel Management, Decommissioning and Remediation) (K.2.4.2)

The following sections provide Canada's updates on these challenges and suggestions.

K.2.1 Decommissioning and remediation of AECL sites

K.2.1.1 AECL

Since the Seventh Review Meeting, AECL sites, CNL, under contract with AECL, has continued to progress on decommissioning and remediation activities, including:

- decommissioning and demolition of 24 structures in the supervised and controlled areas at CRL, bringing the total of removed redundant structures to 117 of the more than 120 committed from 2015 through 2026.
- continued progress toward placing the NRU reactor in a storage-with-surveillance state (following end of operation in March 2018)
- decommissioning and demolition of 35 buildings in total since 2015 September at the Whiteshell Laboratories (WL) site - completion of overall decommissioning of WL delayed beyond 2027 and scheduled no sooner than 2030

- environmental assessment and licensing regulatory processes launched in 2017:
 - On January 9, 2024 the CNSC published its decision to amend the CRL licence to permit construction of the NSDF for the disposal of up to 1,000,000 m³ of LLW at CRL. The forecasted date of operations is 2030. The Commission's decision has been challenged and, as provided for under the NSCA, is undergoing judicial review by the Federal Court.
 - CNL continuing to address comments on the draft EIS for *in situ* decommissioning of the NPD reactor at Rolphton, near CRL. Pending regulatory approval, the site is forecast to be decommissioned by 2030.
 - In December 2022, CNL submitted revised draft EIS submission to the CNSC for federal review of the *in situ* decommissioning of WR-1 reactor at WL. Pending regulatory approval, the reactor is forecast to be decommissioned in 2029.
- Planning and preparation of additional interim storage capacity for LLW at CRL while awaiting construction and licensing authorization to start operations of the NSDF.
- Ongoing evaluation of ILW storage requirements, including near- to medium-term capacity needs, given that current capacity at CNL sites is limited, the plan is to consolidate storage of all AECL/CNL ILW at CRL until ILW disposal becomes available. CNL has completed the design of a new storage array for remote handled ILW and is making preparations to begin construction.
- Expansion of storage capacity at CRL for dry storage canisters for spent fuel to accommodate consolidation of spent fuel storage at CRL until the NWMO APM facility becomes available.
- Confirmed that 4 of the legacy tanks containing stored liquid wastes were empty and handed building B207 over for decommissioning. Continued progress on retrievals and processing of liquids from other legacy tanks containing stored liquid wastes. Continued progress has been made on facility upgrades to enable the completion of the stored liquid waste project at the CRL site, which is forecast for completion in 2034.
- Progress with the PHAI cleanup, including:
 - Completed remediation of the Welcome WMF in 2019 and completed construction of the final cell of the Port Hope WMF in 2021.
 - Continued to make progress on cleanup activities within the municipality of Port Hope; on track to complete the remediation of Port Hope sites by 2030-31, following which the Port Hope ECM facility will be closed and capped and the project will move into Phase 3 for monitoring and surveillance.
 - Completed the remediation at Port Granby; including closing and capping the Port Granby engineered containment mound (ECM) facility in 2022. The Port Granby project has now moved into Phase 3 monitoring and surveillance.
- Phase 1 (of 3) of clean up of impacted sites along the NTR has been completed. Planning, characterization and engagement with Indigenous Nations and communities are well advanced for Phase 2. The plan is to have remedial work completed through phases 2 and 3 at all remaining identified sites along the NTR by 2030.

For more information on the progress of the three projects undergoing environmental assessment (NSDF, and *in situ* decommissioning of NPD and WR-1), see section K.2.1.3. For more information about the progress of decommissioning and environmental remediation at CRL, see annex 8.1. For information on the progress of decommissioning at WL, see annex 8.8. To learn more about the PHAI, see section K.2.1.5, as well as annexes 7.2 and 7.2.1.

K.2.1.2 Waste management and strategic progress for subsequent phases

An environmental assessment (EA) process was initiated in 2016 for a proposed NSDF at CRL. This ground-level facility, or ECM, would be built to permanently and safely dispose of AECL's LLW.

For many years, AECL (and now CNL) has safely placed waste from its operations and from Canadian hospitals and universities in temporary storage facilities at CRL. These temporary facilities have design lives that range from 25 to 50 years. The intent of the proposed NSDF is to provide a safe and permanent disposal solution for LLW.

The NSDF has been designed to allow for the safe and permanent disposal of:

- LLW from >65 years of AECL/CNL nuclear science and technology operations, which is currently stored in temporary storage facilities at CRL
- future CRL operational LLW materials as they are generated (i.e., waste resulting from ongoing nuclear science and technology operations)
- LLW materials received through commercial arrangements, including waste from hospitals, universities, research entities and industry clients – all currently stored in temporary waste storage facilities at CRL
- LLW from future decommissioning activities undertaken by CNL to address other liabilities owned by AECL (e.g., closing the WL and prototype reactor sites)

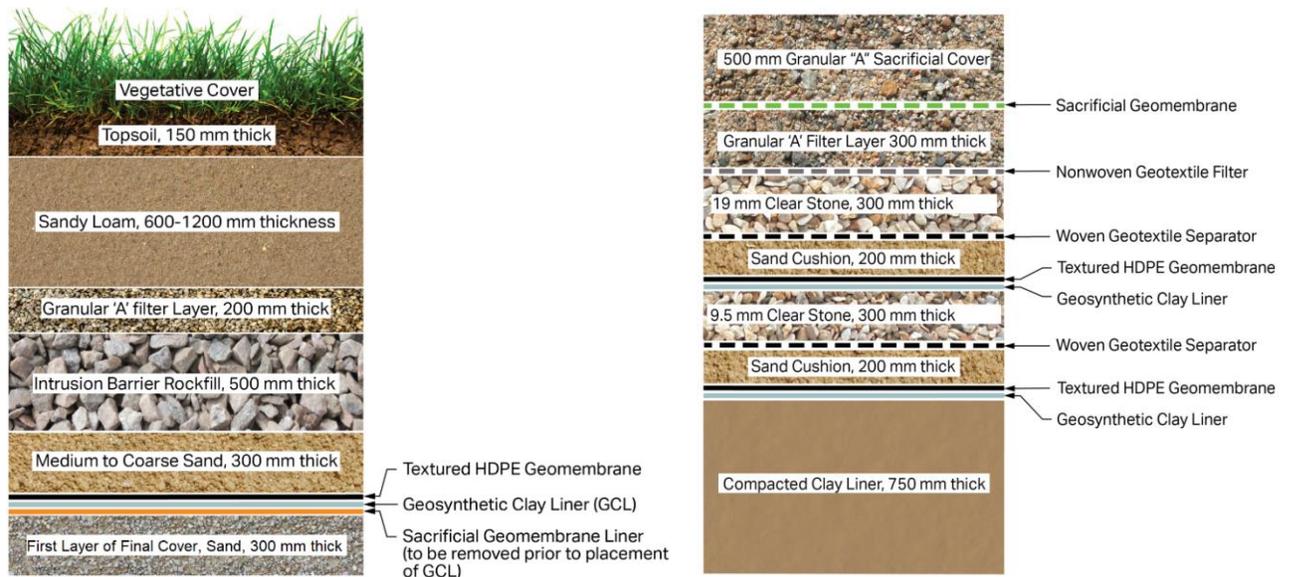
All waste emplaced in the proposed NSDF must follow the waste acceptance criteria defined for the facility. The waste acceptance criteria set limits on the physical (size and packaging), radiological and chemical characteristics of the waste that would be accepted for emplacement in the proposed NSDF to assure compliance with operational and long-term safety requirements. Only wastes that are deemed suitable for this method of disposal and meet the waste acceptance criteria will be accepted at the NSDF for emplacement. Conceptual images of the NSDF are shown in figure K.1 and figure K.2.

Since the Seventh Review Meeting, progress continued on the regulatory application for the proposed facility. CNL performed the necessary work to address all comments from the public, Indigenous Nations and communities, federal and provincial departments and CNSC staff on the environmental impact statement (EIS), as well as CNSC staff comments on licensing documentation. In July 2021, CNSC staff confirmed their acceptance of CNL's final EIS. A two-part hearing was scheduled by the CNSC for the environmental assessment and licensing decision. Part one was held in February 2022 and Part two was held in May and June 2022. Following the second part of the two-part hearing, the CNSC issued a procedural direction to keep the record open to allow for additional consultation with two Indigenous Nations, the Kebaowek First Nation and the Kitigan Zibi Anishinabeg. A hearing to permit oral presentation of final arguments by the intervenor Indigenous Nations and communities was held 2023 August. On January 9, 2024, the CNSC published its decision to amend the CRL licence to permit construction of the NSDF. The Commission's decision has been challenged and, as provided for under the NSCA, is undergoing judicial review by the Federal Court.

Figure K.1: Artist's rendering of closed and capped NSDF



Figure K.2: Artist's rendering of NSDF liner system detail showing the multi-layer cap system (left) and the base liner system (right)



K.2.1.3 Update on the licensing process for CNL accelerated decommissioning and remediation projects (NPD, WR-1 and NSDF)

The following lists the key regulatory milestones and dates since the Seventh Review Meeting:

- NSDF project
 - submission to the CNSC of final EIS and responses to comments from the public and Indigenous Nations and communities – May 2021
 - CNSC staff acceptance of CNL's final EIS – July 2, 2021

- CNSC staff deemed CNL's application complete in meeting the requirements of the *Nuclear Safety and Control Act* and its associated regulations – July 8, 2021
- CNSC Commission public hearing (Part 1) – February 22, 2022
- CNSC Commission public hearing (Part 2) – May 30 – June 3, 2022
- CNSC Commission public hearing (final oral submissions) – August 10, 2023
- CNSC Commission decision and record of decision – January 08, 2024
- Chalk River Laboratories Licence amended – January 08, 2024
- Chalk River Laboratories Licence Conditions Handbook, Revision 4 - issued January 31, 2024
- NPD closure project
 - submission to the CNSC of final EIS and responses to comments from the public and Indigenous Nations and communities anticipated in late 2024
 - CNSC Commission hearing tentatively planned for early 2026
 - CNSC Commission's EA and licence decision planned for 2026
- *In situ* decommissioning of WR-1
 - revised draft EIS was submitted to the CNSC for federal–provincial–Indigenous review in December 2022 and did not meet regulatory requirements for the EA
 - resubmission to the CNSC of revised draft EIS and responses to reviewer comments anticipated in 2024
 - the anticipated date for the CNSC Commission hearing is unknown
 - the anticipated date for the CNSC Commission's EA and licence decision is unknown

K.2.1.4. Management of historic low-level radioactive waste

In 1982, the Government of Canada established the Low-Level Radioactive Waste Management Office (LLRWMO) within AECL to carry out Canada's responsibilities for the management of historic LLW in Canada. The scope of the LLRWMO covers two major programs: a historic radioactive waste program involving the cleanup and management of historic LLW across Canada, and an information program on radioactive wastes in Canada. Over the course of its existence, the LLRWMO has completed historic radioactive waste cleanups across Canada and continues to monitor several sites with historic radium or uranium contamination.

AECL is the government organization responsible for delivering on the federal government's responsibilities with respect to the PHAI and LLRWMO. Under a GoCo contractual arrangement, CNL delivers the PHAI and LLRWMO scopes of work on behalf of AECL. The PHAI focuses on the historic wastes in Port Hope and Clarington, Ontario; the LLRWMO focuses on the clean up of historic wastes and liabilities elsewhere in Canada, primarily the Greater Toronto Area (GTA) and along the NTR in the Northwest Territories and northern Alberta.

K.2.1.5 Port Hope Area Initiative

The bulk of Canada's historic LLW is located in the southern Ontario municipalities of Port Hope and Clarington. These wastes and contaminated soils are forecast to amount to roughly 2.8 million m³. They originate from the operation of a radium and uranium refinery in Port Hope dating back to the 1930s. Although it recognizes that there are no urgent health or environmental risks, the Government of Canada determined that intervention measures were required so that more appropriate long-term management could be put in place 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 cleanup and long-term management of these wastes, thereby launching the PHAI. The objective of the PHAI is to safely manage the historic LLW in two above-ground mounds that are being constructed in the local communities. The initiative comprises two projects: the Port Hope Project and the Port Granby Project (see figures K.3 and K.4).

Figure K.3: Port Granby mound below closed and capped with the wastewater treatment facility in the foreground and the mound at the top of the picture (July 2023)



Figure K.4 Port Granby mound -view North from Lake Ontario showing the remediation areas and the mound in the top of the picture. (July 2023)



The Port Hope Project entails cleaning up the urban area and 13 major sites, as seen in figure K.5, and consolidating all of the wastes in Port Hope (forecast at approximately 1.9 million m³ in total, including waste from the current Welcome WMF) at one long-term WMF, at the site of the existing Welcome WMF. The waste water treatment plant for the proposed long-term WMF was completed in 2016 and is now operational. Construction of the containment mound commenced in the summer of 2016. The first cell was completed in late 2017. On-site waste placement from the Welcome WMF began in 2017 and was followed by placement of wastes from sites within the community in 2018. The remediation of the Port Hope sites is expected to be complete in 2029-30.

The Port Granby Project involved relocating the existing Port Granby wastes (approximately 0.9 million m³) to a new above-ground long-term WMF. Construction of the Port Granby containment mound commenced in the spring of 2016. On November 1, 2016, the first truckloads of LLW were transported away from the Lake Ontario shoreline to the newly built Port Granby WMF. The legacy waste removal (including emplacement of lightly contaminated infrastructure materials [haul roads, drainage ditches etc.]) was completed in November 2020 with the WMF capped and closed in November 2021. The remediated site has also now been restored with landscaping and the planting of trees, shrubs and grass. As of March 2023, the Port Granby project moved into phase 3 monitoring and surveillance.

After the emplacement of wastes and the closure of the new WMFs, the long-term monitoring and maintenance phase will begin and continue for hundreds of years.

Information for the general public regarding either the Port Hope or Port Granby project is transmitted through newsletters, open house events, direct contact with communications specialists in the Project Information Exchange and via the official PHAI website at phai.ca.

Figure K.5: Radiological investigation at a residential property

K.2.1.6 Other historic radioactive waste sites

On behalf of AECL, CNL delivers on the scope of the LLRWMO which involves managing sites along the Northern Transportation Route (NTR). The NTR is a 2,000 kilometre route made up of waterways and portages from Port Radium in the Northwest Territories and northern Alberta. Sites along the NTR contain small quantities of uranium impacted soils resulting from past handling of uranium ore at certain points along the route. The LLRWMO is also responsible for properties in the GTA that are contaminated with radium.

Work is currently underway to complete the remediation of historic LLW liabilities across Canada (non-Port Hope sites). A key objective for CNL is to significantly reduce or eliminate liabilities by 2032 by safely executing remediation projects to facilitate cost-effective long-term management of historic LLW facilities and programs. This is consistent with policy direction provided by AECL.

Since the Seventh Review Meeting, the following progress has been achieved:

- Phase 1 of clean up of impacted sites along the NTR has been completed; the plan is to have remedial work completed through phases 2 and 3 at all remaining identified sites along the NTR by 2030.
- Selective characterization and remediation have been undertaken in the GTA in response to requests for support from property owners as triggered through their property development activities. The plan is to have completed remedial work at all remaining identified sites in the GTA by 2032.

K.2.2 Long-term management of spent fuel and the identification of an acceptable site in a willing host community for a spent fuel repository

In 2007, the NWMO received its mandate from the Government of Canada to implement the APM approach. Canada's deep geological repository (DGR) will use a multiple-barrier system designed to safely contain and isolate used nuclear fuel over the very long term. Proposed to be constructed more than 500 metres below ground, the repository would consist of a network of placement rooms that will store the used nuclear fuel.

The process for selecting a site for the APM DGR remains ongoing. When the site selection process started for APM in 2010, 22 communities expressed interest in learning more about the project. As of March 2024, two communities remain in the site selection process: Saugeen Ojibway Nation¹ - South Bruce and Wabigoon Lake Ojibway Nation - Ignace, both in Ontario. Studies and community consultation continues within these areas. First Nation and Métis communities are also involved, as facilitated through learning agreements.

A site selection decision is expected in 2024, following which the APM DGR approach will transition to the process of detailed site characterization and regulatory-decision-making.

K.2.2.1 Canada's plan for the long-term management of its spent fuel

APM is both a technical method (what the NWMO plans to build) and management system (how the NWMO will work with people to get it done). The technical method involves developing a DGR in a suitable rock formation to safely contain and isolate used nuclear fuel. The management system involves phased and adaptive decision-making, supported by public engagement and continuous learning.

During the past four years, the NWMO has continued to take an adaptive approach in all its work, including technical repository design, field testing, aligning with Indigenous knowledge and working with Indigenous peoples on engagement activities for partnership and community well-being, to name a few examples.

The NWMO is guided by an ethical and social framework that was developed with the involvement of leading ethicists in Canada, including an Indigenous perspective during the study phase of its work. It was first published in 2004.

In 2018, the framework was updated in discussion with communities involved in the site selection process and others who expressed an interest. The updates ensure alignment with the current phase of the NWMO's work and advancement of the site selection process. For more detail, please see <https://www.nwmo.ca/Who-we-are/Our-commitment/Ethical-and-social-framework>

The DGR uses a multiple-barrier system designed to safely contain and isolate spent fuel over the long-term. It will be constructed at a depth of approximately 500 m depending on the geology, and consists of a network of placement rooms for the spent fuel.

At the surface, there will be facilities where the spent fuel is received, inspected and repackaged into purpose-built containers before being transferred to the main shaft for underground placement. There will also be facilities for administration, quality, security, processing of sealing material and ongoing operation of the site.

The repository will include a centralized services area, which allows for ventilation underground through three shafts located within a single, secure area. The layout also includes multiple access tunnel arms that enable technical specialists to situate placement rooms in areas with the most suitable rock.

In preparation, the NWMO has begun work on site-specific conceptual designs of the underground repository layout for potential siting areas in Ontario, based on information from geoscience assessments and initial borehole drilling. This will be an iterative process, and like all aspects of the NWMO work, it will also align

¹ The Saugeen Ojibway Nation (SON) consists of the Saugeen First Nation and the Chippewas of Nawash Unceded First Nation

Indigenous knowledge in the process. As the NWMO acquires additional site-specific information, design of the repository will continue to evolve.

The NWMO is now responsible for implementing APM inclusive of site selection and subject to all necessary regulatory approvals. Future regulatory decision-making processes will include an EIS pursuant to Canada's *Impact Assessment Act* and CNSC licensing under the *Nuclear Safety and Control Act*.

K.2.2.2 Understanding and honouring Indigenous perspectives

Since its inception in 2002, the NWMO has been striving to understand, honour and align with Indigenous knowledge and worldviews to guide all aspects of the work.

The NWMO's commitment to understand and include the perspectives of Indigenous peoples continues to be incorporated into the organization. The NWMO has Indigenous representation on its executive team, board of directors and advisory council to ensure that a strong Indigenous voice is present within the organization. The organization has also committed to aligning Indigenous knowledge in all aspects of its work and contribute to reconciliation through corporate policy.

The Indigenous engagement team builds respectful relationships with First Nation and Métis communities. The NWMO listens to the First Nation and Métis communities with which they are working; they receive ongoing guidance and advice from the Council of Elders and Youth an independent advisory body made up of First Nation and Métis Elders and Youth from across Canada.

From 2017 to 2019, the NWMO continued to incorporate previously established practices into daily activities. These include marking important corporate occasions and milestones through Indigenous ceremonies (as advised by internal Indigenous expertise, the Council of Elders and Youth, and the communities in which the NWMO is currently working), adhering to an Indigenous knowledge policy and acting on the commitment to align with Indigenous knowledge into all aspects of the work.

The Truth and Reconciliation Commission released its final report in December 2015. This report included Call to Action 92, which calls upon the corporate sector in Canada to adopt the United Nations Declaration on the Rights of Indigenous Peoples as a reconciliation framework, and to apply its principles, norms and standards to corporate policy and core operational activities involving Indigenous peoples and their lands and resources.

On July 18, 2018, NWMO made a commitment to contribute to reconciliation by acknowledging historical wrongs in Canada's past and the need to create a better future by addressing the challenges of today. Education and creating a strong foundation of recognition and respect have been key to the NWMO's journey in reconciliation.

The actions taken over the next few years will be vital for the NWMO to demonstrate the truth behind their commitment to reconciliation. The Reconciliation Policy (2019) was intended to disrupt the NWMO at its structural core by shifting policies to reflect community values, restructuring governance models, creating more positions for Indigenous leadership, and creating clear accountability structures wherein the voices of affected communities are heard and effect organizational change. As the NWMO's journey in reconciliation evolves, it is important that the NWMO plans strategically and thoughtfully as to how it will continue to meet and exceed their commitments to co-creating a better future for all beings of Creation. The four key areas of focus that will help the NWMO continue this momentum are learning, action, relationship and healing.

Action and accountability to reconciliation will be vital to the NWMO's success. The Reconciliation Policy is intended to influence decision-making, enhance partnerships and promote reconciliatory action throughout the NWMO. As the NWMO advances in the applying and aligning with Indigenous knowledge systems, the connection of heart and mind intelligence will become increasingly important in meeting the commitments of the Indigenous knowledge and reconciliation policies. The NWMO's Reconciliation Policy has allowed for substantial progress on short-term outcomes for staff in particular and the organization in general. The need

now is to enable and support the more complex and intricate aspects of reconciliation as the organization evolves.

As a part of this approach, the NWMO is committed to align Indigenous knowledge in guiding its work. Since 2018, annual workshops have been held to bring together Indigenous Knowledge Holders and western scientists to bridge the gap that exists among scientists about Indigenous knowledge and explore ways of learning and working together. They discussed how Indigenous knowledge that includes advice and guidance received through ceremony can be combined with a digital data collection and laboratory analysis to understand an area of land from multiple dimensions.

During 2017 and 2018, the Indigenous relations team undertook consulting activities regarding plans to drill the first, second and third boreholes in the Ignace and Wabigoon Lake Ojibway Nation area. Indigenous knowledge studies held in Wabigoon Lake Ojibway Nation then fed into the decision-making matrix of the borehole drilling location. After successful consultations with five First Nations and one Métis community, the NWMO received permission to drill from the Ontario Ministry of Natural Resources and Forestry. The NWMO collaborated with a nearby Indigenous community to provide guides to help with fieldwork and conduct cultural verification studies of the proposed sites and access routes. Drilling commenced with the first borehole in 2017, and the second and third boreholes in 2019. Between 2019 and 2022, after further consultation with communities, three more boreholes were drilled in the area. Community monitors from Wabigoon Lake Ojibway Nation were on-site during the borehole drilling, and they were an important part of the team. They provided input on-site, and they also went back and shared information and insights with WLON so they have a better understanding of the work happening at the borehole sites.

Figure K.6: NWMO Board member Ron Jamieson (right) honoured ahead of the signing of the Reconciliation Statement



K.2.2.3 Social engagement

Dialogue with communities and a range of interested individuals and organizations is central to the work for advancing Canada's plan. As the siting process advances, the NWMO has broadened and deepened engagement activities with municipal, First Nation and Métis communities, as well as surrounding

communities in each area. The NWMO has also maintained relationships with national and provincial Indigenous organizations, and with municipal associations.

Since early 2020, two areas remain in the site selection process – the Wabigoon Lake Ojibway Nation (WLO)-Ignace area and the SON-South Bruce area, both in Ontario. The NWMO continues to support communities and create meaningful connections through the engagement work to develop broad awareness and understanding of Canada's plan for the APM project. A full list of engagement activities is published as a separate document, available in the [reports](#) section of the NWMO website (www.nwmo.ca).

The NWMO engagement activities with Indigenous peoples in and near the siting areas continue, as the NWMO works to align with Indigenous knowledge throughout its work. Through extensive engagement, the NWMO continues to move collaboratively towards defining partnership in both potential siting areas.

The pandemic had a significant impact on the NWMO's activities, creating unprecedented challenges to engagement. There were periods of time when public health measures required most staff to work from home and limited or prevented meetings and gatherings altogether. The NWMO closed offices in Toronto – and for some time, offices in the potential host communities. However, the NWMO ensured it remained present, virtually when necessary, as it adapted alongside the communities working to select a site for Canada's plan. In reviewing the rolling five-year implementation plan and considering the impacts of the pandemic the NWMO made the decision to shift the timing for site selection to the fall of 2024. This shift in timing is not expected to impact the overall schedule for Canada's plan. Construction of the repository is still expected to begin in 2033, and operation of the repository is expected to begin in the early 2040s.

NWMO President and CEO Laurie Swami have visited the Township of Ignace, WLO and the Municipality of South Bruce, and met with leadership from SON, as part of her commitment to ongoing conversations with communities participating in the site selection process. These conversations continued in 2022 and 2023 with further visits and meetings.

OPG has been supporting NWMO's engagement efforts by providing tours and information regarding spent fuel and radioactive waste as requested. OPG has been an open and willing partner and has provided tours of interim storage facilities to interested parties brought by the NWMO. OPG and the CNSC have participated in community learning events in potential host communities as exhibitors.

The NWMO shared its commitment to safety and protecting water, aligning communication efforts with what has been heard from communities that they want to learn more about with respect to the project. Across a variety of platforms, the NWMO has worked hard to ensure it is providing people with accessible, fact-based information on Canada's plan that responds to the feedback and questions heard most frequently.

Since this project is multi-generational, it is critical that the NWMO invest in the education of youth in STEM (science, technology, engineering and mathematics) learning. The NWMO also puts sponsorship and donation dollars to work to meet the needs of students and community groups.

The NWMO continues to lean on science and explore meaningful ways to share information about Canada's plan that resonate with people living in potential host communities and beyond.

The NWMO and communities are beginning more detailed discussions on how to advance learning and build the sustainable partnerships that would be required to support the implementation of Canada's plan for the safe, long-term management of used nuclear fuel.

The NWMO has outlined a multi-step road map to guide these partnership discussions. The road map focuses on exploring the potential to advance the project in partnership with people in the area, while putting in place a framework to implement the project if a preferred site were identified in that area.

K.2.2.4 Site assessment

Based on the results of several years of technical studies, the NWMO's team of scientists and engineers is confident that a deep geological repository can be constructed at either potential site to safely and responsibly manage Canada's used nuclear fuel for the long term.

The NWMO published [Confidence in Safety reports](#) for each site in March 2023. These reports summarized the understanding of the potential sites as of early 2023, which indicated that both sites would be suitable for hosting a repository from a technical perspective. The reports are intended to support public discussion around site selection and are part of a larger and ongoing site assessment process. Ongoing and future technical work will include further site characterization studies, design development and safety analyses to confirm and build on the results to date.

From 2020 through 2024, the site assessment team continued to advance geoscientific understanding of both the WLON-Ignace and SON-South Bruce sites despite the pandemic. The NWMO completed significant field programs, including the drilling and testing of deep boreholes at both sites, as well as data integration and modelling. Ongoing fieldwork activities, as partially depicted in figure K.7, include maintenance of equipment, monitoring the sites and collecting data, and continuing to collect and analyze groundwater samples.

Figure K.7: An aerial view shows a borehole drilling location in the Wabigoon Lake Ojibway Nation-Ignace area



The NWMO was able to safely demobilize the borehole drilling sites due to the pandemic in spring 2020 and remobilize them the following spring. Through 2020 and 2021, advancing fieldwork, as well as interpretation and modelling work, were important ongoing activities for the site assessment team. The team also provided support to the NWMO's engagement teams and the communities in the siting areas.

In 2022, all initial site characterization field activities were completed. In total, drilling and testing was completed on six boreholes in the WLON-Ignace area and two boreholes in the SON-South Bruce area. The technical team installed a shallow groundwater well network and a micro-seismic monitoring network in both areas. The NWMO is analyzing the data to further their three-dimensional understanding of the geosphere at both potential sites.

In the WLON-Ignace area, the potential repository is located on Crown land, and the NWMO has worked with the appropriate government bodies to secure access for studies. Work will continue with these governmental agencies if the area is selected.

In the SON-South Bruce area, through a series of agreements signed with landowners between 2019 and 2021, the NWMO has aggregated just over 1,750 acres of land – enough to host a deep geological repository

if this site is selected. The agreements include a combination of option and purchase arrangements, which allows the NWMO to conduct studies while agricultural and quarrying activities continue on the land.

K.2.2.5 Engineering, safety and technical research

Over the past three years, the NWMO's engineering program focused on advancing the design of the deep geological repository and continuing to develop the project's safety assessments. This included further development of the engineered-barrier system, including manufacturing and testing of several used fuel container and bentonite clay buffer prototypes. The NWMO has also been preparing conceptual designs of the deep geological repository for the two potential sites, conducting layout analysis for the Used Fuel Packaging Plant, and establishing the conceptual used fuel transportation system.

In 2022, the NWMO renamed the Proof Test Facility in Oakville, Ontario, and reopened for in-person tours as the NWMO Discovery and Demonstration Centre. This change recognizes the value it provides to people who want to learn more about the NWMO's innovative work and see it first-hand.

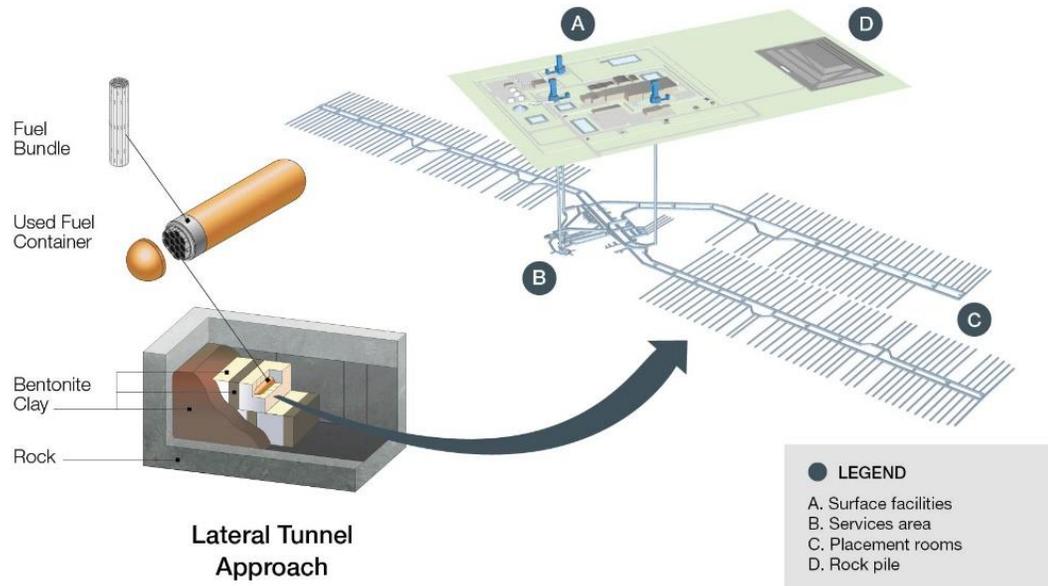
After more than eight years of preparation, a full-scale emplacement trial of the engineered-barrier system began at the Discovery and Demonstration Centre in spring 2022. The demonstration showcased the NWMO's ability to manufacture, handle and place the engineered barriers in a simulated underground emplacement room that replicates the deep geological repository.

In preparation for the emplacement trial, the engineering team designed, fabricated, installed and commissioned key components of the engineered-barrier system, including copper-coated used fuel containers, bentonite clay blocks and gapfill bentonite clay (pellets or chips). The NWMO also fabricated the purpose-built custom equipment that will be required to manufacture and transfer the physical prototypes.

Additionally, the first iteration of a conceptual design for the Used Fuel Packaging Plant was completed. The NWMO will continue to study options for the best layout to facilitate the process of repackaging the used nuclear fuel into the long-lived used fuel containers.

The repository engineering team updated the conceptual designs for the repository facility and documented them in the [2021 Deep Geological Repository Conceptual Design Report](#). Based on these revised designs, associated cost estimates were also updated as input to the 2021 lifecycle cost estimate, which is prepared every five years by the NWMO to comply with the *Nuclear Fuel Waste Act* and the Canadian Nuclear Safety Commission's licensing requirements.

Figure K.8: Deep geological repository concept



For the NWMO, safety is a top priority, both in the near term, when the deep geological repository is operating, and for the long term, after it is filled, sealed off and closed. With the narrowing of the potential sites to two in 2020, the NWMO moved the focus from developing generic safety assessments (often referred to as “case studies”) to starting to develop preliminary site-specific safety assessments. This included conducting regional studies around the siting areas and site-specific supporting studies, and beginning preparatory work for site-specific safety assessments.

Regional studies completed during the period 2020 through 2022 included an assessment of potential climate change effects in the two siting regions, as well as a preliminary flood hazard assessment, including consideration of climate change. For the Saugeen Ojibway Nation-South Bruce area, a comprehensive review of the regional petroleum resource potential, which indicates a low potential in the proposed siting area was published. At both sites, there are no known resources that people in the future might want to extract such as economically exploitable minerals, gas or salt. That means that even if knowledge of the repository is lost in the distant future, the risk of human intrusion into the repository is low.

For both regions, studies on the recent seismic history were also completed to understand the occurrence and frequency of earthquakes in the region. These studies concluded that both siting areas are low risk for earthquakes.

Figure K.9 – A 3D seismic survey is being performed in the Saugeen Ojibway Nation-South Bruce area



In site-specific supporting studies from 2020 to 2022, the NWMO safety and technical research team installed material test modules in a deep borehole at one of the potential repository sites. This will allow for confirmation of the real-world performance of materials used in the engineered-barrier system when exposed to actual underground conditions at the site.

The NWMO's [Confidence in Safety](#) reports summarize the present understanding of the safety of each potential site based on information to date, including geological characteristics. The reports explain why the NWMO is confident that a deep geological repository can be constructed at either potential site and that both are suitable to safely and responsibly manage Canada's used nuclear fuel for the very long term.

The NWMO continued to advance the safety assessment work that will examine the safety and performance of the repository and be submitted in support of a licence application once a site for the repository has been selected. Since 2020, the work in this area has focused on developing updated computer models that allow for more detailed analysis of the repository, as well as preparing for the development of site-specific models for the two sites.

The NWMO continued to advance the understanding of the science supporting the project through their research and development program. In addition to publishing key review papers on topics such as copper corrosion mechanisms and microbial effects on long-term performance, the NWMO has submitted 70 other technical journal articles over the past three years.

Pandemic-related travel and gathering restrictions meant the annual NWMO Geoscience Seminar was held virtually in 2020 and 2021. This seminar brings together NWMO staff and university experts, as well as international collaborators and observers – such as those from the CNSC – to share relevant research and development activities. Although the meeting was not in person, the virtual format of the seminars allowed a record number of participants to attend. In 2022 and 2023 the Seminar returned to the in-person format.

The NWMO also maintained progress in research activities with university partners despite the many challenges to in-lab research caused by pandemic restrictions. From 2020 to 2023, the NWMO collaborated with more than 35 university research groups from 19 universities and supported over 50 projects.

Figure K.10: Prototype used fuel container in half of a highly compacted bentonite clay buffer box



K.2.2.6 Collaborating internationally for a safe future

The NWMO is committed to partnering with and learning from other organizations worldwide that are also responsible for the safe management of spent fuel. Partnering with other radioactive waste management

organizations allows us to foster international co-operation on developing and demonstrating the technology, to learn from other countries' experience, and to keep abreast of repository design and safety case development for various host rock formations.

The NWMO continues to collaborate with international partners to share information, conduct joint research and learn from shared experiences. In particular, the NWMO continued their participation in Posiva's Full-Scale In-Situ System Test project at its ONKALO repository in Olkiluoto, Finland. This was a full-scale underground emplacement trial of its engineered-barrier system and simulated thermal testing for modelling validation.

The NWMO continued to support several underground experiments at the Mont Terri Project and Grimsel Test Site in Switzerland. These projects include studies of chemistry, corrosion, microbiology, sealing system performance and groundwater behaviour in natural underground conditions.

Specialists at the NWMO contributed to international projects, including:

- The Effective Rock Mass and POST Projects (with SKB of Sweden)
- The Nuclear Energy Agency (NEA) Clay Club and Crystalline Club, including support for publication of the Catalogue of Characteristics of Argillaceous Rocks
- The NEA Integration Group for the Safety Case
- The NEA Expert Group on Operational Safety
- The NEA Forum for Stakeholder Confidence
- The DECOVALEX coupled-process modelling project

The NWMO continued to maintain its ongoing co-operation agreements with international counterparts in Belgium, France, Finland, Japan, Sweden, South Korea, Switzerland and the United Kingdom. These agreements help ensure the NWMO is considering international best practices, as well as sharing experiences as the APM project is implemented.

K.2.2.7 Transportation

Canada's spent fuel is currently safely stored on an interim basis in licensed facilities at reactor sites. These sites are located in Ontario, Quebec and New Brunswick, and at AECL's nuclear research facilities in Ontario and Manitoba. The NWMO is responsible for ensuring the transportation activities, whether by road or by rail, are conducted safely and securely.

When transportation begins, spent fuel will be transported in specially designed transportation packages certified by the CNSC to meet stringent testing and regulatory requirements.

As the spent fuel will need to be transported through communities and traditional territories to arrive at the repository, it is essential that the transportation plan reflects public priorities and concerns. While transportation is not expected to begin until the early 2040s, work is already underway to develop the transportation plan.

Figure K.11: NWMO employee talks to a visitor at the Mobile Learn More Center in Wabigoon Lake Ojibway Nation-Ignace area



The focus of the work on transportation during the reporting period has been understanding the priorities of Canadians and Indigenous peoples related to transportation planning, documenting and incorporating these into the early planning. The NWMO actively sought feedback from Canadians and Indigenous peoples through engagement sessions, panel discussions, workshops and surveys, both virtually and in person. The work also continues to be guided by the Council of Elders and Youth and a new Community-Based Transportation Working Group, established in 2021.

Based on the information gathered, a draft transportation framework in 2020 was published, summarizing the priorities that were identified and outlining a proposed approach to collaborative transportation planning. The NWMO then sought further input from people and communities about the draft framework and published the results in a *What we heard* report in 2021.

The NWMO continues to engage with First Nation and Métis communities as transportation planning advances. Applying a Reconciliation lens to this work helps to fully understand how planning can be implemented in a sustainable way that considers how to plan for the next seven generations, takes into account Indigenous priorities and is guided by Indigenous knowledge.

The NWMO's transportation planning remains a work-in-progress. The transportation framework is intended to be a dynamic document. The transportation planning documents will continue to be updated every three years to properly reflect planning priorities, questions and concerns as engagement continues with Canadians and Indigenous peoples. This is one of the ways the NWMO is committing to ensure that the planning is reflective of community values and future generations.

K.2.2.8 The CNSC's role and early involvement in the APM project for the long-term management of Canada's spent fuel

The CNSC has signed special projects arrangements (service arrangements) with the NWMO to recover the cost of work since 2009. The current arrangement has been in place since April 1, 2019, and is valid until March 31, 2025. CNSC staff conduct the following activities through this arrangement:

- provide regulatory guidance to the NWMO on APM implementation

- attend NWMO engagement activities with the general public and Indigenous Nations and communities and provide information on the regulator's role in licensing an APM facility
- conduct pre-project reviews for technical components of the APM project and provide general assessments to identify any regulatory concerns

The CNSC's early engagement in the NWMO APM activities is important to ensure that no misunderstanding arises around the role of the CNSC and its involvement prior to the submission of a licence application and the initiation of an impact assessment. There is also international consensus that the active, independent involvement of a knowledgeable and competent nuclear regulator early in the siting process increases stakeholder confidence. The pre-licensing reviews conducted under the service arrangement do not certify a concept design, do not involve issuing a licence under the NSCA and are not required as part of the licensing process for the DGR. The conclusions of a CNSC pre-licensing review do not bind or otherwise influence the decisions made by the Commission. For more information about the service arrangement, refer to the CNSC website at [Special Project Service Arrangement between CNSC and NWMO](#).

As part of this arrangement, since the last reporting period, the CNSC conducted pre-project reviews of reports that the NWMO has submitted on the design of its Mark II UFC. As well as a review of the environmental baseline program. A summary of the CNSC pre-licensing review is available at [The CNSC's early involvement in the NWMO's Adaptive Phased Management approach](#).

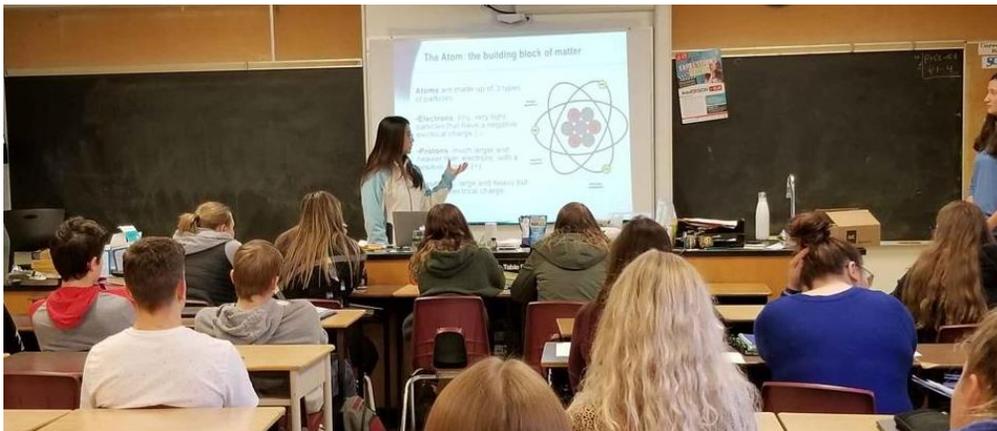
The CNSC and IAAC have a MOU in place that confirms the commitment to work collaboratively in the conduct of integrated impact assessments under the IAA. Information on the IAA is provided in section E. 2.1.5.

K.2.2.8.1 Outreach to communities

CNSC staff continue to meet with the communities that have formally entered the NWMO's siting process and it has expanded this outreach to neighbouring communities, when requested. Outreach and engagement activities have focused on relationship building with the communities/municipalities, as well as Indigenous Nations and communities. In this reporting period, CNSC staff conducted 38 outreach activities (see figures K.12 and K.13).

At the request of interested communities, additional outreach activities have been undertaken. This includes information and education sessions, which are collaboratively organized with representatives from the interested community. The intent is for CNSC staff to be present in the specific community of interest to learn more about their needs, values, concerns and areas of interest and to contribute to the CNSC's mandate to disseminate scientific, technical and regulatory information concerning the activities of the CNSC, and the effects of the environment, on the health and safety of persons, of the development, production, possession and transport and use of nuclear substance, at the CNSC's Ottawa offices (see figure K.14) or via an online platform, such as Zoom or Google Classroom.

Figure K.12: Students learn about radiation fundamentals from CNSC staff



The outreach activities are designed to provide information about the CNSC's role as Canada's nuclear regulator and to explain the organization's early role in the APM initiative. Topics addressed during the sessions include:

- the nuclear regulatory process and the factors that go into a licence application review
- the impact assessment process
- Indigenous engagement and consultation
- technical aspects of a DGR
- the CNSC's early role in the APM initiative
- opportunities for the public to get involved during Commission proceedings and impact assessments
- how the CNSC works with other regulatory bodies to fulfill its mandate when licensing nuclear facilities and activities

The intent of the meetings are to provide an opportunity for participants to ask questions and clarify issues of concern, and for the CNSC to better understand the values of the community and develop mutually beneficial, long-term relationships with those who may be impacted by a project. During these meetings, CNSC staff are interested in hearing and learning about the most effective ways to involve communities as well as Indigenous Nations, and how best to provide information to those who want to know more about the CNSC and other relevant matters within the scope of the CNSC's mandate.

Figure K.13: CNSC staff presenting to a community at the request of a community liaison committee

K.2.2.8.2 Relationship building with Indigenous Nations and communities

Building relationships with First Nation and Métis communities who may have an interest in learning more about projects such as the APM initiative is a priority for the CNSC. As building strong relationships based on trust and mutual respect takes time, the CNSC reaches out to these Nations and communities early in the pre-licensing phase for major projects such as the NWMO proposed DGR project. The CNSC has also been collaborating with the Impact Assessment Agency of Canada (IAAC) during its engagement with Indigenous Nations and communities to provide information early-on regarding the integrated assessment process for major nuclear projects, per the Federal Impact Assessment Act, including roles and responsibilities between the CNSC and IAAC during the impact assessment process.

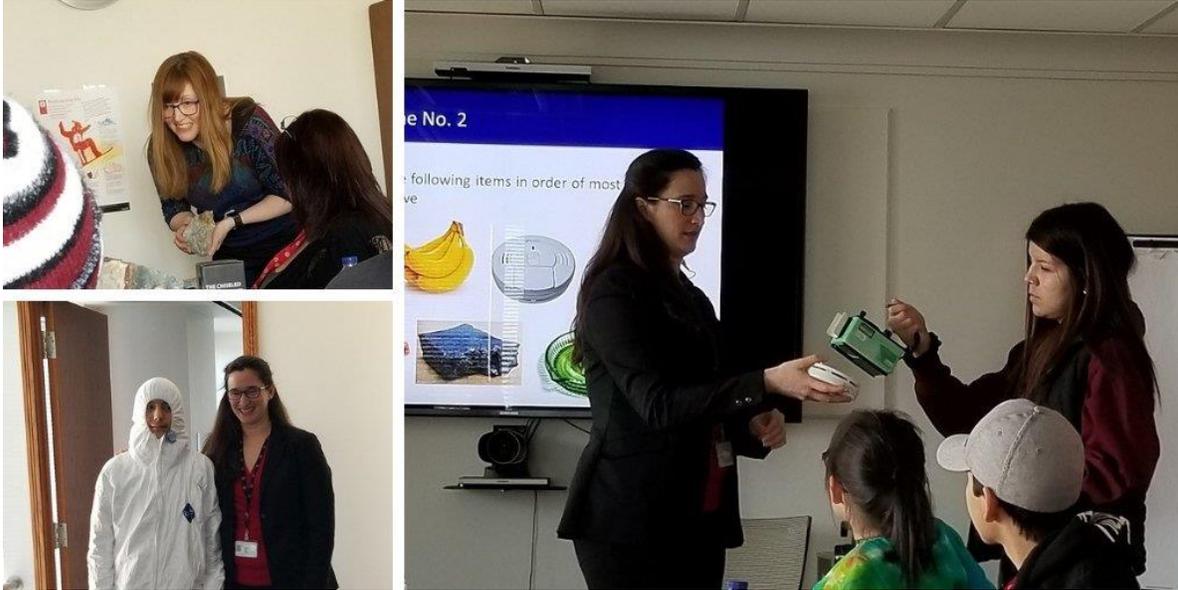
The CNSC coordinates with Indigenous Nations and communities that it engages with to organize outreach, engagement and information sharing events and activities in their communities, or locations of choice to engage community members and leadership. The CNSC is committed to informing community members early-on, before a major nuclear project starts the formal regulatory review process, about the CNSC's role as Canada's independent nuclear regulator, and to ensuring that CNSC staff are always available to meet and provide information about the CNSC and its regulatory role.

With the signing of a memorandum of understanding between NRCan and the NWMO, the NWMO is responsible for continuing its Indigenous consultation and engagement activities prior to selecting a site, maintaining a consultation log and keeping the Crown apprised of these activities during the site selection process for the NWMO's proposed DGR project. NWMO is also keeping the CNSC informed of its activities, for example, by sharing issues and concerns that are raised related to potential and existing Indigenous and treaty rights, as well as plans of upcoming consultation, engagement and outreach activities.

Potential sites for a DGR for spent fuel have been narrowed down as the NWMO's site selection process evolves. The CNSC will continue its early engagement, outreach and relationship-building activities with interested Indigenous Nations and communities activities during this time; however, greater focus will be given to working with First Nation and Métis communities who may be affected directly by the proposed project, once a specific site is selected and the regulatory process and formal consultation is initiated.

More information on the CNSC's Indigenous consultation and engagement can be found at [Indigenous engagement \(cpsc-ccsn.gc.ca\)](https://www.cpsc.gc.ca/indigenous-engagement). In addition, REGDOC-3.2.2, *Indigenous Engagement* sets out the requirements and guidance for licensees and proponents whose proposed projects may raise the Crown's duty to consult.

Figure K.14 CNSC staff meet with an Indigenous youth group at the CNSC offices



K.2.3 Development of an integrated radioactive waste management strategy for low-level and intermediate-level and non-fuel high-level waste

As a complementary step to the modernization of the Policy discussed in Section B 1.2, the NWMO was tasked by the former Minister of Natural Resources in 2020 to develop an Integrated Strategy for Radioactive Waste (ISRW) to outline a plan for the long-term management of all of Canada's radioactive wastes, in particular where disposal plans do not exist, such as for intermediate-level, non-fuel high-level and some low-level radioactive wastes. To develop the ISRW, the NWMO was directed to work with waste owners and engage with Canadians and Indigenous peoples to take stock of Canada's radioactive waste management landscape and challenges and to identify solutions for the long-term management of existing waste and future waste streams from new nuclear technologies. In particular, the NWMO was asked to provide:

- a description of the current waste management situation in Canada in terms of current and future volumes, taking into account potential small modular reactor waste, characteristics, locations and ownership of the waste
- an update on current plans and progress in advancing long-term management and disposal solutions for Canada's wastes, as well as the gaps that must be addressed
- conceptual approaches for dealing with the current and future radioactive waste inventory, including technical options for long-term management or disposal of the various waste types and options for the number of long-term waste management facilities in Canada
- considerations regarding the staging, integration, establishment and operation of long-term waste management facilities

The NWMO was also asked to ensure that the final ISRW was aligned with the modernized Policy.

Following release of the Policy in March 2023, the NWMO submitted the ISRW to the Minister of Energy and Natural Resources for review and consideration. The ISRW was informed by more than two years of engagement with Canadians, Indigenous peoples and waste generators and owners, as well as detailed studies of both technical considerations and international best practices. The final ISRW lays out two fundamental recommendations:

1. Intermediate-level waste and non-fuel high-level waste will be disposed of in a deep geological repository with implementation by the NWMO.
2. Low-level waste will be disposed of in multiple near-surface disposal facilities with implementation by waste generators and waste owners.

The ISRW also includes four principles to support the effective implementation of its recommendations. These principles are based on what Canadians and Indigenous peoples shared was most important to them through the NWMO's engagement efforts:

1. The consent of the local communities and Indigenous peoples in whose territory future facilities will be planned must be obtained through the siting process.
2. The design of facilities should prioritize the protection of water.
3. Long-term caretaking should be established for disposal facilities.
4. We need to take action now and not defer to future generations.

On October 5, 2023, the Minister of Energy and Natural Resources, the Honourable Jonathan Wilkinson, released a public statement accepting the recommendations put forward in the ISRW and outlining expectations for waste owners in implementing, maintaining and updating the ISRW. In keeping with the Policy, the public statement directs waste owners to work together to update the ISRW by 2028, in collaboration with Indigenous peoples, community partners and other involved parties, and submit their recommendations to the Minister of Energy and Natural Resources for review and consideration. It also directs waste owners to meet with Natural Resources Canada officials on an annual basis to report on their progress in implementing the ISRW.

With the ISRW in the public domain, the NWMO are working to develop a consent-based site selection plan for the DGR for intermediate-level and non-fuel high-level wastes and intend to return to the Minister Energy and Natural Resources with this plan in the coming years.

K.2.3.1 Atomic Energy of Canada Limited and Canadian Nuclear Laboratories

Since the Seventh Review Meeting, significant progress has been made in developing and implementing long-term solutions for L&ILW at AECL sites, which will address more than half of Canada's inventory of these waste types. In addition to the long-term management facilities that have been constructed at Port Hope, and constructed, filled and capped at Port Granby for the forecasted approximately 2.8 million m³ of historic LLW associated with the PHAI (see section K.2.1.5 for more details), CNL in January 2024 received regulatory approval to permit construction of a NSDF at CRL with a total capacity up to 1 million m³ for LLW (see section K.2.1.2 for more details). This proposed facility is expected to be operational by 2030.

The Commission's decision has been challenged and, as provided for under the NSCA, is undergoing judicial review by the Federal Court.

The vast majority of wastes (around 90 percent) destined for the NSDF are either already in storage at CRL or will be generated from the decommissioning of redundant facilities or future operations at CRL. The NSDF would also receive small amounts of radioactive wastes from Canadian hospitals, universities, research entities and industry clients, which is consistent with existing commercial arrangements that have been in effect for decades.

K.2.3.2 Ontario Power Generation

As outlined in the ISRW, low-level waste will be disposed of in near surface disposal facilities with implementation by waste generators and waste owners. OPG is starting the Low-Level Waste Initiative (LLWI) in 2024 with a learning phase as part of a province-wide opt-in process to seek willing host(s). In the learning phase, OPG is first engaging with Indigenous Nations and communities, taking a respectful approach through two-way dialogue, listening, learning, and sharing to build a plan together for a Low-Level Waste Disposal Facility (LLWDF).

K.2.3.3 Hydro-Québec

Hydro-Québec produced a waste management strategy for decommissioning in 2016. Waste was quantified and possible disposal options were documented. Hydro-Québec is currently working on reducing these volumes to avoid filling the on-site waste storage facilities and to minimize the L&ILW to be handled later on.

In terms of long-term waste management, Hydro-Québec is continuing its discussions with industry partners. Hydro-Québec does not foresee developing its own waste site; rather, it expects to become a partner in developing a site for the final disposal of its LLW.

K.2.3.4 New Brunswick Power

NB Power has engaged and continues to engage with industry to understand options for the disposal of L&ILW and to ensure appropriate funds are available when required, including participating in the COG peer groups and supporting joint projects.

K.2.4 Seventh Review Meeting Suggestions for Canada

K.2.4.1 Canada waste policy

In September 2019, the CNSC hosted an IAEA IRRS mission to Canada. The IRRS Mission resulted in a recommendation that Canada should enhance the existing policy and establish the associated strategy to give effect to the principles stated in the Canadian Radioactive Waste Management Policy Framework. Canada's response was that Natural Resources Canada will review its existing policy for radioactive waste and consider how it may be enhanced to give effect to the principles stated in the *Radioactive Waste Policy Framework (1996)*, including the establishment of an associated strategy. Refer to section B.1.2 for information on the Government of Canada's modernized Policy for Radioactive Waste Management and Decommissioning, released in March 2023, which establishes the roles and responsibilities of the Government of Canada, and of the waste generators and owners, and replaces the former policy framework.

K.2.4.2. Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) Mission

Canada received a suggestion at the Seventh Review Meeting to host an Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) mission. Canada recognizes the importance of international peer reviews and is committed to regulatory excellence in waste management and decommissioning. Following the 2019 full scope IRRS mission, which had a focus on waste management, the Government of Canada published a modernized Policy for Radioactive Waste Management and Decommissioning in March 2023, and ISRW in June 2023. During the IRRS follow-up mission to Canada in 2024, the international experts concluded that Canada implemented the recommendation and suggestion on waste management. Moving forward, Canada will continue to advance improvement initiatives, including the continued implementation of the modernized policy and strategy on radioactive waste. As a continued demonstration of Canada's commitment to international peer reviews, Canada will request, at an appropriate time, an ARTEMIS mission.

Refer to section K.5.1 for information on the IRRS mission.

K.3 Overarching issues from the Seventh Review Meeting

During the Seventh Review Meeting, overarching issues were identified as a result of the cumulative discussion within the country groups. The Contracting Parties agreed that the following issues would be addressed within national reports highlighting the measures that have been taken to implement these issues:

1. Competence and staffing linked to timetable for spent fuel management and radioactive waste management programmes (K.3.1)
2. Ageing management of packages and facilities for radioactive waste and spent fuel, considering extended storage periods (K.3.2)
3. Long-term management of disused sealed sources including sustainable options for regional as well as multinational solutions (K.3.3)
4. Inclusive public engagement on radioactive waste management and on spent fuel management programmes (K.3.4)

K.3.1 Competence and staffing linked to timetable for spent fuel management and radioactive waste management programmes

Staffing for anticipated changes to Canada's spent fuel management and radioactive waste management landscape is an important consideration, among other human resource strategies, for both the regulator and industry. An overall perspective on the CNSC's approach to workforce planning and competency management is captured under section E.3.1.5. The CNSC has best practices and resourcing strategies in place to identify talent and workforce management requirements, which are utilized to address talent needs related to spent fuel management and radioactive waste management programmes. Specific to spent fuel disposal staffing since the Seventh Joint Convention, the CNSC has established a Major Projects and Strategic Support Division that will focus on DGR regulatory support among other items of interest.

The CNSC also implemented an integrated resourcing strategy. The CNSC's readiness to regulate required an integrated resourcing strategy that included identifying the necessary competencies and capabilities, leveraging internal talent, and plans to recruit new and expert skills by advertising a collective processes. By redistributing ready now talent while recruiting new talent as needed to fill talent gaps, the CNSC was able to quickly reallocate resources where they were required first and supported employee career development and progression.

Industry staffing and efforts to maintain readiness to regulate are captured Section F 2.1.

K 3.2 Aging management of packages and facilities for radioactive waste and spent fuel, considering extended storage periods

Until there is an approved disposal option, spent fuel and radioactive waste will continue to be safely managed/stored in interim storage facilities licensed by the CNSC. Under REGDOC-2.11.1 Waste Management Volume I, *Management of Radioactive Waste*, licensees are required to establish aging management plans to provide for the timely detection and mitigation of aging effects to ensure integrity and functional capacity of the SSCs throughout all stages of the facility's lifecycle.

Licensees are required to manage the aging of structure, system and component (SSC) in accordance with REGDOC-2.6.3, *Aging Management*. This regulatory document sets out the requirements to provide assurance that both physical aging and obsolescence of SSCs are understood and managed effectively and proactively at each stage of the lifecycle of a facility and its SSCs. It also sets out requirements for establishment, implementation, and continuous improvement of aging management programs through application of a systematic approach; this approach provides an integrated framework for coordinating all supporting programs and activities associated with the understanding, control, monitoring and mitigation of aging effects at the facility. It requires establishing and implementing SSC-specific or mechanistic-based aging management plans in accordance with this integrated framework.

Licensees are also required to implement and maintain a safety analysis program. The safety analysis report is to confirm that the consequences of a range of events are acceptable. It includes an integrated assessment of the facility to demonstrate, among other things, adequate safety for external events such as fires, floods, and tornados, and adequate protective features to ensure the effects of an event do not impair safety related systems, structures, and components (SSCs). Licensees are required to continue to demonstrate and validate the safety case. This includes periodic updates to the safety report and continued aging management program to assess the structural integrity of the SSCs at their waste management facility.

Licensees establish and implement integrated aging management programs for safety-related structures based on REGDOC-2.6.3, *Aging Management*. Aging management plans integrate various routine monitoring, inspection, and testing programs to assess each structure's overall condition and to provide basis for the corrective actions, such as repairs or replacements. These requirements are complemented by CSA standard N292.0, *General principles for the management of radioactive waste and irradiated fuel*, provides requirements for an aging management program. An aging management program shall be established to assess and mitigate service-life limiting characteristics of safety critical components with the purpose of assuring that waste packages are maintained and contained in a safe, stable, secure, controlled and monitored environment (clause 4.16.1). The aging management program must demonstrate that SSCs susceptible to aging degradation or effects have been evaluated for the proposed period of operation, the effects will continue to be identified and managed during the planned period of operation, and that the safety analyses involving time-limited assumptions are validated for the planned period of operation to ensure that the effects are effectively managed (clause 4.16.4).

For nuclear-related SSCs identified by licensee's, licensee's are required to establish inspection, testing and maintenance programs to ensure continued safe operation of the facility. Aging management for safety-related structures should apply a systematic and integrated approach to establish, implement, and improve programs to manage aging and obsolescence of SSCs. The life cycle management plans should include structured, forward-looking inspection and maintenance schedules, requirements to monitor and trend aging effects and any preventative actions necessary to minimize and control aging degradation of the SSCs.

Where required as part of a licence condition or as part of their licensing basis, licensees are required to submit the inspection results and their evaluations resulting from the in-service inspections and aging of waste packages to the CNSC as part of annual reporting. Aging management is also considered while assessing compliance during inspections carried out by CNSC staff at licensee facilities to ensure relevant plans and/or licence conditions are being followed.

In Canada, all dry storage modules are within their current design life of 50 years. This service life is achieved through ongoing monitoring programs and regular inspection and maintenance of the structures or containers.

K 3.2.1 Ontario Power Generation

The design life of Ontario Power Generation's (OPG) used fuel storage facilities are maintained through a program of planned monitoring, maintenance, component replacement and testing, as required. OPG dry storage containers (DSCs) are designed to provide a storage life of at least 50 years and to meet all shielding and containment integrity requirements over this period. The fuel can be repackaged into new DSCs, should it be required. The design life of OPG's used fuel dry storage containers is assured and assessed via an aging management program. OPG conducts periodic inspections of the DSCs to ensure their structural integrity. OPG's aging management program for the DSCs focuses on monitoring 6 failure areas:

- Lid-to-base closure weld.
- The flanges adjacent to the lid-to-base closure weld.
- Container base plate and outer shell.
- External drain and vent (if applicable) seal welds.

- Inner liner, vent tube (if applicable) and drain tube.
- Corrosion of components embedded in concrete

To accomplish this, OPG

- checks at least 20% of all DSCs through annual visual inspections.
- conducts DSC base (Underside) inspection on a set of baseline DSCs
- conducts re-inspection of indications in the base plate parent material of select DSCs
- collects Chloride samples on and arounds DSCs to determine if they should anticipate accelerated corrosion
- completed a corrosion monitoring study of a specially designed DSC which concluded in 2016

Currently, there are no indications of premature aging of the OPG DSCs. Previously completed condition assessments found no failure mechanisms that would lead to failure of the DSCs within 100 years. Extension beyond the intended storage life of the DSCs beyond 50 years, would require an updated condition assessment of the DSCs. An updated condition assessment is in progress, which will take into account Operating Experience (OPEX) and aging management results gathered since the last condition assessment. Results of the updated condition assessment will be incorporated into the aging management program as required.

The design life of OPG's low-and-intermediate level storage facilities are maintained through a program of planned monitoring, maintenance, component replacement and testing, as required. OPG conducts periodic visual inspections on in-ground storage structures and more detailed inspections and condition assessments on a longer period, as outlined in the aging management plan. Regular groundwater monitoring and radiation monitoring are also used to monitor for early warning of degradation and inform condition assessments. Systems, structures and components are repaired or replaced as identified through the aging management program.

K.3.2.2 Hydro-Québec:

Hydro-Québec currently has 11 different dry storage modules that were built and commissioned between 1995 and 2017. The current design life of a MACSTOR-200 module is 50 years, but could be extended up to a 100-year period under a performance-based aging management program, and adequate monitoring, maintenance and component replacement activities. While a specific inspection of every module is performed twice a year under the aging management program, a sampling of the inner air of each sealed cylinder is also performed once a year as a radiological surveillance indicating that the first two safety barriers are valid and operational, in compliance with Hydro-Québec's safety report.

K.3.3 Long-term management and disposal of disused sealed radioactive sources

The CNSC uses a risk-informed approach for the regulatory oversight of all sealed sources throughout their life cycle to protect the health, safety, security of people and of the environment. Since the Seventh Review Meeting, Canada has published an internal document, the *CNSC Policy and Strategy on Meeting the IAEA Guidance on the Management of Disused Radioactive Sources* (the Guidance), which describes the CNSC's policy and strategy on meeting the Guidance and demonstrates the CNSC's long-term commitment to the safe and secure management of sealed sources when they are no longer in active use. It also demonstrates the alignment of the CNSC's regulatory oversight of all sealed sources in Canada with the Guidance.

Currently, when a licensee decides they want to dispose of a sealed source, the source is transferred to a licensed WMF for interim storage. The CNSC has implemented the Sealed Source Tracking System (SSTS) and the National Sealed Source Registry (NSSR) as components its efforts in implementing the IAEA's *Code of Conduct on the Safety and Security of Radioactive Sources*. See Section J 1.3.3 for more information.

CNL has repatriated disused sources that are of Canadian origin, specifically sources or equipment that were sold under the previous iteration of AECL prior to the GoCo transition of 2015, and that were used in a country that currently has no means of appropriate disused source management. At CNL-managed sites, disused sources, once designated a radioactive waste, are treated the same as other radioactive wastes in terms of strategy, and they are currently in storage commensurate with the activity and half-lives of the radionuclides, awaiting the availability of a suitable disposal facility. CNL's Integrated Waste Strategy, which encompasses all waste generated by CNL and/or received by CNL, has been updated since the Seventh Review Meeting, is currently being implemented, and is regularly reviewed and kept up to date.

See Section K2.3 for information on the ISRW as it pertains to the disposal of ILW and non-fuel HLW, and LLW, which is inclusive of waste from disused sealed sources J 1.3.2. Disposal of radioactive sealed sources in Canada, also includes additional information.

K.3.4 Inclusive public engagement on radioactive waste management and on spent fuel management programmes

K.3.4.1 Inclusive public engagement at CNSC

Disseminating technical, scientific and regulatory information related to nuclear activities is part of the CNSC's mandate. Outreach activities are meant to demystify nuclear science, describe the CNSC's role as Canada's nuclear regulator and bring a "CNSC face" into communities across the country. Outreach activities are also meant to bring openness, transparency and timely communication to the work and management of Canada's nuclear regulatory regime.

The CNSC has a mandate to be an unbiased scientific expert in the nuclear field, and has a duty to take part in outreach and engagement activities and events. The organization also strives to involve stakeholders, the public and Indigenous Nations and communities in the regulatory process through a variety of consultation, engagement and outreach opportunities.

The CNSC has an established forum with Canadian Environmental Non-Government Organizations (ENGOS). The objective of the Forum is to exchange information on issues of mutual interest, such as radioactive waste management, independently of formal regulatory proceedings and comment periods. It also provides an opportunity for collaboration between CNSC staff and ENGOS to improve the functionality, accountability and effectiveness of the regulator.

The CNSC plays an important role in the communication of regulatory requirements to the nuclear industry, the public and Indigenous Nations and communities. The CNSC has been reviewing and revising the CNSC website content and other public-facing communications materials since early 2022. This work will result in revisions of the CNSC's webpages to make them more user friendly, accessible, and transparent; and the creation of radioactive waste YouTube videos.

Section E.2.3 provides more information on engagement in the licensing process.

For information on requirements for public information programs, see section G.3.1.

For information on outreach activities and relationship building specific to APM, see sections K.2.2.8.1 and K.2.2.8.2.

Figure K.15: Students learn about radiation from CNSC staff



K.3.4.1.1 Indigenous engagement and consultation

In Canada, Indigenous peoples are culturally and legally distinct from other, non-Indigenous, publics. Indigenous peoples in Canada have Indigenous Rights identified in and protected by Canada's constitution and Treaty rights, established through treaties between the Crown and Indigenous Nations. Over time, these rights have been clarified by Canadian courts.

The CNSC is an agent of the Crown and is relied on to discharge the duty to consult, and where appropriate, accommodate Indigenous Nations and communities. In order to ensure that this responsibility is met, Indigenous consultation with rights-holders is conducted in a manner distinct from consultation or engagement with the public. While Indigenous Nations and communities are treated distinctly for engagement and consultation purposes, the requirements set out in REGDOC-3.2.1 for public information and disclosure programs by a licence-holder include Indigenous Nations and communities.

As an agent of the Crown, the CNSC is responsible for fulfilling its legal duty to consult, and where appropriate, accommodate Indigenous peoples when its decisions may have an adverse impact on potential or established Indigenous and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*. Consultation with Indigenous Nations and communities is a formal process undertaken for specific projects that have the potential to impact potential or established Indigenous or treaty rights to fulfill the Crown's legal duty to consult and, where appropriate, accommodate. Consultation involves a meaningful process with potentially impacted Indigenous Nations and communities to identify, assess and address potential impacts to Indigenous or treaty rights and is a legal obligation. The CNSC's approach to Indigenous consultation includes commitments to uphold the honour of the Crown by sharing information, building relationships, promoting reconciliation and meeting its common-law duty to consult. The CNSC supports a coordinated, whole-of-government approach to consultation and engagement to improve the efficiency and effectiveness of the consultation process.

The CNSC cannot delegate its obligation, but it can assign procedural aspects of the consultation process to licensees and proponents, where appropriate. In many cases, licensees are best positioned to collect information and propose any appropriate additional measures. The information collected and measures proposed by licensees and proponents to avoid, mitigate or offset adverse impacts may be used by the CNSC in meeting its consultation obligations and advancing in its reconciliation efforts with Indigenous Nations and communities.

In addition, to date, the CNSC has signed terms of reference for long-term relationships and engagement with 10 Indigenous Nations and communities, in addition to terms of references for consultation on environmental assessments for specific projects. The CNSC currently actively engages with 52 Indigenous Nations and organizations that represent over Indigenous communities in 9 regions across Canada in relation to ongoing regulatory oversight of the nuclear sector. The CNSC is supporting Indigenous capacity through the new Indigenous and Stakeholder Capacity Fund.

Engagement emphasizes ongoing collaboration, information sharing, addressing concerns, capacity building and working together through common priorities and initiatives. The following are some of the engagement activities the CNSC is undertaking:

- long-term relationship arrangements
- regular engagement sessions and discussions
- host and participate in workshops
- walk the land with communities
- participate in community events (as shown in figure K.16)
- collaborate on monitoring activities
- develop terms of reference for long-term engagement and workplans
- track and respond to issues and concerns

The CNSC considers requests by Indigenous Nations and communities to observe CNSC inspections at a licensed site on a case-by-case basis. While no program exists for regular, ongoing observation of CNSC inspections by Indigenous Nations and communities, this type of engagement may be considered with an Indigenous Nation or community that has a mature relationship with the CNSC and a history of a direct interest in a site related to an Aboriginal or treaty right. Observing an inspection can help increase understanding, transparency and trust in the CNSC's robust regulatory oversight and compliance programs.

Further information on the CNSC's approach to Indigenous consultation and engagement can be found in REGDOC-3.2.2, *Indigenous Engagement*.

Figure K.16: CNSC staff at a First Nation cultural camp



The CNSC's Independent Environmental Monitoring Program (IEMP), highlighted in section F.4.6.5, is an independent from licensee, technical environmental sampling program in publicly accessible areas around nuclear facilities. The objective of the IEMP is to build trust in the CNSC's regulation of the nuclear industry via an independent, technical and accessible environmental sampling program around nuclear facilities. The IEMP encourages Indigenous Nations and communities and the public's participation and involvement, but it is not a community-based monitoring program. The level of involvement in sampling campaigns ranges from opportunities to observe sampling, learn more about each site and build relationships while working in the field, to assisting with sampling and even harvesting local foods as shown in Figure K.17.

Figure K.17 IEMP harvesting clams from the beach near Point Lepreau NGS



CNSC staff have worked collaboratively with Indigenous Nations and communities to develop results cards to communicate the result of IEMP sampling. Results cards are shared with local communities and brought to various outreach events. Figure K.18 is an example results card that was developed collaboratively.

Figure K.18 IEMP results card shared at outreach events

Samples Were Taken in Your Community

Sampled area: **Point Lepreau**

Results: **Safe**

What do the results tell us?

The results from our Independent Environmental Monitoring Program (IEMP) support our assessment that the environmental protection program put in place by NB Power is effective. Our results add to the body of evidence that the public and environment around licensed nuclear facilities are protected.

Federal and provincial authorities set safe levels for hazardous substances and radionuclides released by a nuclear facility, such as Point Lepreau Nuclear Generating Site.

At Point Lepreau Nuclear Generating Site, NB Power operates one 705 megawatt CANDU reactor and the Solid Radioactive Waste Management Facility.

The program takes samples in public areas around the facility.

What did we test for?

Radionuclides
Tritium
Cesium-137
Organically Bound Tritium

What did we sample?

We tested the following items around the Point Lepreau Nuclear Generating Site to make sure there is no impact on health or the environment.

Category	Locations
Water	Saint Andrews, Dipper Harbour, Welch Cove, Duck Cove
Vegetation	Mixed Grass, Cedar, Lichen, Sweetgrass, Labrador Tea, Sphagnum Moss
Soil	Saint Andrews, Welch Cove, Duck Cove, Fundy Shore School, Dipper Harbour
Sand	Saint Andrews, Welch Cove, Duck Cove
Plants & food	Dulse, Zucchini, Carrots, Tomatoes, Beet Greens, Beans, Shellfish
Air	Fundy Shore School, Duck Cove, Dipper Harbour

Sweetgrass sampling with the WNNB

To learn more: www.nuclearsafety.gc.ca/IEMP

Canadian Nuclear Safety Commission / Commission canadienne de sûreté nucléaire

Canada

K.3.4.2 Inclusive public engagement at Natural Resources Canada (NRCan)

Engagement with interested Canadians on modernizing Canada's radioactive waste policy took place virtually from 2020 to 2023 through various online forums and activities, and by telephone. The engagement approach was designed to help ensure public safety during the COVID-19 pandemic. Engagement activities were led by Natural Resources Canada (NRCan) with the support of federal departments that have responsibilities for radioactive waste in Canada. The avenues of engagement were:

- an online engagement and policy modernization website featuring discussion papers on key topics, including waste minimization, waste storage facilities, decommissioning and waste disposal, and an open forum available to all Canadians to suggest ideas and discuss topics.
- written submissions from individuals and organizations-NRCan received over 600 written submissions and 70 online forum posts.
- a series of over 150 meetings and virtual engagement sessions, including 24 round tables, with participants from organizations such as environmental and public interest groups, interested citizens, Indigenous peoples, the industry sector, other levels of government, youth, and academics.

In addition, an Indigenous Participant Funding Program was launched in spring 2021 to support respectful, meaningful two-way dialogue and engagement throughout the policy review. The funding program, which was concluded in fall 2022, supported in-depth engagement with nine Indigenous groups, including written submissions to inform policy development and provide input on the draft Policy.

This final Policy is the result of more than two years of extensive and active engagement with Indigenous peoples, interested Canadians, experts, waste generators and owners, and other levels of government. In February 2022, the Government of Canada shared the draft Policy for public comment and incorporated feedback in finalizing the modernized Policy for Radioactive Waste Management and Decommissioning, which was released in March 2023.

The policy sets out that the federal government is committed to inclusive engagement, openness, and transparency on radioactive waste management and decommissioning with Indigenous peoples, provinces, territories, interested communities, including current and prospective host communities, scientific experts, waste generators and owners, and other interested persons in Canada. It includes measures that support an integrated strategy for Canada's radioactive waste and the importance of considering future generations when making decisions. Moreover, it includes measures for openness, transparency and inclusive public engagement by waste generators and owners with respect to advancing radioactive waste projects and the integrated strategy.

The modernized Policy also affirms Canada's commitment towards building partnerships and advancing reconciliation with Indigenous peoples and elaborates on the role of federal government and waste owners/producers in early and on-going engagement, recognizing Indigenous knowledge and Indigenous stewardship and capacity building. This includes a recognition by the federal government that meaningful engagement, which aims to secure free, prior and informed consent, provides opportunities to build trust and beneficial and respectful relationships with Indigenous peoples. In addition, the policy acknowledges that some wastes may have been stored in Indigenous traditional and treaty territories without prior engagement or consultation and recognizes the importance of the federal government working with affected Indigenous peoples, in the spirit of reconciliation, to find a path forward to address these past issues. Stemming from the Policy, Natural Resources Canada has continued an open dialogue with interested Indigenous Nations and communities regarding these issues and possible solutions.

Further information on the Policy can be found in section B.1.2.

K.3.4.3 Inclusive public engagement at Ontario Power Generation

Ontario Power Generation Indigenous Engagement on Spent Fuel and Radioactive Waste Management

Ontario Power Generation (OPG) is committed to building and growing long-term, mutually beneficial working relationships with Indigenous Nations and communities near current and future operations.

OPG respectfully acknowledges that the lands on which its generating stations and other assets, including waste management facilities, are located are within the traditional and treaty territory of many Indigenous Nations and communities. OPG is committed to taking concrete and measurable actions to advance reconciliation with Indigenous peoples and to regularly reporting on the company's activities and progress in achieving established goals.

In 2021, OPG launched the Reconciliation Action Plan (RAP), which serves as the roadmap for how OPG continues to engage and work with Indigenous communities, businesses, and organizations to advance reconciliation. The RAP includes the following overall goals with supporting actions:

1. Commit to reconciliation as a journey and track progress on accountability with metrics and targets around commitments.
2. Build positive and mutually beneficial relationships with Indigenous Nations and communities and peoples based on respect and understanding.
3. Create an engaged and inclusive workforce that reflects the broad diversity of Indigenous Nations and communities and peoples across our company.

4. Advance economic reconciliation with Indigenous communities and businesses through meaningful engagement, collaboration and partnership.
5. Be a trusted partner in environmental stewardship and an ally in addressing climate change.

Annually, OPG publishes a report providing updates on the actions taken under the RAP. OPG has completed the goals set forth for 2023 and published a refresh of the RAP in 2024 to push forward toward new actions and targets. The Nuclear Sustainability Services (NSS) division of OPG, responsible for interim storage of spent fuel and radioactive waste, is an active participant in the RAP actions. This includes, but is not limited to, increasing Indigenous procurement, and contributing to the goal of achieving target spends in 2022 and 2023. RAP Annual Reports can be found on the OPG website (www.opg.com/about-us/our-commitments/indigenous-relations/reconciliation-action-plan/).

OPG regularly shares information to treaty-rights holders for the lands on which OPG's radioactive waste and spent fuel facilities reside, including potential changes to operations and projects. Participation, engagement, and consultation is enabled through capacity agreements and framework agreements with interested Indigenous Nations and communities in these areas.

OPG public engagement on spent fuel and radioactive waste management

At OPG, the response to the CNSC's REGDOC-3.2.1 is the Nuclear Public Information and Disclosure Protocol. This standard provides requirements for OPG to ensure effective and timely external communications to the public regarding waste operations, health and safety, and security and environment. Transparent and effective public communications is OPG's social license to operate within host communities and works in tandem with OPG's operating licenses.

Inclusive public engagement actions include:

- open, transparent and effective communications to stakeholders and the public, utilizing inclusive communication strategies
- target audiences
- public information strategies and products
 - Public Information Disclosure and Transparency Protocol
 - Regulatory and Public Disclosure of Significant Events and Reports
- public and media opinion
- tours provided to the public of all of OPG's waste management facilities
- communications received from Stakeholders and the Public
- high level of communication standards

This protocol is utilized to ensure there is clear, transparent and effective public communication pertaining to waste management operations throughout communities local to each waste facility.

Nuclear projects are an important pillar of OPG's mission to "build a sustainable future powered by our electricity, ideas and people", as demonstrated by announcements of future investment (such as the potential refurbishment of Pickering Units 5-8 and four small module reactor units for Darlington New Nuclear Project). OPG is prepared to engage with the public on the topic of spent fuel and radioactive waste facilities in support of these projects. The OPG WMFs maintain an open invitation for tours, conversation, and presentations. By touring the public through the waste facilities, OPG can demonstrate the techniques used to prevent waste before it is created, manage the waste in their care and harness waste and by-products to make nuclear power useful beyond just generation.

K.4 International cooperation

To fulfill Canada's international obligations, the CNSC collaborates with Global Affairs Canada and various agencies, such as its counterparts in other countries, to ensure that nuclear cooperation is consistent with the terms of international agreements and the non-proliferation regime.

The CNSC's cooperation and involvement with international nuclear organizations extends to the IAEA and the OECD-NEA. The CNSC's participation in these organizations helps to promote the implementation of the highest standard for nuclear safety, security and safeguards around the world. The CNSC's role is also to evaluate international recommendations, standards and guides for adoption into the CNSC's regulatory framework.

Refer to the Seventh Canadian National Report for the Joint Convention for information on Canada's international collaboration efforts related to the Treaty on the Non-Proliferation of Nuclear Weapons, Incident and Trafficking Database, and CNSC international collaboration on DGRs.

K.4.1 International Internal Audit Collaboration Working Group

The Institute of Internal Auditors (IIA) is an international professional association. The IIA is the internal audit profession's leader in standards, certification, education, research, and technical guidance throughout the world. Generally, members work in internal auditing, risk management, governance, internal control, information technology audit, education, and security. Globally, the IIA has more than 245,000 members. The mission of the IIA is to provide dynamic leadership for the global profession of internal auditing. Activities in support of this mission will include bringing together internal auditors from all countries to share information and experiences.

In 2020, the internal audit functions at both the Canadian Nuclear Safety Commission (CNSC) and the Federal Authority for Nuclear Regulation (FANR) established an International Internal Audit Collaboration Working Group (IIACWG) for nuclear regulatory bodies. This collaboration has allowed the two organizations to strengthen aspects of their respective mandates by sharing best practices and knowledge with regards to both internal audit functions and technical functions. This sharing of experiences enriches practices for both organizations.

In 2023, collaborative efforts increased, resulting in the group's first white paper on auditing an inspection process. The white paper provides high-level guidance in the form of a methodology and audit program for Internal Audit Functions of nuclear regulatory bodies to audit the inspection process for nuclear power plants, radioactive waste management and storage facilities and regulated materials licensees (radioactive and nuclear material users). The audit approach outlined aligns with the global recognizable Institute Internal Audit Standards. The IIACWG will be used to share best practices with the Internal Audit Functions of nuclear regulatory bodies and to solicit interest in expanding the membership.

K.5 International peer reviews

Canada has hosted international peer reviews that have covered spent fuel and radioactive WMFs and will continue to identify opportunities for future reviews. Canada continues to support international peer reviews including both IRRS and ARTEMIS missions by providing Canadian experts to lead and participate in the missions.

K.5.1 Integrated Regulatory Review Service

In September 2019, the CNSC hosted an IAEA Integrated Regulatory Review Service (IRRS) mission to Canada. The objective of an IRRS mission is to evaluate a Member State's regulatory infrastructure for safety against IAEA safety standards. An IRRS mission results in findings, which include recommendations and suggestions for improvement as well as good practices.

The scope of the 2019 mission included all activities and facilities licensed by the CNSC, including the regulation of WMFs. The only exceptions were emergency preparedness and response (module 10), as this was covered by the EPREV mission also held in 2019, and medical exposure, which falls under provincial and territorial jurisdiction in Canada.

The 2019 IRRS mission confirmed that the CNSC has a strong regulatory framework and continues to ensure the safe operation of nuclear facilities in Canada. The mission to Canada provided valuable insights for the CNSC and the other participating parties. Along with a number of good practices, the CNSC and other Canadian federal departments were presented with suggestions and recommendations to further improve Canada's oversight of the nuclear industry, including the CNSC's regulatory framework (see section K.2.1 on modernizing the waste and decommissioning regulatory framework). Most of the findings are directly related to how Canada regulates the use of nuclear energy and materials to protect the health, safety and security of Canadians and to protect the environment, which fall within the CNSC's mandate. However, a few elements highlighted in the findings are not under the CNSC's purview; they come under the oversight of other Canadian federal departments. These other departments include NRCAN, which is the lead department responsible for developing and implementing federal nuclear energy policy, and Health Canada, which is responsible for promoting and protecting Canadians' health from the risks posed by exposure to natural and man-made sources of ionizing radiation in living, working and recreational environments.

The IAEA IRRS Final Report to Canada can be found at:

https://www.iaea.org/sites/default/files/documents/review-missions/irrs_canada_2019_final_report.pdf.

The CNSC developed an action plan to address the findings of the 2019 IRRS mission. On February 18, 2020, the CNSC publicly shared Canada's response to each recommendation, suggestion and good practice. Measures include developing and updating some CNSC regulatory documents, and having NRCAN review its existing policy for radioactive waste and consider ways to enhance it, to give effect to the principles stated in the Radioactive Waste Policy Framework, which include establishing an associated strategy. The action plan can be found at: <http://www.nuclearsafety.gc.ca/eng/resources/international-cooperation/irrs/canada-response-irrs-2019.cfm>.

The actions listed in Canada's response to the 2019 IRRS report show Canada's commitment to addressing the findings of the 2019 IRRS mission. These actions will be the measures used to determine whether recommendations and suggestions have been fully addressed prior to the IRRS follow-up mission.

The CNSC continues sharing progress on continuous improvement initiatives that result from the 2019 IRRS mission in an open and transparent manner. In keeping with international best practice, the CNSC requested a follow-up mission to Canada on November 28, 2022, to evaluate Canada's progress in addressing the review team's findings and recommended improvements.

On October 19, 2023, Canada hosted an IAEA Preparatory Meeting for the IRRS follow-up mission to Canada. The objective of the meeting was to demonstrate Canada's readiness to host the follow-up mission based on the progress made on addressing the 2019 IRRS Recommendations and Suggestions. The meeting resulted in the signing of the Terms of Reference for the mission that was carried out from June 3 to 10, 2024, at CNSC headquarters. During this IRRS follow-up mission to Canada, Canada shared its progress and updates on how it addressed the suggestion and recommendation on waste and decommissioning as follows:

- REGDOC 2.11.2, *Decommissioning*, prescribes that in-situ decommissioning may only be considered in exceptional circumstances or in the case of legacy sites. Furthermore, the REGDOC recognises that in cases where the end state for of in-situ decommissioning entails the establishment of a waste disposal facility with the demonstration of compliance with all requirements for a waste disposal facility.
- Publication of Canada's Policy for Radioactive Waste Management and Decommissioning in March 2023 (see section K.2.4.1) as well as the Integrated Strategy for Radioactive Waste in June 2023 (see section K.2.3).

K.5.2 Emergency Preparedness Review and Follow-Up Mission

From June 3 to 13, 2019, the IAEA carried out an EPREV at the request of the Government of Canada, making Canada the first G7 country to request an EPREV mission and highlighting its commitment to protecting the health and safety of Canadians. This mission focused on preparedness for emergencies originating from events at Emergency Preparedness Category I facilities, as defined in *IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency*, which includes emergencies taking place at NPPs, irrespective of their initiating events.

After receiving the final report on February 19, 2020, Canada developed an action plan in response to the findings and acknowledged all good practices, suggestions and recommendations given by the EPREV review team. The action plan was a key reference for the follow-up mission which consisted of reviewing the results of the action plan and associated future plans against IAEA Safety Standards of preparedness and response for a nuclear or radiological emergency.

The EPREV follow-up mission to Canada was conducted from June 26-30, 2023, which consisted of five international EPR experts and a team coordinator from the IAEA. The IAEA review team reviewed reference materials and interviewed Canadian participants, which included government officials, representatives of response organizations at all levels, and staff of Ontario Power Generation and New Brunswick Power.

The IAEA review team concluded that all the recommendations and suggestions formulated in 2019 are closed, either based on completed actions, progress made and confidence in effective completion, or on the basis that it is no longer relevant. In addition, two new best practices were highlighted:

- Health Canada, with contributions from the CNSC, Natural Resources Canada, Public Safety Canada and the Department of National Defence, published the *Guidance on Planning for Recovery Following a Nuclear or Radiological Emergency* in December 2020. This document provides guidance for the planning and execution of off-site recovery operations following a nuclear or radiological emergency and provides recommendations on best practices for recovery operations including the characterization, classification and management of off-site radioactive waste arising from nuclear emergencies.
- Incorporating nuclear emergency exercises as part of the National Priority Exercise series was identified as a best practice to ensure participation from senior management in the FPT RN exercise strategy's full-scale priority exercises.

The EPREV follow-up mission final report is available on the CNSC and IAEA websites at www.iaea.org/sites/default/files/documents/review-missions/report_eprev_followup_canada_2023.pdf

K.5.3 International Physical Protection Advisory Service

In October 2015, Canada hosted an IAEA International Physical Protection Advisory Service (IPPAS) mission. The mission to Canada was highly successful and the IAEA team noted in their final report that Canada has a “mature and robust nuclear security regime.” For information on the 2015 IPPAS, refer to the Seventh Canadian National Report for the Joint Convention.

K.5.4 Country Specific Safety Culture Forum

The Country-Specific Safety Culture Forum (CSSCF) is a programme established by the OECD Nuclear Energy Agency (NEA) and the World Association of Nuclear Operators (WANO) to provide host countries and their principal nuclear institutions and organizations an opportunity to reflect on national characteristics and engage in exercises to assess the influence those characteristics could have on the overarching nuclear safety culture. The CSSCF analyses cultural traits of a country's nuclear sector and identifies how they might influence assumptions, values, beliefs and behaviours within nuclear organizations. To achieve this, the CSSCF comprises a series of steps: data gathering and analysis, development of a scenario script, the conduct of a two-day forum, detailed analysis, and development of the final report containing findings and, most importantly,

country-specific recommendations for continuous improvement in enhancing a healthy safety culture across the nuclear community.

Since 2018, the CSSCF has convened annually for a two-day forum. The third meeting was held in Canada in 2022 and was co-organised by WANO in collaboration with the CNSC. Over 80 participants attended and proactively engaged in the deliberations of the Forum, which were fruitful and delivered positive outcomes. International experts from France, Japan, Switzerland and the United Kingdom participated as observers during the event.

K.6 Openness and transparency

Canada has a dedicated web page on the Joint Convention that gives the public access to all previous Canadian national reports: <http://nuclearsafety.gc.ca/eng/resources/publications/reports/jointconvention/>. Canada also publishes answers to questions presented to Canada about the report, as well as presentations given at the review meetings. In addition, Canada's web page offers information about the IAEA Joint Convention and includes a link to the Joint Convention web page.

Furthermore, in order to enhance openness and transparency, updates to Canada's Joint Convention web page are proactively shared with the public. When a new national report becomes available, Canada issues a news release and sends a notification of publication to a distribution list of approximately 4,000 members of the media and the public. Social media is also used to disseminate information to the public, with regular announcements about related publications appearing on the CNSC's Facebook and X (formerly known as Twitter) platform pages. Canada also communicates regularly with the public on social media to provide updated statuses of review meetings and information about upcoming activities related to the Joint Convention. In addition, CNSC staff present the Joint Convention report and the results of the review meeting to the Commission at a public meeting.

The [Commission](#) is an independent administrative tribunal set up at arm's length from government, with no ties to the nuclear industry. The Commission makes its decisions fairly and transparently, guided by clear rules of procedure. Members of the public, Indigenous Nations and Communities and other stakeholders who have an interest or expertise in the matter being considered, or who have information that may be useful to the Commission in coming to a decision can formally participate as intervenors in public proceedings. For more information, refer to section E.3.1.3.1.

Previously, every three years, NRCan collected compiled and analyzed data on the radioactive waste inventory in Canada. The updated data was published in the triennial *Inventory Summary Report* which provides an overview of the production, accumulation and future projections of radioactive waste in Canada based on Canada's four waste classes. This data was also included in the IAEA's radioactive waste management database, which tracks L&ILW worldwide.

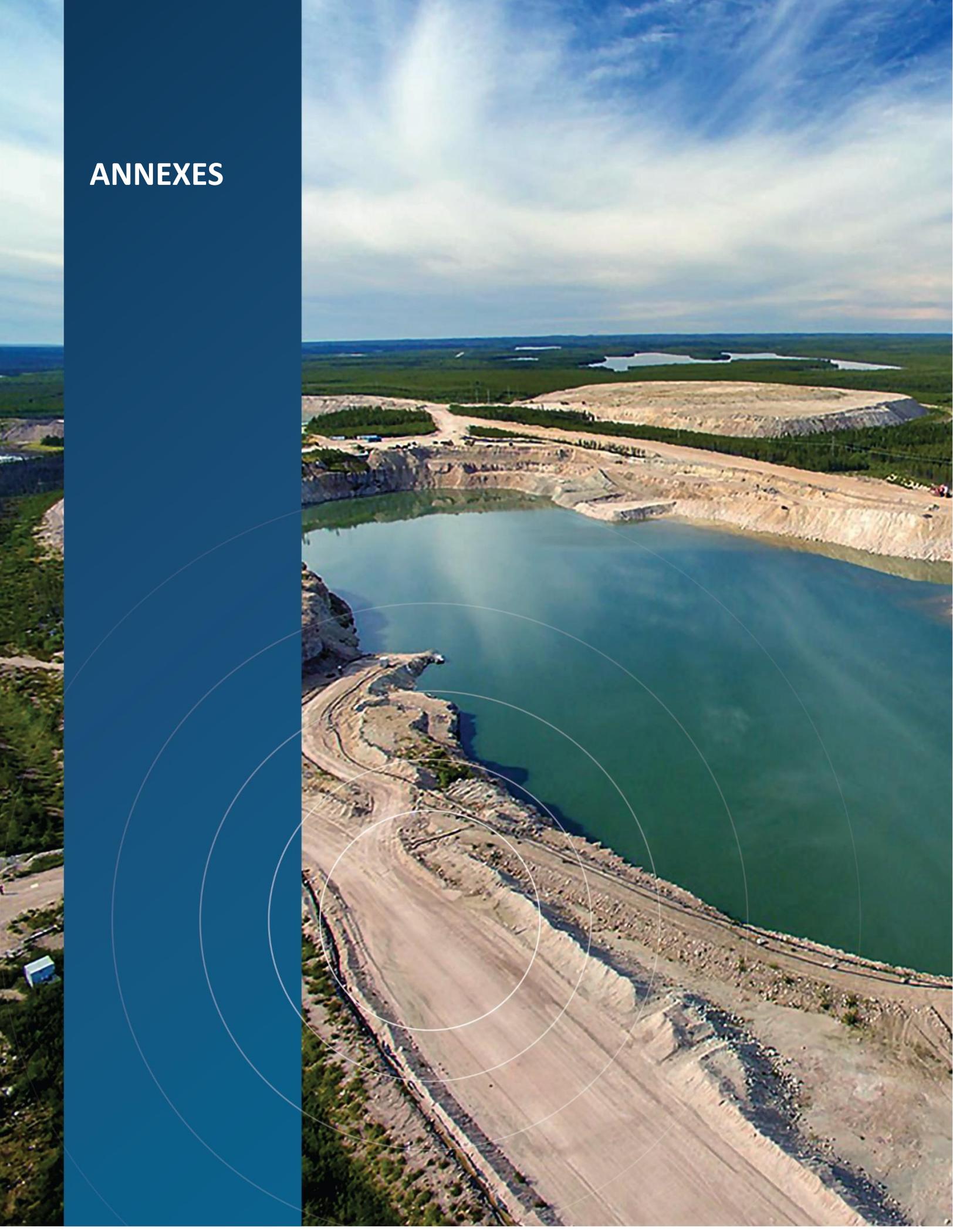
The IAEA has developed the Spent Fuel and Radioactive Waste Information System (SRIS), which replaces the IAEA's radioactive waste management database. The system provides information on Canada's radioactive waste management programmes, radioactive waste inventories and radioactive waste disposal and information on its laws and regulations and policies, plans and activities. Information on SRIS is available to members of the public to view. Canada's inventory data was posted on SRIS; the CNSC and NRCan updated their websites to note the change and provide information on how to locate updated inventory data. Canada has published Canada's inventory on SRIS. For more information on Canada's inventory, see section D and is available for on [SRIS - Spent Fuel and Radioactive Waste Information System \(iaea.org\)](#).

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ANNEXES



Annex 1 – Canadian Nuclear Safety Commission Regulatory Documents

A listing of CNSC regulatory documents published since the last review meeting can be found in table 1.1.

Table 1.1: Regulatory documents published by the CNSC since the Seventh Review Meeting

Document number	Document title	Publication date
REGDOC-1.1.1	<i>Site Evaluation and Site Preparation for New Reactor Facilities</i>	July 2022
REGDOC-1.1.2	<i>Licence Application Guide: Licence to Construct a Nuclear Power Plant</i>	October 2022
REGDOC-1.1.3	<i>Licence Application Guide: Licence to Operate a Nuclear Power Plant</i>	July 2022
REGDOC-1.2.1	<i>Guidance on Deep Geological Repository Site Characterization</i>	January 2021
REGDOC-1.2.2	Licence Application Guide: Class IB Processing Facilities	January 2024
REGDOC-1.2.3	Licence Application Guide: Licence to Prepare Site for a Deep Geological Repository	April 2024
REGDOC-1.4.1	<i>Licence Application Guide: Class II Nuclear Facilities and Prescribed Equipment</i>	March 2021
REGDOC-1.5.1	<i>Application Guide: Certification of Radiation Devices or Class II Prescribed Equipment</i>	September 2020
REGDOC-1.6.2	<i>Developing and Implementing an Effective Radiation Protection Program for Nuclear Substances and Radiation Device Licences</i>	August 2021
REGDOC-2.2.1	<i>Human Performance</i>	December 2023
REGDOC-2.2.3	<i>Volume III: Personnel Certification, Volume III: Certification of Reactor Facility Workers</i>	October 2023
REGDOC-2.2.3	<i>Personnel Certification, Volume I: Exposure Device Operators</i>	December 2022
REGDOC-2.2.4	<i>Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 2</i>	January 2021
REGDOC-2.4.2	<i>Probabilistic Safety Assessment (PSA) for Reactor Facilities</i>	May 2022
REGDOC-2.4.3	<i>Nuclear Criticality Safety</i>	September 2020
REGDOC-2.4.4	<i>Safety Analysis for Class IB Nuclear Facilities</i>	October 2022
REGDOC-2.4.5	Nuclear Fuel Safety	April 2024
REGDOC-2.5.2	<i>Design of Reactor Facilities</i>	May 2023
REGDOC-2.5.4	<i>Design of Uranium Mines and Mills: Ventilation Systems</i>	February 2022
REGDOC-2.5.6	<i>Design of Rooms Where Unsealed Nuclear Substances Used</i>	May 2023
REGDOC-2.5.7	<i>Design, Testing and Performance of Exposure Devices</i>	September 2020
REGDOC-2.7.1	<i>Radiation Protection</i>	July 2021
REGDOC-2.7.2	<i>Dosimetry, Volume I: Ascertaining Occupational Dose</i>	July 2021

Document number	Document title	Publication date
REGDOC-2.7.2	<i>Dosimetry, Volume II: Technical and Quality Assurance Requirements for Dosimetry Services</i>	August 2020
REGDOC-2.9.1	<i>Environmental Principles, Assessments and Protection Measures</i>	September 2020
REGDOC-2.9.2	<i>Controlling Releases to the Environment</i>	March 2024
REGDOC-2.11	<i>Framework for Radioactive Waste Management and Decommissioning in Canada</i>	March 2021
REGDOC-2.11.1	<i>Waste Management, Volume I: Management of Radioactive Waste</i>	January 2021
REGDOC-2.11.1	<i>Waste Management, Volume III: Safety Case for Long-Term Radioactive Waste Management, Version 2</i>	January 2021
REGDOC-2.11.2	<i>Decommissioning</i>	January 2021
REGDOC-2.12.3	<i>Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2</i>	September 2020
REGDOC-2.14.1	<i>Volume I Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015</i>	January 2021
REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants	May 2024
REGDOC-3.1.2	<i>Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills</i>	July 2022
REGDOC-3.2.2	<i>Indigenous Engagement, Version 1.1</i>	February 2022
REGDOC-3.3.1	<i>Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities</i>	January 2021
REGDOC-3.4.1	<i>Guide for Applicants and Intervenors Writing CNSC Commission Member Documents</i>	February 2022
REGDOC-3.5.1	<i>Information Dissemination: Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills, Version 2</i>	February 2022
REGDOC-3.5.3	<i>Regulatory Fundamentals</i>	March 2023
REGDOC-3.6	<i>Glossary of CNSC Terminology</i>	February 2023

The draft regulatory documents are listed in table 1.2. Draft documents are either currently being developed by CNSC staff, issued for external stakeholder comment or revised to incorporate comments received during consultation. For a complete list of regulatory documents and the current status of the draft regulatory documents listed in table 1.2, visit the CNSC website at <http://www.nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/index.cfm>.

Table 1.2: Draft regulatory documents

Document number	Document title	Status
REGDOC-1.1.4	<i>Licence Application Guide: Licence to Decommission Reactor Facilities</i>	External stakeholder comment
REGDOC-2.10.2	<i>Fire Protection</i>	Currently under development

Annex 2 – The Five Branches of the Canadian Nuclear Safety Commission

2.1 Regulatory Operations Branch

The Regulatory Operations Branch supports the CNSC mission and mandate by making final regulatory decisions or making recommendations to the Commission in the areas of licensing, certification and regulation of NPPs, uranium mines and mills, uranium fuel fabricators and processing facilities, WMFs, nuclear substance processing and transport, and industrial and medical applications. The Regulatory Operations Branch also coordinates the planning, monitoring and reporting of operational activities and leads the implementation of the CNSC Harmonized Plan and the CNSC Management System documentation.

This branch consists of the following directorates and respective divisions:

- Operations Secretariat
- Directorate of Nuclear Cycle and Facilities Regulation
 - Canadian Nuclear Laboratories Regulatory Program Division
 - Nuclear Processing Facilities Division
 - Uranium Mines and Mills Division
 - Wastes and Decommissioning Division
 - Major Projects and Strategic Support
- Directorate of Nuclear Substance Regulation
 - Accelerators and Class II Facilities Division
 - Nuclear Substances and Radiation Devices Licensing Division
 - Operations Inspection Division
 - Transport Licensing and Strategic Support Division
- Directorate of Power Reactor Regulation
 - Bruce Regulatory Program Division
 - Darlington Regulatory Program Division
 - Gentilly-2/Point Lepreau Regulatory Program Division
 - Pickering Regulatory Program Division
 - Power Reactor Licensing and Compliance Integration Division
- Directorate of Advanced Reactor Technologies
 - Advanced Reactor Licensing Division
 - Advanced Reactor Assessment Division

2.2 Technical Support Branch

The Technical Support Branch supports the CNSC mission and mandate by providing leadership and specialized expertise in the areas of nuclear science and engineering, safety analysis, safety management, human factors, personnel training and certification, environmental and radiation protection, security, nuclear emergency management, safeguards, and nuclear non-proliferation.

This includes:

- participating in and supporting the licensing and compliance processes established for the CNSC's regulatory program
- developing and maintaining regulations and regulatory documents
- leading the activities associated with the CNSC's responsibilities under the IAA
- managing the CNSC's laboratory services and licensed dosimetry services
- certifying qualified licensee personnel
- overseeing implementation of the CNSC's Nuclear Emergency Management Program
- licensing the import and export of nuclear substances, materials and technology
- ensuring the effective implementation of IAEA safeguards agreements in Canada and administering Canada's bilateral nuclear cooperation agreements
- collaborating with stakeholders in Canada and other countries and sharing scientific and technical information

This branch consists of the following directorates and respective divisions:

- Directorate of Assessment and Analysis
 - Engineering Design Assessment Division
 - Operational Engineering Assessment Division
 - Probabilistic Safety Assessment & Reliability Division
 - Reactor Behaviour Division
 - Reactor Physics and Thermalhydraulics Division
 - Systems Engineering Division
- Directorate of Environmental and Radiation Protection and Assessment
 - Environmental Review Division
 - Environmental Risk Assessment Division
 - Health Sciences and Environmental Compliance Division
 - Laboratory Services Division
 - Radiation Protection Division
- Directorate of Safety Management
 - Human and Organizational Performance Division
 - Management Systems Division
 - Personnel Certification Division
 - Training Program Evaluation Division
- Directorate of Security and Safeguards
 - Emergency Management Programs Division

- o International Safeguards Division
- o Non-Proliferation and Export Controls Division
- o Nuclear Security Division

2.3 Regulatory Affairs Branch

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

This Branch consists of the following directorates and respective divisions:

- Regulatory Policy Directorate
 - o Regulatory Framework Division
 - o Regulatory Policy Analysis Division
- Strategic Communications Directorate
 - o Communications, Executive Priorities
 - o Creative, Linguistic and Digital Communications Division
 - o Corporate and Regulatory Communications Division
- Strategic Planning Directorate
 - o Corporate Planning Division
 - o Indigenous and Stakeholder Relations Division
 - o International and Government Affairs Division

2.4 Corporate Services Branch

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

This branch consists of the following directorates and respective divisions:

- Finance and Administration Directorate
 - o Contracting, Facilities and Administration Division
 - o Corporate Security Division
 - o Financial Management and Internal Controls Division
 - o Financial Reporting, Accounting, Policy and Systems Division
- Human Resources Directorate
 - o People Strategies and Workplace Experience Division
 - o Workplace Wellness, Compensation and Resourcing Division
- Information Management and Technology Directorate
 - o Enterprise Architecture and Solutions Delivery Division

- o IT Operations and Service Delivery Division
- o Program and Project Management Division

2.5 Legal and Commission Affairs Branch

The Legal and Commission Affairs Branch of the CNSC consists of the following:

- o Legal Services, which is responsible for providing legal advice to the CNSC, its members and its staff.
- o Commission Registry, which is responsible for the management and administration of the Commission Registry

Annex 3 – Canadian Nuclear Safety Commission Safety and Control Area Framework

Safety and control areas (SCAs) are the technical topics that CNSC staff use to assess, review, verify and report on regulatory requirements and performance across all regulated facilities and activities. By providing a common language and architecture, SCAs improve understanding and communication within the CNSC, as well as between the CNSC and licensees, the Commission and other stakeholders. The CNSC's 14 SCAs are organized in three functional areas: management, facility and equipment, and core control processes.

SCAs do not constrain the CNSC in its conduct of regulatory oversight activities. Additional topics may be added as needed to provide satisfactory assurance of compliance.

Table 3.1 outlines each functional area and their respective SCAs and specific areas.

Table 3.1: Safety and control areas

Functional area	Safety and control area	Specific area
Management	Management system	Management system
		Organization
		Performance assessment, improvement and management review
		Operating experience (OPEX)
		Change management
		Safety culture
		Configuration management
		Records management
		Supply and Contractor Management
		Business continuity
	Human performance management	Human performance program
		Personnel training
		Personnel certification
		Work organization and job design
		Fitness for duty
	Operating performance	Conduct of licensed activities
		Procedures
		Reporting and tending
		Outage management performance
		Safe operating envelope
Severe accident management and recovery		
Accident management and recovery		
Facility and equipment	Safety analysis	Deterministic safety analysis

Functional area	Safety and control area	Specific area
		Hazard analysis
		Probabilistic safety assessment
		Criticality safety
		Severe accident analysis
		Management of safety issues (including R&D programs)
	Physical design	Design governance
		Site characterization
		Facility design
		Structure design
		System design
		Component design
	Fitness for service	Equipment fitness for service/equipment performance
		Maintenance
		Structural integrity
		Aging management
		Chemistry control
		Periodic inspection and testing
	Core control processes	Radiation protection
Worker dose control		
Radiation protection program performance		
Radiological hazard control		
Conventional health and safety		Performance
		Practices
		Awareness
Environmental protection		Effluent and emissions control (releases)
		Environmental management system
		Assessment and monitoring
		Protection of people
		Environmental risk assessment
Emergency management and fire protection		Conventional emergency preparedness and response

Functional area	Safety and control area	Specific area
		Nuclear emergency preparedness and response
		Fire emergency preparedness and response
	Waste management	Waste characterization
		Waste minimization
		Waste management practices
		Decommissioning plans
	Security	Facilities and equipment
		Response arrangements
		Security practices
		Drills and exercises
		Cyber security
	Safeguards and non-proliferation	Nuclear material accountancy and control
		Access and assistance to the IAEA
		Operational and design information
		Safeguards equipment, containment and surveillance
		Import and export
	Packaging and transport	Package design and maintenance
		Packaging and transport
		Registration for use

Annex 4 – Spent Fuel Management Facilities

4.1 Bruce Nuclear Generating Station

The Municipality of Kincardine, Ontario, hosts the Bruce nuclear site, which contains two NPPs: the Bruce A NGS and the Bruce B NGS. Bruce A consists of four CANDU reactors (Units 1, 2, 3 and 4). Unit 1, 2, and 4 are currently in operation. In 2023, Unit 3 was safely removed from service in order to complete a major component replacement. Bruce B also consists of four CANDU reactors (Units 5, 6, 7 and 8). Unit 6 was safely returned to service from major component replacement in September 2023 and currently, all four units are in operation.

Bruce Power operates the Bruce A and Bruce B NGSs under a lease agreement with OPG. Spent fuel discharged from the reactor cores is wet-stored within the station's irradiated fuel bays. Bruce Power exercises the care and custody of the spent fuel on behalf of OPG which assumes title to spent fuel upon receiving it in the bays. After a minimum of 10 years in wet storage, Bruce Power loads used fuel into dry storage containers (DSCs) and OPG collects and transfers loaded DSCs to an on-site used fuel dry storage facility at OPG's Western WMF.

Figure 4.1: Bruce NGS irradiated fuel bay



4.2 CRL National Research Universal

The NRU research reactor was 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. The NRU research reactor ceased operation on March 31, 2018. Approximately 30 related buildings and structures, along with the main reactor facility, will be turned over to decommissioning and waste management under SWS by 2024.

Spent fuel rods were initially stored in water-filled bays located within the research reactor. All NRU spent fuel has been transferred to tile holes in Waste Management Area B at CRL. The tile holes are also used to store the spent fuel from the NRX reactor which was shut down in 1992. The NRU rod bays continue to be available for wet storage of research reactor fuels subject to ongoing research activities.

Figure 4.2: CRL National Research Universal

4.3 CRL Waste Management Area B

Spent fuel from the operation of research reactors at CRL is currently stored below ground in vertical cylindrical concrete structures called tile holes. These are situated in CRL 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. The fuel consists of about 700 prototype and research reactor fuel rods, with a total mass of approximately 22 tonnes. Although the fuel is safely stored, monitoring and inspection have shown that some of the fuel containers and fuel are corroding.

An above-ground dry storage facility was constructed to repackage, dry and store the inventory of spent legacy research fuel, from 97 tile holes. The last fuel package was transferred into this facility and dried in early 2020. The new dry storage system is located in the fuel packaging and storage building at Waste Management Area B. The fuel packaging and storage building contains a packaging and vacuum drying station and a monitored storage structure. The existing storage container was placed in a new stainless-steel container with the spent fuel remaining inside and dried before being placed in the monitored storage structure. The storage structure is engineered to last a minimum of 50 years and provides safe interim storage for the packaged fuel until a long-term management facility is available.

Fuels stored in tile holes at CRL since 1983 are more corrosion-resistant and continue to be stored in tile holes that are better designed to prevent water ingress.

Figure 4.3: CRL Waste Management Area B

4.4 CRL Waste Management Area G

CRL Waste Management Area G, which is operated by CNL, is a spent fuel dry storage area that contains concrete canisters, as described in section B.1.3.4.1. The NPD reactor was operated by Ontario Hydro (now OPG) from 1962 until 1987 when it was decommissioned. As part of its decommissioning program, the spent fuel was transferred to concrete canisters located at CRL Waste Management Area G. This site has stored 68 full and partial spent fuel bundles from Bruce, Pickering and Douglas Point, and 4,886 fuel bundles from the NPD reactor in 12 dry storage concrete canisters.

As CNL proceeds with the decommissioning of AECL sites, and until a national repository is available, further consolidation for storage of spent fuel at CRL is planned, with transfers from WL to CRL expected to commence in late 2024. Two concrete canisters were constructed on the existing concrete support pad; these were originally to store calcined waste from the processing of radioisotopes separated in the new processing facility at CRL, which was never completed. These canisters will be combined with an additional 22 canisters, constructed between 2019 to 2023, in two phases, to accommodate the spent fuel currently stored at WL and G-1.

Figure 4.4: CRL Waste Management Area G

4.5 Darlington Nuclear Generating Station

The Darlington NGS, operated by OPG, consists of four CANDU reactors. The station began commercial operation in 1990 and continues to operate today. After years of detailed planning, OPG has started work to refurbish the four reactors at the Darlington site. The mid-life refurbishment of this facility will ensure continued power for 30 more years. The Darlington refurbishment is scheduled for completion by 2026.

The spent fuel generated at Darlington is stored in the spent fuel bays for a minimum of 10 years before being transferred to DSCs and moved to the Darlington WMF.

Figure 4.5: Darlington NGS

4.6 Darlington Waste Management Facility

The Darlington WMF (figure 4.6) is located at the Darlington site. The Darlington WMF is currently made up of a processing building and two storage buildings, each designed to house up to 500 DSCs. Construction of a third storage structure is in progress. Once completed, it will house another 600 DSCs. The Darlington WMF is designed to provide storage capacity for up to 825,600 fuel bundles (approximately 2,150 DSCs) once a fourth additional storage structure is constructed in the future. The fuel will continue to be stored at the site until it is transferred to the NWMO disposal facility.

The Darlington spent fuel dry storage system is designed to transfer spent fuel from wet storage in the Darlington NGS spent fuel bays into a steel-clad concrete DSC designed by OPG. Before being transferred to the Darlington WMF, each loaded DSC is drained, its cavity is vacuum dried, and the container surface is surveyed for loose contamination. Decontamination is carried out if necessary.

Once the DSC loaded with spent fuel is received at the Darlington WMF processing building, the transfer clamp is removed, and the lid is seal-welded to the DSC body. The lid weld is subsequently inspected for defects. The DSC undergoes final vacuum drying and helium backfilling. Subsequently, the drain port is welded and inspected, and helium leak testing is performed.

Finally, touch-up paint is applied to scuffs or scrapes on the container's exterior. After processing, IAEA seals are applied to each container and placed in storage.

In 2023, the Darlington WMF processed 57 DSCs (or 21,888 spent fuel bundles). In September 2023, a total of 901 DSCs were being stored at the Darlington WMF.

In 2022, OPG reported releases of 3,200 Bq particulate from the Darlington WMF into the air. This release is orders of magnitude below the DRLs for the Darlington WMF which are derived from the public dose limit of 1 mSv/year. Stormwater and foundation drainage monitoring was discontinued in 2022 in alignment with Canadian Standards Association N288 standards and OPG programs.

Figure 4.6: Darlington WMF

4.7 Douglas Point Waste Management Facility

The Douglas Point WMF (figure 4.7) is located at the Bruce nuclear site. The prototype CANDU power reactor at Douglas Point became operational in 1968 and was shut down permanently after 17 years of operation. AECL is responsible for the decommissioning of Douglas Point, and that work is now being executed by CNL under a GoCo arrangement.

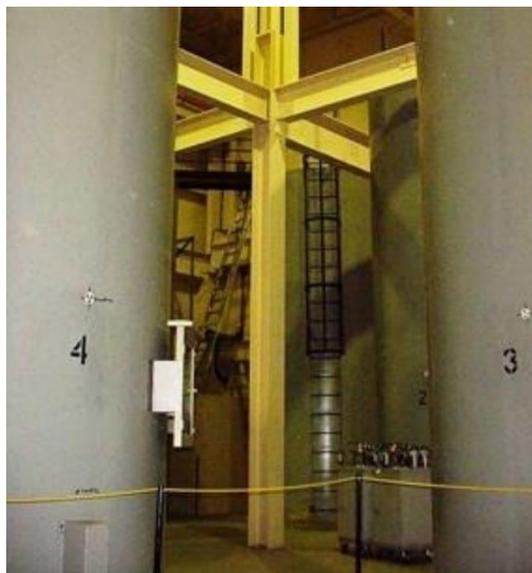
Decommissioning began in 1986. Approximately 22,256 spent fuel bundles were transported to on-site concrete canisters in late 1987. The dry fuel storage canister air sampling program demonstrates safe SWS with a continuing trend of close to zero releases. The maximum air sampling results for any one canister for the period from 2020 through 2023 was less than 0.682 Bq/filter gross gamma activity, 0.479 Bq/filter gross beta activity and 0.0286 Bq/filter gross alpha activity. This ongoing monitoring confirms that the facility continues to remain in a safe SWS state. In 2025, AECL will evaluate whether to consolidate the fuel at the Chalk River Laboratories.

Figure 4.7: Fuel storage at Douglas Point

4.8 Gently-1 Waste Management Facility

The Gently-1 NGS 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. Responsibility for decommissioning Gently-1 belongs to AECL; this work is now being executed by CNL under a GoCo arrangement.

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 dry fuel storage canister air sampling program demonstrates safe SWS with a continuing trend of close to zero releases. Maximum air sampling results for any one canister for the period from 2020 through 2023 was less than 0.483 Bq/filter gross gamma activity, less than 0.305 Bq/filter gross beta activity and less than 0.0283 Bq/filter gross alpha activity. This ongoing monitoring confirms that the facility continues to remain in a safe SWS state. Consolidation of this fuel at the Chalk River Laboratories will commence in 2024.

Figure 4.8: Internal view of the fuel storage at Gently-1

4.9 Gently-2 Nuclear Generating Station

Operated by Hydro-Québec (H-Q), Gently-2 (figure 4.9) houses one CANDU reactor. The station went into service in 1982 and began commercial operation in 1983. At the end of 2012, H-Q ended operations at Gently-2 to proceed with decommissioning.

Because the station has ended operations, the total number of spent fuel bundles on-site will not increase. There are 129,925 spent fuel bundles in safe storage at the station. Spent fuel was first stored in a pool; after an appropriate cooling period of at least seven years (or six years under specific conditions), it was transferred to the dry storage facility. The transfer of spent fuel in baskets was performed directly in the pool. The loaded baskets were then transferred to a shielded workstation where the contents were dried, and the basket lids were welded on. Once the work on the baskets was complete, the baskets were transported to a H-Q on-site spent fuel dry storage facility. As of December 2020, all spent fuel bundles had been removed from wet storage and moved into dry storage at the Gently-2 WMF.

Figure 4.9: Gently-2 NGS



4.10 Gently-2 Waste Management Facility

In operation since 1995, the Gently-2 WMF (figure 4.10) stores fuel used during the station's operation. H-Q was authorized to build all of the MACSTOR modules required for the storage of its spent fuel. There are 11 MACSTOR modules now in service. Each MACSTOR module can store up to 12,000 spent fuel bundles.

The storage spent fuel baskets were transferred on an as-needed basis, in accordance with decommissioning planning requirements. Transfers were normally done between April and October each year until 2020. H-Q must ensure that dose rates at the fence line of these facilities stay within the authorized limit of 2.5 $\mu\text{Sv}/\text{hour}$ at all times.

Figure 4.10: Gentilly-2 Spent Fuel Dry Storage Facility**4.11 McMaster Nuclear Research Reactor**

The McMaster Nuclear Reactor is a pool-type reactor with a core of LEU fuel moderated and cooled by light water. The reactor operates at powers of up to 5 megawatts. It was converted from HEU fuel to LEU fuel in 2006–07. The original HEU fuel was returned to a licensed spent fuel management facility in the U.S.

The McMaster Nuclear Reactor is the only Canadian medium-flux reactor operated in a university environment. The reactor's neutrons are used in nuclear physics, biology, chemistry, earth sciences, medicine and nuclear medicine. Spent fuel at the McMaster Nuclear Reactor is stored in the pool. Prior to 2020, spent fuel was shipped to a licensed spent fuel management facility in the U.S. McMaster is engaged with the NWMO in seeking alternate long-term spent fuel storage or disposal options.

Figure 4.11: McMaster Nuclear Research Reactor pool

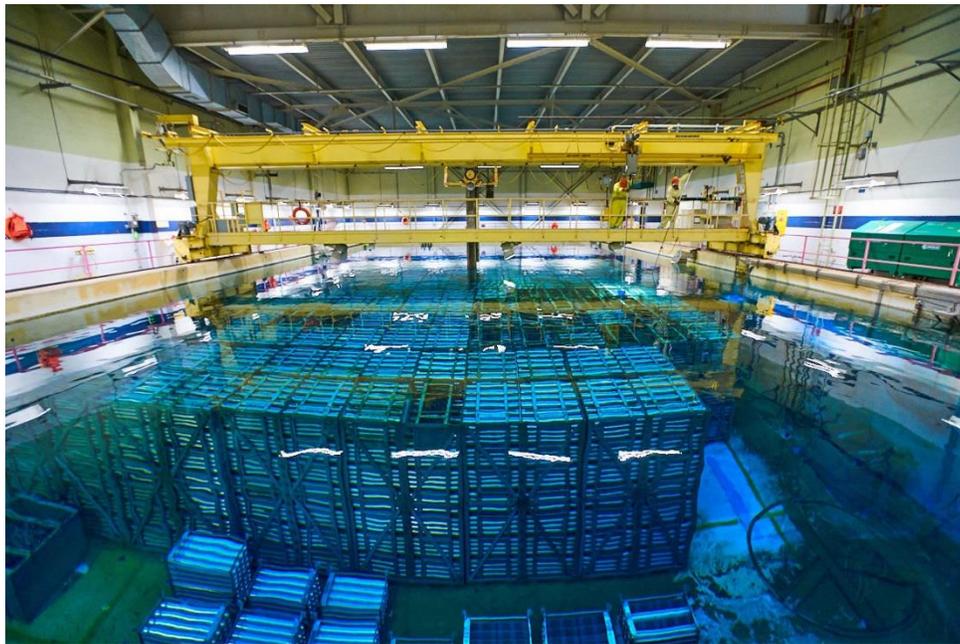
4.12 Pickering Nuclear Generating Station

Pickering hosts two NPPs, each consisting of four CANDU reactors. The first station (Units 1–4, formerly known as Pickering A) commenced operation in 1971 and Units 1 and 4 continue to operate. Units 2 and 3 were shut down in 1997 and placed in safe storage by September 2010.

The second station (Units 5–8, formerly known as Pickering B) commenced commercial operation in 1983 and continues to operate today. OPG is currently licensed to operate through 2024 and plans to continue operating the Pickering NGS Units 5-8 through 2026, pending regulatory approval.

The spent fuel generated at both Pickering stations is stored in the spent fuel bays for a minimum of 10-years before it is transferred to the Pickering WMF. OPG completed analysis on dry storage of 6-year-old fuel and is in the process of obtaining approval to store fuel in the spent fuel bays for a minimum of 6 years before transferring to dry storage. This shorter time frame will be used on a limited basis as identified in the analysis. There is a primary fuel bay for each side of the station (014 and 058) and an auxiliary fuel storage bay for the 014 side. Each bay is filled with demineralized water, with associated heat exchangers, filters and ion exchange columns to maintain water temperature and clarity. Fuel bays are connected to the station's active ventilation system to monitor for any airborne emissions.

Figure 4.12: Spent fuel bays at the Pickering NGS



4.13 Pickering Waste Management Facility

OPG's Pickering WMF processing building and first two storage buildings are located within the protected area of Pickering (phase 1); storage buildings 3 and 4 are located within their own security protected area (phase II) on the Pickering site. In operation since 1996, the facility's primary purpose is to store spent fuel from the Pickering reactors. It is expected that the Pickering WMF will be in operation (receiving spent fuel) until at least 10 years after the shutdown of the last Pickering reactor unit. The fuel will continue to be stored at the facility until it is transferred to the NWMO long-term disposal facility.

The spent fuel dry storage area of the Pickering WMF comprises a dry storage container processing building and four storage buildings. The nominal design capacity of the Pickering WMF is approximately 650 DSCs, or 249,600 fuel bundles, in the two existing storage buildings in the Pickering WMF Phase I area. The Pickering WMF Phase II area has been constructed in the Pickering East complex, as shown in figure 4.13. The Pickering WMF Phase II complex currently contains two spent fuel dry storage buildings (storage buildings 3 and 4) with a

nominal capacity of 480 and 624 DSC, respectively, and has space for additional storage buildings. The storage buildings in the Pickering WMF Phase I and Phase II areas will eventually have a combined capacity of up to 3,000 DSCs, sufficient to store all of the fuel consumed during the operating lifetime of the Pickering site.

Spent fuel is stored in dual-purpose (i.e., storage container plus transportation package) concrete DSCs that are identical to those currently in use at the Darlington and Western WMFs. The processing of DSCs is also identical to the operations at the Darlington and Western WMFs.

In 2023, the Pickering WMF processed 70 DSCs, or 26,880 spent fuel bundles. As of September 2023, a total of 1,245 DSCs were being stored at the Pickering WMF.

In 2022, OPG reported releases of $<1.2 \times 10^5$ Bq particulate to air from the Pickering WMF used fuel dry storage container processing building. These releases are orders of magnitude below the DRLs for the Pickering WMF, which are derived from the public dose limit of 1 mSv/year. Stormwater and foundation drainage monitoring was discontinued in 2022 in alignment with Canadian Standards Association N288 standards and OPG program documents.

Figure 4.13: Pickering WMF



4.14 Point Lepreau Nuclear Generating Station

The Point Lepreau NGS, operated by NB Power, consists of one CANDU reactor. The station commenced operation in 1983. It is currently in full-power operation (following a major refurbishment outage that concluded in the fall of 2012, which will enable the station to operate for another 25 to 35 years).

Figure 4.14: Point Lepreau NGS

4.15 Point Lepreau Waste Management Facility

The spent fuel generated at Point Lepreau is initially stored in the spent fuel bay for a minimum of seven years, then transferred to the Spent Fuel Dry Storage Facility (figure 4.15), also known as the Phase II area of the Solid Radioactive WMF. In operation since 1990, this facility provides storage capacity for Point Lepreau in 300 above-ground concrete canisters, which can house a total of 180,000 spent fuel bundles. In order to accommodate the spent fuel from the station's extended operational life following the refurbishment outage, land was prepared to permit the construction of up to 300 additional canisters (the exact number depending on future needs).

During the reporting period (from April 1, 2020 to March 31, 2024), 25 canisters were filled and sealed and 250 of the 300 canisters constructed had been filled and sealed. Approximately 5,000 spent fuel bundles are transferred to dry storage for each year the station operates, depending on the power output of the Point Lepreau NGS.

Samples of surface runoff from the Phase II area, collected and analyzed over the reporting period, had an average tritium concentration of 112 Bq/L. The average dose rate for the reporting period at the spent fuel storage facility perimeter fence, as read from TLDs, was 0.11 $\mu\text{Sv}/\text{hour}$. The regulatory limit for dose to the public is 1 mSv/year.

Figure 4.15: Point Lepreau Solid Radioactive WMF

4.16 Western Waste Management Facility

OPG's Western Used Fuel Dry Storage Facility, which is part of the Western WMF, began operations in February 2003. The facility was designed to provide safe interim storage for spent fuel from Bruce A and B. The fuel will continue to be stored at the site until it is transferred to the NWMO disposal facility.

The Western WMF can currently provide dry storage for 3,000 DSCs, or 1,152,000 fuel bundles, generated at the Bruce NGSs in six storage buildings. Spent fuel is stored in dual-purpose concrete DSCs, identical to those currently in use at the Darlington and Pickering WMFs. DSCs are processed in a manner similar to that followed at the Darlington and Pickering WMFs.

In 2023, the Western WMF processed 113 DSCs, or 43,392 spent fuel bundles. As of September 2023, a total of 2,011 DSCs were being stored at the Western WMF.

Annex 5.13 describes the combined releases to air and water of the Western WMFs spent fuel dry storage area and the L&ILW storage area.

Figure 4.16: Western Used Fuel Dry Storage Facility



4.17 Whiteshell Laboratories

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 WR-1 organic cooled reactor, which began operation in 1965. WR-1 continued to operate until 1985.

The Concrete Canister Storage Facility Program was developed at Whiteshell in the early 1970s to demonstrate that dry storage was a feasible alternative to water pool storage for spent reactor fuel.

Due to the success of the demonstration program, the Concrete Canister Storage Facility (see figure 4.17) was built to store all remaining WR-1 spent fuel. In addition, a number of spent fuel bundles from CANDU stations are stored in the facility after undergoing post-irradiation examinations in Whiteshell's shielded facilities. The facility provides storage for 2,268 spent fuel bundles originating from both the WR-1 operation and CANDU reactors. Some spent fuel from operations prior to 1975 is stored in standpipes in the waste management area. Further details on the Whiteshell decommissioning program can be found in annex 8.8.

The transfer of spent fuel currently in storage at WL for consolidation at CRL until a national repository is available is expected to commence in 2025.

Figure 4.17: Whiteshell Laboratories Concrete Canister Storage Facility



Annex 5 – Radioactive Waste Management

5.1 AECL nuclear research and test establishment facilities

AECL currently has one research facility in Canada: Chalk River Laboratories (CRL) in Chalk River, Ontario. AECL previously had another active research facility, WL in Manitoba, which is currently undergoing decommissioning (annex 8 provides more information about decommissioning activities). After transitioning to a GoCo model in 2015, these sites are operated by CNL under agreement with AECL. The radioactive wastes produced at these two sites are stored in WMFs at each site.

5.1.1 Chalk River Laboratories

The CRL site is located in Renfrew County, Ontario, on the shore of the Ottawa River, 160 kilometres northwest of Ottawa. The site, which comprises 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 northeastern boundary of the site. The Petawawa Military Reserve abuts the CRL property to the southeast.

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 on the CRL property, along the southwest to northeast corridor. The CRL waste management areas provide some fee-based waste management for institutions such as universities, hospitals and industrial users that have no other means to manage their wastes.

The CRL waste management areas manage eight types of waste:

- nuclear reactor operation wastes (from AECL-owned prototype and research reactors), which include fuel and reactor components, reactor fluid cleanup materials (e.g., resins and filters), trash and other materials contaminated with radioactivity as a result of routine operations
- fuel fabrication facility wastes, which include zirconium dioxide and graphite crucibles used to cast billets, filters and other trash like gloves, coveralls and wipes
- isotope production wastes, which include general radioactive wastes contaminated primarily with cobalt-60 and molybdenum-99
- isotope usage wastes, which include general radioactive wastes contaminated primarily with cobalt-60 and molybdenum-99
- hot cell operations wastes, which include cleaning materials, contaminated air filters, contaminated equipment and discarded irradiated samples
- decontamination and decommissioning wastes, which include a variety of contaminated wastes with variable physical, chemical and radiological properties
- remediation wastes, which include solidified waste resulting 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 types of wastes described above (e.g., wastes from radioisotope laboratories and workshops)

Liquid wastes, such as scintillation cocktails, radiological-contaminated lubricating oils, wastes contaminated by polychlorinated biphenyl and isotope production wastes are also handled by the CRL waste management operations. Approximately 15 to 20 m³ of these types of waste are received into the waste management areas each 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. After processing through a liquid waste evaporator, the treated effluent is monitored and released to the process sewer, which eventually discharges to the Ottawa River.

Figure 5.1: Aerial photo of built-up area of CRL site



5.1.1.1 Waste Management Area A

The first emplacement of radioactive waste at the CRL site took place in 1946 into what is now referred to as Waste Management Area A. These emplacements took the form of direct disposal of solids and liquids into excavated sand trenches. The scale of operations was modest and unrecorded until 1952, when the cleanup from the NRX accident generated large quantities of radioactive waste (which included the reactor's calandria) that had to be managed quickly and safely. At that time, approximately 4,500 m³ 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. Waste is no longer accepted for emplacement in Waste Management Area A.

The two active liquid waste tanks in this area 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 received an estimated 3.7×10^{13} Bq of strontium-90 and about 100 g of plutonium. The radioactive liquids inside the tanks were recovered in 2013 and sent to an off-site service provider for processing. Retrieving the liquids from these tanks minimizes the potential for and consequences of contaminant release from the tanks.

Waste Management Area A is on the western flank of a sand ridge. In its vicinity, three aquifers have been identified: lower sand, middle sand and upper sand (see figure 5.2). Groundwater flow is initially to the south. As the aquifer sands thicken, the flow direction bends to the south-southeast.

Most of the wastes at Waste Management Area A (WMA A) are believed to be above the groundwater table. The exception to this includes the active liquid waste Tank 1, which appears to be in contact with the groundwater table in the northern portion of the WMA. The infiltration of surface water has transported contaminants into the groundwater, which has created a contaminated plume with an area extent of about 38,000 m². The groundwater

plume is subject to periodic investigations to monitor its migration and to identify any deviations from expected conditions. Immediately downgradient of WMA A (i.e., near the source of the plume), routine groundwater monitoring conducted to date has revealed the presence of gross beta (17 Bq/L to 24,700 Bq/L), gross alpha (below minimum detectable activity to 3 Bq/L) and tritium (13 Bq/L to 34,593 Bq/L). The 2023 monitoring results indicate that the groundwater immediately downgradient of WMA A continues to be substantially affected by past operations of the WMA, with gross beta being the most significant contaminant. In general, long-term trends of radiological parameters have indicated that the groundwater conditions are stable or improving, because the contamination levels in the groundwater around the perimeter are generally either remaining at similar concentrations or gradually declining with time, often with variability.

The South Swamp funnel and gate Permeable Reactive B (PRB) was constructed in 2013 with the goal of treating the Sr-90 groundwater plume emanating from WMA A. The PRB is intended to provide long-term, passive interception and treatment of the Sr-90 and thereby mitigate the continued discharge of Sr-90 into the South Swamp wetland. To assess performance of the PRB, groundwater samples are collected from the monitoring wells directly up- and downgradient of the PRB. Sampling results confirm that the PRB significantly reduces the Sr-90 concentrations before reaching the South Swamp wetland. In 2023, the concentration of Sr-90 in upgradient monitoring wells was up to 605 Bq/L, while in the downgradient wells, the concentration was up to 0.45 Bq/L, lower than the Canadian drinking water guideline value of 10 Bq/L.

Figure 5.2: Waste Management Area A at CRL



5.1.1.2 Waste Management Area B

Waste Management Area B was established in 1953 to succeed Waste Management Area A as the site for solid waste management at CRL. The site is located on a sand-covered upland, approximately 750 m west of Waste Management Area A. Early waste storage practices for LLW were the same as in Waste Management Area A, namely, emplacement in unlined trenches, capped with sandy fill, in what is now the northern portion of the site. Additionally, numerous special burials of components and materials 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 Waste Management Area B for LLW was discontinued in 1963 in favour of concrete bunkers and Waste Management Area C.

Concrete structures were used to store solid waste packages that did not meet sand trench acceptance criteria, but also did not require a significant amount of shielding. Early concrete bunkers were rectangular. These were superseded in 1979 by cylindrical structures, which are still used.

Cylindrical bunkers are formed by using removable metal forms to create corrugated reinforced concrete walls on a concrete pad. The maximum volume of a cylindrical concrete bunker is 110 m³, but typical volumes of stored waste average about 60 m³.

Wastes that present a higher level of hazard are also stored in Waste Management Area 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. A new tile hole array at Waste Management Area B was constructed in 2010 and made available for use in 2011.

Several groundwater contaminant plumes extend from Waste Management Area 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. This solvent 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 Waste Management Area B (near the source of the plume) indicates stable conditions, given that the contamination levels in the groundwater at the perimeter remain at similar concentrations over time.

The second plume emanates from the northwest corner of Waste Management Area B 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 Waste Management Area B (near the source of the plume) indicates improving conditions; 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 2019, the Spring B Treatment Plant treated 2,201 m³ of groundwater, removing 3.7 GBq of strontium-90 and reducing input concentrations from 1,704 Bq/L (average) to 5.0 Bq/L (average). A new Spring B Treatment Plant was constructed and operated in parallel with the original plant for 34 months, with the original plant being shut down in June 2022. The New Spring B facility B598, had an average feed concentration of 1458 Bq/L and a total of 1474 m³ of Sr-90 contaminated groundwater was treated for the 2023 calendar year. The average discharge concentration for 2023 was 1.08 Bq/L. The 2023 operational year had a removal efficiency of 99.9%, which exceeded the target of 96% removal efficiency.

Tritium is another contaminant observed in the groundwater at Waste Management Area B. Routine groundwater monitoring indicates that the tritium contamination levels remain stable over time. A number of different types of waste storage structures within Waste Management Area B are considered the source of this contamination.

Figure 5.3: Waste Management Area B at CRL

5.1.1.3 Waste Management Area C

CRL's Waste Management Area C was established in 1963 to receive LLW with hazardous half-lives of 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, part of the original parallel trenches were covered with an impermeable membrane of high-density polyethylene.

An extension was constructed adjacent to the south end of Waste Management Area C in 1993 and began accepting wastes in 1995. As the continuous trench and/or its extension was backfilled and landscaped, material from the suspect soil stockpile was used for grading purposes to ensure the surface of Waste Management Area C was 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 wastes were also placed in specific sections of the trenches or in special pits located along the western edge of the area, although this practice was discontinued. Contaminated sewage sludge was also emplaced in the sand trenches until late 2004.

Since 2006, additional waste inventory, including sewage sludge, has been restricted to interim above-ground storage of sealed containers. The new bulk materials landfill was completed in 2010 and the sewage sludge in containers on the surface of Waste Management Area C was transferred to Waste Management Area J in late 2010. Groundwater monitoring data at Waste Management Area C indicates that a plume has been emanating from this area. The primary contaminant is tritium, although organic compounds are also observed at elevated concentrations in some boreholes. In 2012 and 2013, materials stored on the surface of Waste Management Area C, namely the NRX stack pieces, were removed in preparation for the installation of an engineered cover over Waste Management Area C. The NRX stack pieces were re-packed in specially designed PacTec bags and transferred to Waste Management Area H for surface storage. In 2013, the engineered cover with geotextile and geomembrane layers was installed over Waste Management Area C to minimize infiltration of atmospheric water in the stored waste.

Routine groundwater monitoring indicates that the tritium contamination levels have decreased and the plume has been receding since the engineered cover was installed in 2013. In early 2020, a nuclear safety note was prepared to consider modifications to Waste Management Area C making it possible to mobilize the area as a recoverable surface storage area for LLW in marine containers only. The nuclear safety note was approved, and the prerequisite for entering the detailed design phase for the necessary modifications was satisfied. Construction started in 2022 and was completed in 2023. Operation of the site is planned for 2024 once consent is received from the CNSC.

Figure 5.4: Waste Management Area C at CRL



5.1.1.4 Waste Management Area D

Waste Management Area D (WMA D) was established in 1974 as a lay-down area for storing equipment and materials known or suspected to be contaminated with low levels of contamination, such as pipes, vessels and heat exchangers. All of this legacy material was removed and either returned to owners or disposed of through off-site metal recycling. Temporary storage of equipment in WMA D was stopped in 2017.

The mixed waste storage facility is composed of three interconnected, engineered structures designed for the safe short-term storage and handling of mixed liquid waste (i.e., waste that is both chemically and radiologically hazardous). The structures have two storage rooms with proper leak containment and ventilation, as well as a sampling or bulking area with fume hoods, exhaust and leak containment capabilities.

The site consists of a fenced compound that encloses a gravel-surfaced area in which the components are placed. Components that have surface contamination must be packaged appropriately to make them free of surface contamination.

In an aggressive cleanup campaign that started in 2014, the outside compound was cleared of all but neatly stored marine containers. In 2016, material that had been stored in the buildings from prior LLRWMO remediation activities was consolidated in modern standard storage containers to be disposed of in the proposed near-surface disposal facility, when it becomes available. All storage in Waste Management Area D is above ground. No burials are authorized in this area. In 2019 this waste management was modified in conjunction with neighbouring Waste Management Area H (see annex 5.1.1.8), and boundary fences that previously prevented free movement between these two areas were modified. To support accelerated decommissioning and waste management activities, both of these areas have been modified to be able to accommodate the development of

new waste treatment capabilities, the expansion of the fenced compound area and improvement of the hard-standing surfaces to permit maximum capacity for interim storage of packaged LLW waiting for operations to begin at the NSDF.

Figure 5.5: Waste Management Area D at CRL



5.1.1.5 Waste Management Area E

Waste Management Area E is an area that received suspect and slightly contaminated soils and building materials, as well as other bulk soils and building debris, from approximately 1977 to 1984. The waste materials were used to construct a roadway in the area that was meant to become a site for suspect contaminated materials, to be used in place of Waste Management Area C, but it was never put into operation.

Figure 5.6: Waste Management Area E at CRL



5.1.1.6 Waste Management Area F

Waste Management Area F was established in 1976 to accommodate contaminated soils and slag from Port Hope, Albion Hills and Ottawa – all located in Ontario. 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 the possible migration of radioactive and chemical contaminants. A detailed environmental characterization is being planned for WMA F to confirm characteristics and waste quantities. This data will be used to support the Remedial Action Plan for WMA F and enable planning for the ultimate disposition of all waste, which may include disposal in the proposed Near Surface Disposal Facility (NSDF).

Figure 5.7: Waste Management Area F at CRL



5.1.1.7 Waste Management Area G

Waste Management Area G was established in 1988 to store the entire inventory of spent fuel from the NPD prototype reactor in above-ground concrete canisters. It originally consisted of 12 NPD fuel canisters and two calcine waste canisters. A total of 11 NPD canisters are full and one canister is empty, as a spare. The calcine waste canisters were constructed for the anticipated waste that would be created by the processing of radioisotopes separated in the new dedicated isotope facility at CRL. However, both of the calcine waste canisters are currently empty. These two canisters, plus an additional 10 identical canisters that were constructed in 2019, will store all fuel from Whiteshell. Transfers to CRL from G-1 will commence in 2024, and those from Whiteshell to CRL are expected to commence in 2025.

5.1.1.8 Waste Management Area H

Waste Management Area H began operating in 2002. It is the location for the MAGS and SMAGS structures. Dry LLW is packaged, and in some instances, compacted in steel containers prior to storage in MAGS (see figure 5.9) and SMAGS. In March 2014, the CNSC granted approval for the construction of six SMAGS structures at CRL. The first three structures have been completed and are operational. The remaining three have been deferred pending the availability of the proposed NSDF. Once the NSDF is operational, pending regulatory approvals, wastes that meet the proposed NSDF waste acceptance criteria will be routed directly to it and suitable wastes currently in storage will be sent to the facility for disposal. SMAGS will then be focused on storage of wastes not suitable for disposal in the proposed NSDF.

The footprint in Waste Management Area H that SMAGS 4 through 6 would have occupied has been prepared as a compacted gravel hard-standing surface to accept containerized wastes for interim storage while construction of the proposed NSDF is being planned. This waste management area has been further modified in conjunction with neighbouring Waste Management Area D (see annex 5.1.1.4). Waste Management Area H can now accommodate up to 138,000 m³ of LLW in marine containers.

All waste that used to be stored in the two MAGS structures has been recovered, characterized, sorted and segregated, and repackaged in NSDF packages that are compliant with waste acceptance criteria while awaiting disposal once the proposed NSDF is available. This work has informed the development of plans for improved processing of legacy waste in storage that will need to be recovered and reworked in order to be compliant for disposal. In 2019 MAGS building B599B was converted into a Sort and Segregation Facility (SSF) Pilot, to deliver proof of concept for operating a SSF. Also in 2019, MAGS building B599A was demolished and a SSF building (B599F) was then constructed on the demolished B599A footprint. This SSF has operated successfully since 2021 reducing CRL legacy waste liabilities and freeing up storage space for new waste inventories. In 2023, the engineering change processes were started to convert B599B from a SSF Pilot back into a MAGS.

Figure 5.9: Waste Management Area H at CRL



5.1.1.9 Waste Management Area J

Construction of Phase 1 of the bulk material landfill located in CRL's Waste Management Area J was completed in 2010. The landfill is designed for the long-term management of the dewatered sewage sludge produced at the sewage treatment plant at CRL. Dewatered sewage sludge had been stored in roll-off containers in Waste Management Area C since 2004; the contents of these containers were safely emplaced in the bulk material landfill in late 2010.

The facility consists of an engineered landfill lined with impermeable layers of geotextile and semi-permeable layers of clay. The leachate from the waste is collected and sent for further processing following analysis.

Construction of phase 2 was completed in 2017. Once all phases (a total of four) are complete, the bulk material landfill will be able to accommodate 100 years of sewage sludge generated at CRL and will ensure proper long-term management of the waste in an environmentally responsible manner. Since the Seventh report, the vast majority of the sludge from the modern sewage treatment plant at the CRL site meets the requirements for off-site disposal as non-radioactive.

Figure 5.10: Waste Management Area J at CRL



5.1.1.10 Liquid dispersal area

The 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 Waste Management Area A on 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 g 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 Waste Management Area 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 to transfer 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.

A 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.

A laundry pit, installed in 1956, is the last facility in the liquid dispersal area. As its name implies, the laundry pit was used for waste water from the active area laundry and the decontamination centre, but it was only employed for that purpose for a year. The recorded inventory is 100 GBq of mixed fission products.

The liquid dispersal area has not been used since 2000 and there are no plans for the future use of this area. Two groundwater plumes emanate 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 decreased 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; the contamination levels in the groundwater are decreasing. The effects of this contaminant migration are mitigated by a plume treatment system known as the chemical pit treatment plant. This facility removes a significant fraction of strontium-90 from the groundwater collected from four collection wells that are spaced across the width of the plume near the pit. In 2013, the chemical pit treatment plant treated 2,550 m³ of groundwater, removing 2.1 GBq of strontium-90 and reducing input concentrations from 743 Bq/L (average) to 3.5 Bq/L (average). In 2023, the chemical pit treatment plant treated a total of 3,688 m³ of Sr-90 contaminated groundwater, with a removal efficiency of 99.1%, reducing input concentrations from 654 Bq/L (average) to 5.9 Bq/L (average).

The current groundwater treatment facility has been operating for over 20 years and is approaching the end of its design life. Given many recent developments, the strategy for this particular area is being revisited. With the proposed NSDF expected to be available in 2030, and with continued work on proposed land uses and interim soil cleanup levels, the future for this area could involve either early source removal or continued pump and treat. The current treatment methods will continue to be used while the options are further evaluated.

5.1.1.11 Acid, chemical and solvent pits

There are three small pits located north of Waste Management Area C, which 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 acid, chemical and solvent wastes. The acid pit received about 11,000 L 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 L of mixed solvents, oils, paint thinner and acetone, while the chemical pit received smaller volumes of wastes. Although the intent was to exclude active materials, investigations later showed that radioactive materials were inadvertently placed in the pits due to poor segregation practices, and lightly contaminated sands were used to backfill the holes in 1987.

5.1.1.12 Waste tank farm

The waste tank farm contains seven underground stainless-steel tanks that store liquid ILW. The first series of three tanks contains ion exchange regeneration solutions from fuel rod storage bays. 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 solutions have been added since then. One of the four tanks is empty and serves as a backup in the event that one of the other tanks leaks.

In 2012, the tank 40D leak avoidance project was launched to reduce the environmental risk of a leak in an aging storage structure. Tank 40D is a single-walled direct buried tank. The objective of the project was to protect the environment by removing the tank contents before any leakage occurs. By 2014, more than 80% of the liquid contents of this tank was retrieved and processed, leaving only a fine silty sludge. This volume was further reduced with improved filtration in 2017.

More hazard reduction activities are underway. It is expected that by 2033, the stored liquid wastes from this tank farm will have been removed and will be undergoing processing. The resulting waste product is expected to be transferred to interim storage if it is not suitable for immediate disposal in the proposed NSDF. The tank farm facilities will then be turned over for decommissioning.

5.1.1.13 Ammonium nitrate decomposition plant

The ammonium nitrate decomposition 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, given 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 – that operates passively using a clinoptilolite zone installed in the ground next to an impermeable barrier that extends across the plume flow path. This passive treatment system removes a significant portion of the strontium-90 activity in the influent. The total volume of groundwater treated in 2023 was 1.66×10^7 L. The average influent Sr-90 concentration, which is sampled on a semi-annually basis, was 384 Bq/L. The average effluent total beta concentration, which is sampled monthly, was 0.2 Bq/L. The calculated amount of Sr-90 retained in the PRB in 2023 was 6.37×10^9 Bq and the total estimated retention (1998 to 2023) was 2.42×10^{11} Bq.

5.1.1.14 Thorium nitrate pit

In 1955, about 20 m³ of liquid waste from a uranium-233 extraction plant on the CRL site was discharged into a pit. The solution contained 200 kg of thorium nitrate, 4,600 kg of ammonium nitrate, 10 g of uranium-233 and 1.85×10^{11} Bq each of strontium-90, cesium-137 and cerium-144. The pit was filled with lime to neutralize the acid and precipitate the thorium, then covered with soil.

5.1.1.15 Glass block experiments

In 1958, a set of 25 hemispheres of glass (weighing 2 kg each) of mixed fission products was buried below the water table as part of a program to investigate methods for converting high-level liquid radioactive 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 since been recovered and transferred to secure storage in the waste management areas.

5.1.1.16 Bulk storage area

The bulk storage area was used prior to 1973 to store large pieces of equipment from the control area. Significant cleanup of this area was completed, resulting in a reduction of future liability. The cleanup of the area was completed in November 2013.

5.1.1.17 Emissions

The operation of the CRL waste management areas results in the release of radioactive and non-radioactive contaminants into the environment. Most of the existing releases are historic. They resulted from discontinued practices, such as the dispersal of intermediate-level liquid waste and sand trench disposal of intermediate solid and liquid wastes. The releases 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. In addition, CRL has developed administrative levels set at a fraction of the DRL and close to the normal operating levels. These levels are used to provide timely warning that a higher than expected release has occurred and that the situation will be investigated promptly.

5.1.1.18 CRL Waste Treatment Centre

The CRL Waste Treatment Centre treats liquid wastes from CRL facilities that are contaminated or suspected of being contaminated by radioactivity. It also treats small volumes of liquid radioactive waste received by CRL from off-site waste generators.

Prior to September 2020, when the baler was permanently taken out of service, the WTC also received and treated wet solid wastes. The wet solid wastes were baled (after compacting, if possible) and transferred for storage in concrete bunkers in Waste Management Area B. Between 50 and 150 bales measuring 0.4 m³ were produced per year. The Waste Treatment Centre also generates a small volume of solid waste internally. This waste includes disposable clothing, paper and cleaning materials, and is compacted (where possible), and stored in Waste Management Area B. Liquid waste is treated in variable amounts per year, currently ranging from 300 – 500 m³/year (whereas the range was 1,500 m³ to 4,000 m³/year when the NRU was still operating). It consists primarily of liquid wastes from the decontamination centre, chemical active drain system and reactor active drain system. Smaller amounts of concentrated legacy-stored liquid wastes originating from historical operations are pre-treated locally with ion exchange media to reduce radioactive content prior to final treatment in the Waste Treatment Centre. Treatment facilities include a liquid waste evaporator, which concentrates the waste, and a liquid waste immobilization system, which immobilizes the concentrated liquid in a bitumen matrix in drums that are then stored in Waste Management Area B.

Since the permanent shutdown of the NRU reactor in March 2018, annual quantities of radioactive liquids sent for treatment have reduced considerably. Progress has been achieved in retrieving legacy liquid wastes as part of the stored liquid waste project. As such, operations have shifted from running both the liquid waste evaporator and liquid waste immobilization system roughly the same amount time, to operating the liquid waste immobilization system as the primary support for the stored liquid waste project and operating the liquid waste evaporator only periodically, as required. This mode of operations will continue until the Waste Treatment Centre reaches its end of life, coinciding with the completion of the stored liquid waste project, which is expected by 2034. Future needs for liquid waste treatment capability at CRL beyond the Waste Treatment Centre are currently being determined.

Atmospheric releases of radionuclides from the Waste Treatment Centre occur via roof vents. Roof vents are monitored for particulate gross alpha activity, particulate gross beta activity, tritium oxide and iodine-131. Treated liquid effluent from the Waste Treatment Centre is discharged to the process outfall after sampling for gross alpha, gross beta and tritium oxide. The liquid effluent is also regularly monitored for suspended solids, total phosphorus, nitrates, power of hydrogen, conductivity, organic carbon, chemical oxygen demand, solvent extractables, metals, volatile organics and semi-volatiles.

5.1.2 Whiteshell Laboratories

WL is a nuclear research and test establishment currently undergoing decommissioning in Manitoba, located on the east bank of the Winnipeg River, about 100 km northeast of Winnipeg. Comprising a number of nuclear and non-nuclear facilities and activities, the major facilities on-site include the WR-1, shielded facilities, research laboratories, and liquid and solid radioactive waste management areas and facilities, which include the concrete canister storage facility complex for the dry storage of spent research reactor fuel. Annex 8.8 provides further information on these decommissioning activities.

One waste management area is located approximately 1.5 km northeast of the main WL site (2.7 km by road). The area measures approximately 148 m by 312 m, representing 4.6 hectares. The waste management area, which has been in operation since 1963, provides storage for L&ILW and includes the following facilities:

- LLW storage bunkers
- LLW unlined earth trenches
- LLW/ILW storage bunkers
- ILW in-ground concrete bunkers
- HLW/ILW in-ground concrete standpipes (similar to the CRL tile holes described in annex 5.1.1.2)
- liquid waste storage tanks

The concrete canister storage facility, described in annex 4.17, is located next to the waste management area.

Hydrologically, the waste management area 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 excavations is limited to ensure the impermeable clay layers are not penetrated.

From 1963 to 1985, LLW was buried in unlined trenches approximately 6 m wide by 4 m deep, and up to 60 m long. Trenches were covered with at least 1.5 m of excavated material after they were filled. There are 25 filled trenches located in the waste management area. Trench storage of LLW was discontinued in 1985 in favour of engineered above-ground LLW storage bunkers. The LLW bunkers are constructed of concrete; overall dimensions are 26.4 m long by 6.6 m wide by 5.2 m high, with a wall thickness of 0.3 m, for a total of 805 m³ of storage space in each bunker. A SMAGS structure has been constructed (discussed in annex 5.1.1.8) for the storage of future LLW from decommissioning.

In-ground or partially in-ground bunkers are used to store ILW. Possessing a variety of dimensions, these bunkers are constructed of reinforced concrete, with a wall thickness of 0.25 m. In-ground, concrete standpipes (similar to the CRL tile holes described in annex 5.1.1.2) 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 m thick, with a 0.3 m integral base lined with galvanized steel pipes. A removable concrete shielding plug, about 0.9 m thick, provides access.

As part of the decommissioning plan for WL, all radioactive waste currently stored in bunkers, standpipes and above-ground storage buildings is to be sent to CRL for disposal at the NSDF, or consolidated for storage with CRL ILW until disposal is available. A safety case must be developed for the *in situ* disposal of the trenches. Wastes for which such a safety case cannot be made will be retrieved and sent to CRL for disposal or storage, as appropriate.

Figure 5.11: Whiteshell Laboratories waste management areas

5.2 Best Theratronics Manufacturing Facility Kanata

Best Theratronics Ltd. is a medical device manufacturing company, located in Kanata, Ontario, which manufactures medical equipment used throughout the world. Best Theratronics has a Class 1B licence that covers activities related to manufacturing radiation devices and radiation teletherapy machines, self-contained irradiators for blood or research irradiation, and cyclotrons with beam energies ranging from 15 to 70 MeV. Currently, Best Theratronics Ltd. stores disused cobalt-60 sealed sources, cesium-137 sources and depleted uranium in dry storage.

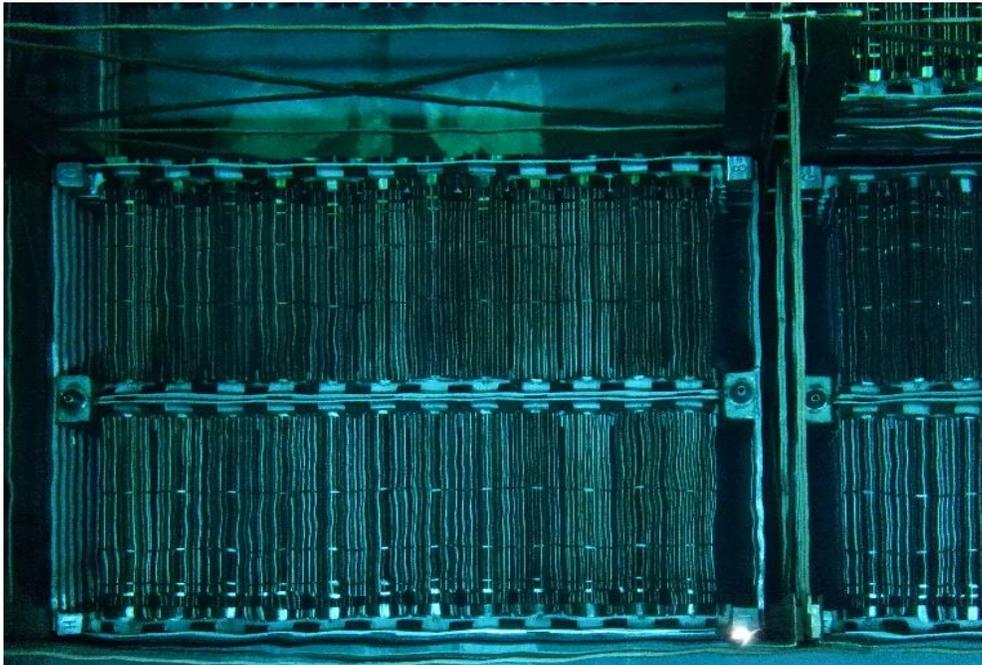
Figure 5.12: Best Theratronics Manufacturing Facility Kanata

5.3 Bruce Nuclear Generating Station

For more than 30 years, the four reactors at BP's Bruce B NGS have been a reliable cobalt-60 supply for Nordion, an Ottawa-based company. BP's cobalt-60 helps to sterilize 40 percent of the world's single-use medical devices, including sutures, syringes, masks and gloves. Bruce Power also produces medical-grade cobalt-60 that is used in radiation-based cancer treatments, as well as other diseases in Canada and around the world.

The cobalt-60 rods are stored in BP's secondary fuel bay. The harvested rods are suspended on the wall of the fuel bay, about 4.3 m below the surface; the water provides employees with shielding from the radioactivity. From the reactivity mechanism deck over the fuel bay, BP's specialized fuel handlers extract the individual irradiated rods and place them in a shielded flask to be shipped to Nordion's facility.

Figure 5.13: Non-fuel HLW at the Bruce NGS



5.4 BWXT NEC Peterborough and Toronto

BWXT NEC implements programs to conserve natural resources, prevent pollution and minimize waste. All articles removed from radiation-controlled areas are included in radioactive waste, unless they meet the limits for unconditional release. BWXT NEC has an effective and well-established radioactive waste program that ensures all radioactive waste disposals are compliant with regulations and the conditions of the facility's operating licence. The production of radiological waste is minimized by minimizing articles that enter radiological areas and reusing items like shop coats and shoe covers that are laundered. Scrap materials like pellets, powder and sludge are returned to the supplier for recycling.

Radioactive solid wastes generated from fuel manufacturing, which consist of or are contaminated by uranium are accumulated in controlled and classified areas in drums, in waste boxes or on skids. A low volume of radioactive waste from Peterborough is transported to and consolidated with the Toronto facility's wastes. These are combined, compacted for volume reduction where possible and shipped routinely to a licensed radioactive waste facility.

Figure 5.14: BWXT NEC Peterborough



Figure 5.15: BWXT NEC Toronto



5.5 Cameco Blind River Refinery, Port Hope Conversion Facility and Cameco Fuel Manufacturing Facility

For both environmental and economic reasons, conserving resources and recycling materials is an important part of operations. At Cameco's Blind River Refinery (see figure 5.16), nitrogen oxide off-gases are absorbed and converted to nitric acid for reuse.

Figure 5.16: Cameco Blind River Refinery

At Cameco's Port Hope Conversion Facility (see figure 5.17), ongoing recycling programs include in-plant recovery of hydrofluoric acid from air emissions for reuse, as well as the creation and sale of an ammonium nitrate by-product for use as commercial fertilizer.

Figure 5.17: Port Hope Conversion Facility

Several process streams in the uranium refining, conversion and fuel manufacturing processes result in materials that contain economically viable quantities of natural uranium. The Blind River Refinery receives and processes small quantities of natural uranium-bearing scrap materials, such as uranium dioxide from the Cameco Fuel Manufacturing Facility (see figure 5.18) and the Port Hope Conversion Facility in various forms (e.g., fuel pellets, sludge and powder). The uranium refining process produces two recyclable products: the regeneration product produced in the solvent treatment circuit, and the calcined product produced in the raffinate circuit. The conversion process produces a uranium-containing fluoride product. These three products contain recoverable uranium and are recycled via re-milling for uranium recovery at a uranium mill.

Figure 5.18: Cameco Fuel Manufacturing Facility

The waste management programs at Cameco's Blind River Refinery, Port Hope Conversion Facility and Cameco Fuel Manufacturing outline the implemented process to collect, clean and monitor all materials for free release to commercial recycling organizations. Material that is contaminated with uranium and cannot be recycled or does not meet the strict release criteria can be incinerated and reduced to ash or packaged for disposal at a licenced WMF. The packaged non-recyclable material that cannot be cleaned consists of materials like insulation, sand, soil and some scrap metal.

The Government of Canada has agreed to accommodate 150,000 m³ of waste from the Port Hope Conversion Facility that arises from the early operations of that site and pre-date Cameco's formation. These wastes include drummed radioactive wastes, contaminated soils and wastes arising from decommissioning that are part of the PHAI (see annex 7.2.1 for more details). The transfer of these materials began in 2018 and is expected to continue until approximately 2030.

5.6 Darlington Waste Management Facility

The operating lives of the Darlington NGS reactors are limited by the condition of the major reactor fuel channel components. As a result, refurbishment is required in order to extend the lives of these reactors. Reactor refurbishment consists of a large-scale overhaul wherein the fuel channel components and channel feeder tubes are replaced.

The Retube Waste Storage Building was constructed as part of the Darlington Refurbishment Project, and was placed in service in 2017. As part of the refurbishment of each reactor, after the calandria tubes and feeders are removed, the materials are sent to a processing building where they are prepared for safe disposal or storage, as applicable. The refurbishment retube waste is classified as ILW.

The reactor retube waste is placed in a primary shielded container known as the Darlington retube waste container, which is stored within a secondary shielding overpack, referred to as the Darlington storage overpack. Darlington storage overpacks are loaded in the processing building before transport to storage at the Darlington WMFs Retube Waste Storage Building. Interim storage of the processed Darlington storage overpacks is required for approximately 25 years to allow the waste to radiologically decay and reduce dose rates to acceptable levels so it can be transported off-site to a permanent long-term storage facility.

The Retube Waste Storage Building has the capacity to accommodate the waste from all four Darlington reactor refurbishments.

Figure 5.19: Darlington storage overpacks stored at the Darlington WMF

5.7 Gently-2 Waste Management Facility

Hydro-Québec's (H-Q) solid radioactive waste management facilities consist of two separate on-site facilities that provide safe storage for radioactive materials produced at the Gently-2 NGS (see figure 5.20). Both facilities comprise several types of reinforced concrete bunkers.

Figure 5.20: Compacted LLW stored at Gently-2

The Phase I of the newest solid radioactive waste management facility was commissioned in 2008; the commissioning of Phase II was authorized in 2013. These facilities were originally built for the storage of refurbishment waste. This most recent facility stores spent resins, ILW and LLW from operations and decommissioning activities.

The volume of LLW produced at Gentilly-2 is now less than 10 m³/year. Samples of surface water runoff from both solid radioactive waste management areas collected and analyzed in 2023 have shown that average tritium concentrations were 122 and 132 Bq/L. The average gamma dose rates for 2023 at each of these facilities' perimeter fences were 0.054 and 0.072 µSv/hour. The regulatory limit for dose to the public is 1 mSv/year.

Figure 5.21: Gentilly-2 Waste Management Facility



5.8 Nordion manufacturing facility, Kanata

Nordion has designated space and processes to store and segregate radioactive waste that is generated in its operations. The primary area where radioactive materials are processed and stored consists of processing hot cells (see figure 5.22) and storage pools. Cobalt-60 encapsulated radioactive sources are stored underwater in storage pools; the water in the pools serves as a cooling and shielding medium. The storage pools are used for unloading incoming encapsulated radioactive sources and measuring, storing and transferring the materials into hot cells for further processing. Spent cobalt-60 sealed sources may be returned by customers to Nordion, where they are reprocessed or transferred to licensed facilities for long-term management. Returned cobalt sources may be recycled into new-source manufacturing, re-encapsulated into new sources or added to Nordion's source inventory.

Figure 5.22: Hot cells at the Nordion manufacturing facility, Kanata

5.9 Pickering Waste Management Facility

The Pickering WMF (see figure 5.23) consists of the spent fuel dry storage area (see annex 4.13) and the retube components storage area, which stores reactor core component waste from retube activities at the Pickering NGS (Units 1–4) conducted in the 1990s. The retube components storage area is located in the protected area of Pickering NGS and is operating in SWS mode; as such, it is closed to new waste, unless it receives prior written approval from the CNSC.

The retube components storage area uses dry storage modules – cylindrical casks made of reinforced heavy concrete – to store the retube components. The storage area was designed to accommodate 38 dry storage modules. The design of the modules provides adequate shielding to meet dose rate requirements outside the facility and to keep worker dose rates ALARA. At present, the retube components storage area consists of 34 loaded dry storage modules, two empty modules and space for two additional modules.

The ground surface of the retube components storage area is covered with an impermeable membrane that provides a low-maintenance surface. A drainage system directs the runoff water from the storage area to the Pickering NGS Units 5–8 outfall. Catch basins permit the periodic sampling of the water.

In 2024, the Ontario government announced plans to proceed with next steps toward refurbishing Pickering Nuclear Generating Station's "B" units (Units 5-8). Once refurbished, Pickering would produce a total of 2,000 megawatts (MW) of electricity. Similar to Darlington NGS, reactor refurbishment will consist of a large-scale overhaul wherein the fuel channel components and channel feeder tubes are replaced, along with other major equipment as required. Lessons learned from retube waste storage at Darlington are being incorporated into planning for waste storage required from Pickering refurbishment. A storage structure is being planned for the Pickering site to accommodate some of the waste resulting from refurbishment. Refurb waste profiles are being analyzed, along with existing container designs and potential new container designs to determine the most practical container storage solutions.

Figure 5.23: Pickering WMF with retube components storage area (left) and spent fuel dry storage area (right)



5.10 Point Lepreau Waste Management Facility

The Point Lepreau Solid Radioactive WMF is composed of Phase I (for the storage of operational solid radioactive waste), Phase II (for the storage of spent fuel, as described in annex 4.15) and Phase III (for the storage of solid radioactive waste from the refurbishment outage).

Figure 5.24: Point Lepreau Waste Management Facility



The Phase I area contains the following storage structures:

- **Vaults** – The Phase I vaults are concrete structures (see figure 5.25) used to store operational LLW and ILW. There are six vaults, five of which contain four equal compartments and one of which contains two such compartments, and two compartments that were modified to be filter storage structures (described below). The activity associated with the majority of the waste stored in the Phase I vaults is expected to decay to an insignificant level by the end of the design life of these structures. Of the approximately 3,071 m³ of storage space in the six vault structures, a total of approximately 566 m³ was occupied with solid radioactive waste at the end of 2023.
- **Quadricells** – The Phase I quadricells are designed to house high-dose rate ILW, such as spent ion exchange resins and contaminated system components. Approximately 144 m³ of storage space is available in a total of nine quadricells. These structures were empty at the end of the reporting period and have not been used to date.
- **Filter storage structures** – The two filter storage structures in Phase I are used for storing operational ILW filters, specifically, spent purification filters from the heat transport purification, moderator purification, active drainage, gland seal supply, spent fuel bay and fuelling machine systems. These structures are contained within one of the vault structures, as mentioned above. There is approximately 43 m³ of storage space in two structures. A total of approximately 15 m³ of spent filter waste was stored in these storage structures at the end of the reporting period.

A total of approximately 423 m³ of radioactive waste was transferred from the station to Phase I over the reporting period. A volume reduction strategy was implemented in December 2010. Under this strategy, processable radioactive waste is sent to EnergySolutions' Bear Creek Processing Facility in Oak Ridge, Tennessee. An approximate volume reduction of 80:1 is realized via this process in terms of incinerable waste, while an approximate volume reduction of 5:1 is realized in terms of compactable waste. Recyclable radioactive metal waste is used for shielding purposes in the nuclear industry in the United States and is therefore not returned to NB Power. A total of approximately 822 m³ of radioactive waste was transferred from Phase I to EnergySolutions during the reporting period.

The samples of surface runoff from Phase I, collected and analyzed over the reporting period, had an average tritium concentration of approximately 200 Bq/L. The average dose rate for the reporting period at the Phase I perimeter fence, as read from TLDs, was approximately 0.12 µSv/hour. The regulatory limit for dose to the public is 1 mSv/year.

Figure 5.25: Point Lepreau vault storage structure



The Phase III area contains the following storage structures:

- **Vaults** – The Phase III vaults are concrete structures identical to those in Phase I. They are used to store LLW and ILW from the refurbishment outage. There is approximately 890 m³ of storage space in the two vault structures. As of March 31, 2024, approximately 871 m³ of vault storage space was being occupied.
- **Retube canisters** – The Phase III retube canisters (see figure 5.26) are concrete structures used to store high dose rate ILW from the Point Lepreau refurbishment outage, which consists primarily of reactor components. There is approximately 165 m³ of storage space in the five structures. Approximately 140 m³ of retube canister storage space was occupied at the end of the reporting period.

No solid radioactive waste was transferred to or from this facility during the reporting period.

Samples of surface runoff from the Phase III area, collected and analyzed over the reporting period, had an average tritium concentration of approximately 122 Bq/L. The average dose rate for the reporting period at the Phase III perimeter fence, as read from TLDs, was approximately 0.11 µSv/hour. The regulatory limit for dose to the public is 1 mSv/year.

Figure 5.26: Point Lepreau retube waste canisters



5.11 Radioactive waste management at decommissioned reactor sites

The Douglas Point, Gentilly-1 and NPD reactors are currently shut down, partially decommissioned and in SWS. Because these facilities contain radioactive materials, including radioactive wastes from preliminary decommissioning activities, they are presently licensed as WMFs. Annex 8 provides more information about the decommissioning activities at each of these sites.

5.11.1 Douglas Point Waste Management Facility

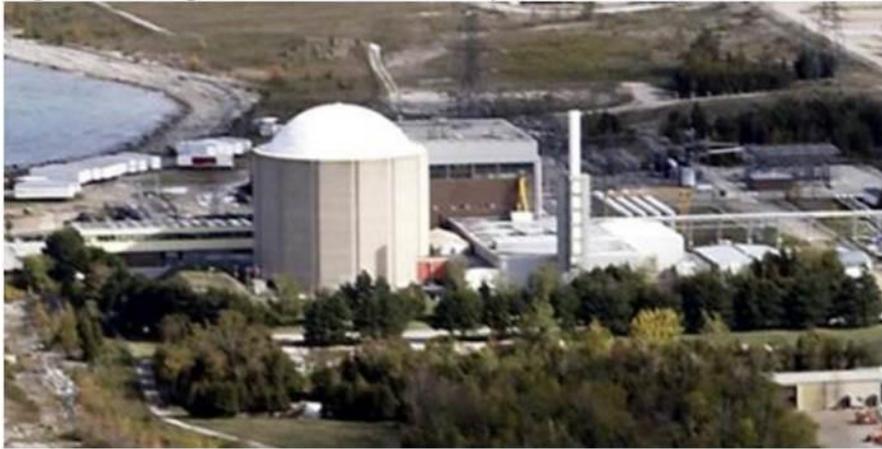
The Douglas Point WMF is located on the Bruce nuclear site in Kincardine, Ontario. The prototype CANDU power reactor was shut down permanently in 1984 after 17 years of operation. Decommissioning began in 1986 and the spent fuel was transferred to concrete canisters in late 1987. The responsibility for decommissioning Douglas Point belongs to AECL, and this work is now being executed by CNL under a GoCo arrangement.

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 that remain at Douglas Point 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
- ILW stored in the fuel transfer tunnel leading from the reactor building to the receiving bay

Routine discharge and environmental monitoring measurements confirm that the facility continues to operate safely.

Figure 5.27: Douglas Point



5.11.2 Gently-1 Waste Management Facility

The Gently-1 WMF is situated within H-Q's Gently-2 NGS boundary. The responsibility for decommissioning Gently-1 belongs to AECL, and work is now being conducted by CNL. For more information, refer to annex 4.8.

The Gently-1 WMF 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 that remain at Gently-1 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

There are no airborne releases from the facility. Routine waste water discharge and environmental monitoring measurements confirm that the facility continues to operate safely.

Figure 5.28: Gentilly-1

5.11.3 Nuclear Power Demonstration Waste Management Facility

Located in Rolphton, Ontario, the NPD WMF contains the decommissioned NPD station. The station operated from 1962 until 1987, when Ontario Hydro (now OPG), with assistance from AECL, decommissioned it, placing it in a static-state interim storage condition. After the static state was achieved, Ontario Hydro turned over control of the NPD WMF to AECL in September 1988. Since then, various non-nuclear ancillary facilities – 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 spent fuel was transferred to the CRL waste management area for storage.

The NPD WMF is divided into nuclear and non-nuclear areas. Stored waste consists of induced radioactive products, activated corrosion products and some fission products. The confined residual radioactivity in NPD after removal of the spent 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
- small amounts of radioactivity in auxiliary systems, components and materials stored in the nuclear area of the facility

Routine discharge and environmental monitoring measurements confirm that the facility continues to operate safely.

After the transition to a GoCo model in 2015, AECL is seeking to close the NPD site through the work of CNL. While AECL continues to own the site, CNL is responsible for the facility; the facility is presently in the SWS phase of decommissioning under a waste facility decommissioning licence issued by the CNSC. The NPD site currently comprises a limited number of structures, including the main reactor building, a diesel generator, a guardhouse and a ventilation stack. Several temporary structures are being added to support the decommissioning project.

Figure 5.29: Nuclear Power Demonstration

5.12 Radioactive Waste Operations Site-1

Radioactive Waste Operations Site-1 is owned and maintained by OPG at the Bruce nuclear site. The facility is used for the storage of L&ILW produced at the Douglas Point reactor and from the early operating life at Pickering Units 1–4. The majority of the original wastes from this facility were retrieved and relocated to the Western WMF in the late 1990s and early 2000s. A small volume of waste remains stored in reinforced concrete trenches with concrete covers inside in-ground monoliths and lined tile holes.

The facility currently operates in caretaking mode and no longer receives new wastes. OPG monitors and maintains the site and structures; new waste can only be added with the prior written approval of the CNSC.

The spent solvent treatment facility was demolished in October 2019, after a rigorous process of radiological surveying with results submitted to and approved by the CNSC. As an older facility adjacent to the Western WMF, it was used from the 1990s until 2008 to process solvents used at the Bruce NGSSs. On October 31, 2019, the Radioactive Waste Operations Site-1 waste nuclear substance licence was amended to remove the spent solvent treatment facility, following its demolition.

Figure 5.30: Radioactive Waste Operations Site-1



5.13 Western Waste Management Facility

The Western WMF is owned and operated by OPG at the Bruce nuclear site near Kincardine, Ontario. The Western WMF consists of two distinct areas (see figure 5.31):

- L&ILW storage area
- spent fuel dry storage area (see annex 4.16)

The L&ILW storage area provides safe handling, processing and storage of radioactive materials produced at Ontario's nuclear stations (Pickering, Darlington and Bruce) as well as other facilities currently or previously operated by OPG or its predecessor, Ontario Hydro. The L&ILW storage area consists of various buildings, such as the waste volume reduction building and the transportation package maintenance building. The storage structures used in this facility consist of above-ground LLW storage buildings, refurbishment waste storage buildings, quadricells, in-ground containers, in-ground trenches and tile holes.

The waste volume reduction building (WVRB) can receive LLW and sort it into processable and non-processable streams. In 2023, sorting of LLW also began at the Western Clean Energy Sorting and Recycling Facility (WCSR). This facility is not located on the WWMF site, but OPG staff is able to sort and segregate operational and/or legacy waste into processable waste streams at this location. Staff can further process some of the waste by compacting or incinerating it prior to storage. The WVRB consists of the following main areas:

- the radioactive waste incinerator area, which contains the radioactive waste incinerator, auxiliary systems and equipment, as well as an active drainage sump
- the compaction area, which contains a box compactor and a civil maintenance shop. Control and mechanical maintenance shops are located in the transportation package maintenance building to carry out repairs and equipment maintenance

- the material handling, storage and sorting area, which provides for material movement, sorting and temporary storage of incoming and processed wastes. This area has close access to the incinerator and compaction areas
- the control room which houses the main work control centre. All L&ILW storage area systems and services alarms are monitored in this room
- truck bays, which establish a weather-protected area for receiving and unloading LLW
- 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, which provide housing for electrical switch gear and motor control centres, as well as storage for non-waste products

Figure 5.31: Western WMF



OPG has developed DRLs for airborne radioactive releases from the radioactive incinerator and active ventilation in the waste volume reduction and transportation package maintenance buildings, as well as for releases to surface and subsurface drainage at the site. The non-radioactive effluents must conform to the environmental compliance approval for the Western WMF site issued by the Ontario Ministry of the Environment and Climate Change. Radioactive and non-radioactive effluents are all now below regulatory requirements and have historically been so.

The safe handling, processing and storage of radioactive waste at the Western WMF 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 L&ILW storage area of the Western WMF received approximately 1,600 m³ of radioactive waste in 2022. The annual amount can vary widely, depending on maintenance activities at the various NPPs. The waste is subsequently processed, when possible, and placed into the appropriate storage structure.

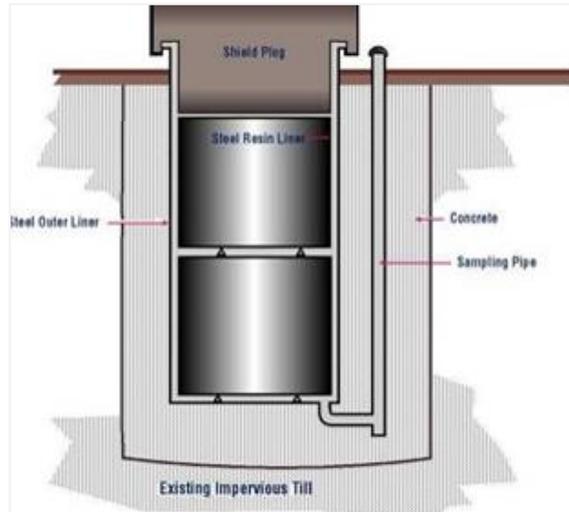
There are two refurbishment waste storage buildings located within the L&ILW storage area. These buildings store the waste from the refurbishment of Bruce A NGS Units 1 and 2 and major component replacement, ongoing at Bruce Power. One of these buildings contains the reactor tube (“retube”) components in specially designed concrete and steel boxes, while 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 NPPs by the power reactor licensee.

In 2022, the Western WMF (the spent fuel dry storage area and L&ILW storage area combined) released 1.4×10^{13} Bq of tritium, 0 Bq of particulate, 5.2×10^3 Bq of iodine-131 and 5.2×10^9 Bq of carbon-14 to air. Releases to water were 2.4×10^{10} Bq of tritium and 8.6×10^6 Bq of gross beta. These releases are orders of magnitude below the DRLs and action levels for the Western WMF.

Figure 5.32: In-ground storage structures at Western WMF for intermediate-level waste



Figure 5.33: Schematic of in-ground storage structures at Western WMF (note: only 2 of 6 resin liners are shown)



Annex 6 – Uranium Mine and Mill Facilities

6.1 Key Lake

McArthur River ore is processed at the Key Lake mill. The McArthur River mine and Key Lake mill suspended production for an indeterminate period in 2018. On February 9, 2022, Cameco announced its intent to begin the process to transition both operations from care and maintenance to production over the course of 2022 and 2023. On November 9, 2022, Cameco announced that ore from the McArthur River mine had been milled and that production had resumed. Uranium mills and operational tailings management facilities (TMF) exist at Key Lake. Non-operational tailings management areas are located at Key Lake.

6.1.1 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 achieve quality standards acceptable for release to the environment. The waste metal precipitates removed during water treatment are disposed of as solids in the TMF.

From 1983 to 1996, waste from the Key Lake mill was deposited in an above-ground TMF that covered an area 600 m by 600 m (36 hectares) and 15 m deep. The TMF was constructed five metres above the groundwater table 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 the solids consolidation of overlying tailings.

Tailings were initially deposited into the pit by sub-aerial deposition, with water extracted from the tailings mass through the bottom drain layer and the raise well pumping system. The facility later changed to sub-aqueous deposition by allowing the pit to partially flood.

Tailings are deposited under the water cover using a tremie pipe system which offers benefits in terms of the placement and attenuation of radon emissions. In this system, tailings are placed in the mined-out pit using a “natural surround” containment strategy. 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 2023, the Deilmann TMF (see figure 6.1) contained 6.35 million tonnes of tailings.

Figure 6.1: Deilmann TMF at Key Lake

6.1.2 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. While operating, material from the special waste areas is reclaimed for blending with high-grade McArthur River ore for the Key Lake mill feed. All other waste rock areas are inactive.

To reduce the decommissioning liability associated with the Deilmann north waste rock pile, approximately 1.3 million m³ of nickel-rich waste rock were excavated and disposed of in the Gaertner pit in 1998. In addition, an additional 300,000 m³ was processed and used in the Deilmann TMF west wall stabilization project in 2013. Similarly, in 2017, a total of 57,320 m³ of nickel-rich waste rock was removed from the Gaertner waste rock pile and placed on the south bench of the Deilmann TMF.

6.1.3 Contaminated industrial wastes

Contaminated industrial wastes are either recycled or landfilled in the above-ground TMF. Leachates from these materials are collected by the above-ground TMF's seepage collection system and returned to the mill for use as process make-up water or treated and released to the environment. An estimated 16,048 tonnes of uncompacted contaminated waste were placed at this site from 2020 to the end of 2023.

6.2 Rabbit Lake

Rabbit Lake entered an indefinite period of care and maintenance, suspending mining and milling operations in mid-2016. Uranium mills and operational TMFs exist at Rabbit Lake. Non-operational tailings management areas are also located at Rabbit Lake.

6.2.1 Tailings management

The Rabbit Lake above-ground TMF is about 53 hectares in area and contains approximately 6.5 million tonnes of tailings which were deposited between 1975 and 1985. These tailings are all derived from the processing of the original Rabbit Lake ore deposit. The tailings within the above-ground TMF are confined by earth-filled dams at the north and south ends, and by natural bedrock ridges along the east and west sides. The above-ground TMF is currently undergoing long-term stabilization and progressive reclamation.

The original Rabbit Lake open-pit mine was converted to a TMF in 1986 using pervious surround technology. Since its commissioning, the Rabbit Lake in-pit TMF has been used as a tailings repository for ore from the Rabbit Lake, B-zone, D-zone, A-zone and Eagle Point mines (see figures 6.2 and 6.3). At the end of 2023, the Rabbit Lake in-pit TMF contained 9.13 million tonnes (dry weight) of tailings.

The pervious surround, consisting of sand and crushed rock, is placed on the pit floor and walls before the tailings deposition. The pervious material allows the excess water contained in the tailings to drain to an internal seepage collection system, and it 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 to the environment. Upon final decommissioning and return to normal hydrogeologic conditions, groundwater will flow preferentially through the pervious surround rather than through the low-permeability tailings. Discharge of contaminants will be limited to diffusion across the tailings/pervious surround interface.

Figure 6.2: Rabbit Lake in-pit TMF



Figure 6.3: Rabbit Lake in-pit TMF



6.2.2 Waste rock management

The Rabbit Lake site contains a number of clean and mineralized stockpiles of waste rock produced in the course of mining the 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 Rabbit Lake in-pit TMF. 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 the surface at Eagle Point after the mining and backfilling of mined-out stopes is complete. The A-zone (28,307 m³ of clean waste rock) and D-zone (200,000 m³ of primarily lake-bottom sediments) waste rock piles have been flattened, contoured and vegetated. The B-zone waste pile contains an estimated 5.6 million m³ of waste material stored on a pile covering an area of 25 hectares. The B-zone pile was contoured and reclaimed through the installation of an engineered cover followed by a one-metre till cover, complete with vegetation and drainage channels to promote controlled runoff. All the special waste from the A-zone (69,749 m³), B-zone (100,000 m³) and D-zone (131,000 m³) 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 6.89 million m³ of predominantly sandstone waste rock with some basement rock and overburden tills stored on the West 5 waste rock pile adjacent to the Rabbit Lake in-pit TMF. Mineralized waste is stored on four piles (630,000 m³) adjacent to the Rabbit Lake mill. Runoff and seepage from these areas are collected in the Rabbit Lake in-pit TMF.

6.2.3 Contaminated industrial wastes

Radioactive and other contaminated materials from the Eagle Point mine, Rabbit Lake mill and Cigar Lake mine are disposed of in the contaminated landfill site located on the west side of the Rabbit Lake above-ground TMF. An estimated 612 m³ of uncompacted waste were placed at this site in 2022.

6.3 McClean Lake

Orano Canada Inc. (Orano) operates a mill and TMF for the disposal of tailings generated through the processing of uranium.

6.3.1 Tailings management

McClean Lake is the only uranium mill constructed in North America in the last 20 years. The mill and TMF feature state-of-the-art efforts for worker and environmental protection when processing high-grade uranium ore. Open-pit mining of the initial ore body (the John Everett Bates or JEB pit) began in 1995. After the ore was removed and stockpiled, the pit was developed as a TMF (see figures 6.4 and 6.5). The design of the TMF has been optimized for performance, both during operation and for the long term, by employing key features such as:

- the production of thickened tailings within the mill process (addition of lime, barium chloride and ferric sulphate) to remove potential environmental contaminants from the solution and yield geotechnically and geochemically stable tailings
- the transport of the tailings from the mill to the TMF through a continuously monitored pipe-in-pipe containment system
- the JEB TMF has been expanded vertically above the pit rim with an embankment constructed from waste rock with a soil bentonite liner on the upstream side of the embankment to contain pond water
- with current pit configuration tailings will be placed above the lowest natural ground elevation, and consolidate to, at or above lowest ground elevation (post decommissioning)

- the use of natural surround as the optimum approach for long-term groundwater diversion around the consolidated tailings plug
- the subaqueous placement of the thickened tailings below a water cover in the pit; this method prevents the freezing of the tailings and enhances radiation protection by using the water cover to attenuate radon emissions
- a bottom filter drain feeding a dewatering drift and raise wells to allow collection and treatment of discharged pore water during tailings consolidation
- the recycling of pond water by a floating barge reclaim pump system
- the complete backfilling of the pit upon decommissioning with clean waste rock and a low permeability cover

At the end of this reporting period (March 31, 2023), the JEB TMF contained 2.406 million tonnes (dry weight) of tailings.

Figure 6.4: McClean Lake operation with JEB TMF located to the left of the mill



Figure 6.5: JEB TMF at McClean Lake

6.3.2 Waste rock management

Open-pit mining at McClean Lake has progressed from one pit to the next, and has included the JEB, Sue A, Sue B, Sue C and Sue E pits (see figures 6.6 and 6.7). Mining was completed at the Sue B open pit on November 26, 2008. Open-pit mining has not occurred at McClean Lake since the completion of Sue B.

The majority of the wastes removed from the JEB and Sue open pits were overburden material or sandstone. Waste rock is segregated into clean and 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 x-ray fluorescence scanner that was successfully tested during Sue A mining and subsequently implemented in the segregation procedures). The overburden and clean waste rock stockpiles are located near the pits. The pad for the clean waste rock stockpile has been constructed using overburden. Special waste from the Sue C and JEB pits was stockpiled during mining and was subsequently backhauled into the Sue C pit after the completion of mining.

Figure 6.6: Sue mining area at McClean Lake**Figure 6.7: Sue E pit at McClean Lake**

Wastes (exclusive of the overburden) from the Sue A pit were deposited into the mined-out Sue C pit. This was a conservative approach, given the uncertainty about segregating special waste based on its arsenic content. Special waste from Sue E was also placed in the mined-out Sue C pit, while clean waste was placed in a separate Sue E waste rock stockpile.

Material removed from the Sue B pit was classified as special waste and placed in the mined-out Sue E pit below an elevation of 400 m above sea level. As of March 31, 2023, the total waste rock inventory at McClean Lake was 46.2 million tonnes of clean material (primarily waste rock) and 13.7 million tonnes of mineralized waste rock (special waste).

6.3.3 Contaminated industrial wastes

Chemically or radiologically contaminated waste materials originate from the mining, milling and water treatment areas of the McClean Lake Operation. Contaminated material is collected in yellow dumpsters that are distributed around the site, and then deposited in the landfill designated for chemically and radiologically contaminated materials contained, located in the Sue C pit (formerly located at the perimeter of the JEB TMF). In summer 2017, the temporary contaminated landfill located at the perimeter of the JEB TMF was decommissioned and a permanent contaminated landfill was developed on a platform within the Sue C pit (the Sue C contaminated landfill). Approximately 17,000 m³ of waste was relocated from the temporary contaminated landfill into the Sue C contaminated landfill, where it and newly generated waste is routinely covered and compacted. The Sue C contaminated landfill has a design capacity of between 57,000 and 65,000 m³; it is estimated that the McClean Lake Operation generates a maximum of 1,500 m³ of contaminated waste annually. The waste will remain in place permanently and be capped with the decommissioning of the Sue C pit at the end of operations. During the reporting period (April 1, 2020 to March 31, 2023) approximately 5,996 m³ of contaminated waste was generated and placed in to the contaminated landfill(s).

6.4 Cigar Lake

6.4.1 Tailings management

Cigar Lake does not have a mill and does not produce tailings. Cigar Lake ore is processed at the McClean Lake mill, and the resulting tailings are deposited in the JEB TMF. Due to the COVID-19 pandemic, uranium mining at Cigar Lake was suspended between April and September of 2020.

6.4.2 Waste rock management

There are four mine rock waste stockpiles (stockpile A clean rock, and A1 concrete and benign rock; B low-grade contaminated waste including wood, metal and rock, and C potentially reactive-acid waste rock) in operation at Cigar Lake. The current inventories are the result of mine development and operation at the site. The waste rock is classified as either clean or benign waste rock, potentially acid-generating waste rock or mineralized waste rock. Potentially acid-generating and mineralized waste rock (stockpiles B and C) are temporarily stored on engineered lined containment storage areas. Leachate from these areas is contained and collected for treatment in the mine water treatment plant. When possible, clean or benign waste rock is used as fill or construction material on-site. While some potentially acid-reactive waste rock may be used as backfill in the mine, the majority of this material is expected to be eventually transported to the McClean Lake mine site for disposal in a mined-out pit. At the end of 2023, stockpile B contained 3,644 m³ and stockpile C contained 410,889 m³. All potentially acid-generating mine rock (remaining stockpile C) is to be transported and disposed of at McClean Lake in a purpose-engineered in-pit repository, or used in cement production/underground backfill. No mineralized mine rock, potentially acid generating rock or other contaminated or mineralized waste materials will remain on the surface after decommissioning is complete.

6.4.3 Contaminated industrial wastes

Contaminated industrial wastes are stored on stockpile B, which is one of the stockpiles used to store mineralized waste rock (described in annex 6.4.2) at Cigar Lake and other approved storage areas. These materials will ultimately be disposed of underground during the backfilling of exhausted mine chambers and drifts, or at other approved locations. In 2023, all contaminated industrial wastes were transported to the Rabbit Lake above-ground TMF for disposal.

Figure 6.8: Aerial view of Cigar Lake operation with waste rock stockpile C in the right foreground

6.5 McArthur River

6.5.1 Tailings management

McArthur River does not have a mill and does not produce tailings. During operation, McArthur River ore is processed at the Key Lake mill. Production at the McArthur River mine and Key Lake mill was suspended for an indeterminate period of time in 2018. On February 9, 2022, Cameco announced its intent to begin the process to transition both operations from care and maintenance to production over the course of 2022 and 2023. On November 9, 2022, Cameco announced that ore from the McArthur River mine had been milled and that production had resumed.

6.5.2 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 waste rock or low-grade mineralized material. Potentially acid-generating and low-grade mineralized material 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.

If not required for blending or underground tight filling, the low-grade mineralized material 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.

6.5.3 Contaminated industrial wastes

A transfer area adjacent to the mine headframe is used to sort and temporarily store contaminated material. The contaminated material is then shipped to the Key Lake operation, where it is disposed of in the above-ground TMF.

Figure 6.9: Arial view of McArthur River operation with waste rock pads 1–4 in the middle foreground



Annex 7 – Inactive Uranium Mines and Mills Tailings Management Areas and Contaminated Sites

7.1 Introduction

A total of 20 tailings management sites have resulted from operating uranium mines in Canada: four in Saskatchewan, two in the Northwest Territories and 14 in Ontario. See figure D.4 for a map of their locations.

7.1.1 Saskatchewan

There are four inactive uranium tailings sites in Saskatchewan: Beaverlodge, Gunnar, Lorado and Cluff Lake. In September 2013, Orano's Cluff Lake project completed decommissioning activities, and site occupancy ceased. In 2020, Orano applied to begin the process of transitioning the Cluff Lake site to the Province of Saskatchewan's institutional control program.

7.1.1.1 Beaverlodge

Cameco holds a waste facility operating licence for the decommissioned Beaverlodge uranium mine and mill properties near Uranium City in the northwest corner of Saskatchewan. Mining and milling of ore at this site began in 1952 and milling in 1953; both activities continued until its closure in 1982 when decommissioning began and was completed in 1985. The site has since been in a monitoring and maintenance phase. All mine structures have been removed from the site, the open pits have been completely backfilled or allowed to flood and the mine shafts have been capped and decommissioned.

All of the control structures associated with this site are passive, and there are no effluent treatment plants. Some roads, waste rock piles and tailings management areas are subject to inspection programs and local and area-wide environmental monitoring programs.

The decommissioned Beaverlodge tailings management areas contain approximately 5.6 million tonnes of tailings. In addition, 4.3 million tonnes of tailings were disposed of underground – for a total of 9.9 million tonnes of lower-grade uranium mine tailings. In addition, there are approximately 4.8 million tonnes of waste rock on the site.

At the time of decommissioning in 1982, the site consisted of 70 separate properties that covered approximately 744 hectares. There were 10 different mining areas; 10.161 million tonnes of ore recovered averaged 0.25 percent uranium (0.10 to 0.43 percent ranges). The Saskatchewan *Reclaimed Industrial Sites Act* later came into effect and created an institutional control (IC) framework for the long-term provincial management of post-decommission properties. As a result, five of the 70 decommissioned Beaverlodge properties were exempted from CNSC licensing and entered into this framework in 2009. These five properties were not part of the overall radiological waste inventory considered in this report. In 2019, an additional 20 decommissioned properties were released from CNSC licensing, and 19 of them were transferred into the IC framework in 2020; one property was free released due to a lack of disturbance. In 2022 another 18 properties were released from CNSC licensing, to enable their transfer into the IC framework. A total of 27 properties remained under CNSC licence at the end of 2023.

Figure 7.1: Beaverlodge former mill area

7.1.1.2 Gunnar

The Gunnar mine site is located on the southern tip of the Crackingstone Peninsula along the north shore of Lake Athabasca, approximately 25 km southwest of Uranium City, Saskatchewan (see figure 7.2). The Gunnar mine site has been abandoned since 1964 and was not adequately decommissioned. The Gunnar site consists of open and underground mine pits, mining infrastructure, three mine tailings deposits and waste rock piles. The total volume of mine tailings at the site is 4.4 million tonnes and the total volume of waste rock is approximately 2.2 to 2.7 million tonnes. The Province of Saskatchewan now has ownership of the site, under the Saskatchewan Ministry of the Economy. The ministry subsequently appointed the Saskatchewan Research Council (SRC) as project manager to oversee the ongoing management and remediation of the Gunnar mine site.

On April 2, 2007, the governments of Canada and Saskatchewan announced the first phase of the cleanup of the Gunnar legacy uranium mine site in northern Saskatchewan. Private sector companies that no longer exist operated this facility from the 1950s until the early 1960s. When the site was closed, the regulatory framework in place was not sufficient to ensure the appropriate containment and treatment of the waste, and this had environmental impacts on local soils and lakes.

Since the CNSC issued the licence to the SRC in 2015, it has completed Phase 1 of its project which involved characterizing and monitoring the on-site waste and developing remediation plans. Final designs other cleanup aspects were submitted, reviewed and approved in early 2020. The SRC is currently in Phase 2 of the project and has completed the following remediation work:

- 100% completion of cover systems for Gunnar Main and Central tailings; preparatory work began in 2023 with the plan to begin grading, excavating and construction of the Langley Bay tailings area cover system in 2024.
- Construction of two landfills for the disposal of radioactive and hazardous waste.
- Waste piles grading, excavation and placement at both Gunnar Main and Central tailings has been completed.



Figure 7.2: Photo of warning sign at entrance to Gunnar Main Tailings Area, August 2023 (Photo source: CNSC staff)

Additional remediation work is scheduled to continue until the end of 2024. The current licence is valid until November 30, 2024, but will need to be renewed once remediation work is complete, and the site transitions to Phase 3.

Figure 7.3: Aerial view of Gunnar mine site (taken by the SRC in 2017)



7.1.1.3 Lorado

The Lorado legacy mill site is located north of Lake Athabasca in the northwest corner of Saskatchewan, approximately 8 km southwest of Uranium City. The Lorado mill was closed in 1961 and minimal decommissioning work was completed. The Lorado mine site is several kilometres away from the Lorado mill and is not included in the Lorado mill site remediation project.

At the end of operations at Lorado, uranium mine tailings covered an area of about 14 hectares, including tailings submerged in the adjacent Nero Lake. EnCana West Limited had 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, EnCana West Limited negotiated an agreement with the Government of Saskatchewan. The company paid a significant amount of money for the Saskatchewan government to assume current and future control of and responsibility for the site.

The Province of Saskatchewan now has ownership of the site which is administered by its Ministry of the Economy. The ministry subsequently appointed the SRC as the project manager to oversee the ongoing management and remediation of the Lorado site. The SRC's current CNSC licence for Lorado is valid until April 30, 2023.

The SRC completed the remediation of the Lorado site at the end of 2015 (see figure 7.3). In 2016, the SRC completed the placement of till in the remaining areas of the cover, installed riprap on the shore of Nero Lake and initiated the revegetation of the cover, which concludes the active remediation activities planned for Lorado. In 2017, the SRC continued to monitor the local environment and the progress of the cover revegetation. The SRC submitted an application in 2019 to amend its licence to transition to the long-term monitoring phase. CNSC staff reviewed the application and a designated officer made the decision to amend the licence in mid-2020. In 2022, the SRC submitted an application to renew the licence for a period of 10 years to continue long term monitoring. CNSC staff reviewed the application and on April 17, 2023, a designated officer made the decision to grant the licence.

Figure 7.4: Remediated Lorado tailings site, June 2019



7.1.1.4 Cluff Lake

The Cluff Lake Project (see figure 7.4), owned and operated by Orano Canada Inc., began in 1980 and ended mining in late 2002 when ore reserves were depleted. More than 6 million pounds of triuranium octoxide was produced over the 22-year life of the project. Site facilities included the mill and tailings management area, four open-pit and two underground mines, the camp for workers and site infrastructure.

Following a comprehensive environmental assessment and licensing process, including extensive public engagement, regulatory approval for decommissioning was granted in 2004 with agreed end-state decommissioning objectives. Physical decommissioning work to achieve long-term objectives was completed by 2006. Since then, during the post decommissioning period, Orano conducted routine monitoring and the remaining minor physical decommissioning work. In 2019, regulators agreed that decommissioning objectives had been achieved.

Continuous site occupancy ended in 2013 accompanied by a program to decommission infrastructure that had remained in support of on-site monitoring and maintenance crews, and minor remedial work to prepare the site for open public access. In the summers of 2017 and 2018, final earthwork was conducted to ready the site for transfer to the Province of Saskatchewan's Institutional Control Program (ICP).

The CNSC Comprehensive Study Report in 2003 described the effects of decommissioning as largely positive. Decommissioning involved removing or stabilizing built structures and reclaiming disturbed areas. Orano's key objective was to remove, minimize or control potential contaminant sources and thereby minimize the potential for adverse environmental effects associated with the decommissioned property. Decommissioning was designed to minimize the need for care and maintenance activities and long-term institutional controls, taking socio-economic factors into consideration. The objectives for decommissioning have been achieved.

In 2019, the CNSC granted a renewal of the Cluff Lake licence for five years. While retaining CNSC regulatory oversight, the requested amendments administratively prepare for the transfer of the Cluff Lake site to the provincial ICP. In January 2020, Orano applied to commence this process. In 2023, after a public hearing, the CNSC revoked the licence, allowing the project to enter the final stages of transitioning into the province of Saskatchewan's Institutional Control Program, established under the *Reclaimed Industrial Sites Act*, which allows low-risk, decommissioned projects to be administrated and monitored by the Province of Saskatchewan, with funds for these activities paid for by the licensee. This transfer is expected to be complete in early 2024.

The following subsections briefly describe the main decommissioning activities at the site.

7.1.1.4.1 Mill area

The mill was decommissioned in two phases which were completed in 2004 and 2005. The mill demolition work was broadly similar to the demolition of other similarly sized 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. Two warehouses were retained for storage and equipment repair up until 2013, when they were demolished during site cleanup activities. Waste materials were disposed of in one of the open pits at the site, along with much larger volumes of waste rock. After the mill was demolished, 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.

Figure 7.5: Cluff Lake mill areas during operation



Figure 7.6: Cluff Lake mill area following decommissioning, before vegetation was re-established (2008)



Figure 7.7: Cluff Lake mill area with re-established vegetation (2019)

7.1.1.4.2 Tailings management area

The TMA at Cluff Lake is a surface impoundment constructed using a series of engineered dams and dikes that extends over about 70 hectares. It formerly consisted of a solids containment area, a water decantation area and water treatment facilities (see figure 7.8). Thickened tailings were pumped to the solids containment area, where consolidation and liquid decantation occurred. The decant water, along with waste water from other sources, was piped to a two-stage water treatment facility for radium-226 precipitation.

Decommissioning of the tailings management area was initiated by covering the tailings with till in stages to promote consolidation. When consolidation was complete, the cover of the tailings management area was contoured to provide positive drainage, using locally available till with a minimum one-metre thick cover, then revegetated (see figure 7.9). The surface contour and vegetated cover promote the runoff of rainfall and snowmelt as well as the evapotranspiration 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.

More than a decade of post-decommissioning monitoring (2006 to 2022) has provided the environmental data for comparison to water quality, radiological objectives or key model inputs used to forecast long-term surface water quality (e.g., infiltration rates through soil covers and source terms). The decommissioning groundwater and ecological risk models are validated and long-term predictions remain within decommissioning objectives. During the licence renewal hearing in 2019, CNSC staff and the Commission concluded that Orano met the objectives of the Cluff Lake Project detailed decommissioning plan (see figure 7.10). A new detailed post-decommissioning plan was accepted, along with a revised financial guarantee which reflects the decommissioned state of the site.

Figure 7.8: Cluff Lake tailings management area during operation



Figure 7.9: Cluff Lake tailings management area after decommissioning, before vegetation was re-established (2008)



Figure 7.10: Cluff Lake tailings management area with re-established vegetation (2019)



7.1.1.4.3 Mining area

Mining involved four open pits and two underground mines (see figure 7.11). 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. 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 the two also used to accept industrial waste during operations and decommissioning, including 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 the waste rock, re-contouring it within another open pit (Dominique-Janine North), then allowing this pit and the contiguous Dominique-Janine extension pit to flood to the natural level to eventually form a small lake that meets surface water quality criteria (see figure 7.12)
- reclaiming the remaining Claude waste rock pile by re-sloping for long-term stability, compacting the waste rock surface, covering with till and establishing a vegetation cover
- re-contouring and establishing native vegetation on all disturbed areas (see figure 7.13)

Extensive characterization of the waste rock, geologic formations in the area and site hydrogeology has been performed to acquire reliable data for assessing 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. Eleven nested piezometers were installed in the Claude pit in 2010 and seven more were installed in 2012 to collect additional hydrogeological data for comparison with the key assumptions. The groundwater and contaminant transport modelling, and the ecological and human health risk assessment were updated for the Cluff Lake Project in 2019. This update incorporated the new monitoring data along with data collected through other components of the follow-up program.

Figure 7.11: Cluff Lake mining areas during operations



Figure 7.12: One of the decommissioned Cluff Lake mining areas



Figure 7.13: One of the decommissioned Cluff Lake mining areas (2019)



7.1.2 Northwest Territories

There are two licensed legacy uranium mine, mill and tailings sites in the Northwest Territories: the Port Radium and Rayrock mines.

7.1.2.1 Port Radium

The Port Radium site, shown in figure 7.12, is located in the Northwest Territories at Echo Bay on the eastern shores of Great Bear Lake, about 265 km east of the Dene community of Deline, at the edge of the Arctic Circle. Mining at the Port Radium site took place from 1932 to 1940, from 1942 to 1960, and from 1964 to 1982 (in the last instance, to recover silver). The licensed area covers approximately 12 hectares and is estimated to contain 1.7 million tonnes of uranium and silver tailings (see figure 7.13). The site was partially decommissioned in 1984 according to the standards of the day. In 2006, the Government of Canada reached an agreement with the local community and completed the remediation of the site in 2007 under a CNSC licence. In 2016, the CNSC renewed the licence for the Port Radium closed uranium mine site for 10 years to continue long-term monitoring and maintenance at the site. Under the renewed licence, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) (formerly Indigenous and Northern Affairs Canada [INAC]) will continue performance and environmental monitoring and reporting under the licence.

CIRNAC sampled surface water in 2016 and have confirmed radionuclide concentrations remained below detection limits and below Health Canada's drinking water criteria throughout the initial 10-year Port Radium Long-term Monitoring Program period. CIRNAC continues to report these findings through its annual reporting to the CNSC while it works to finalize the Port Radium Phase II Long Term Monitoring Plan.

Figure 7.14: Google satellite view of Port Radium

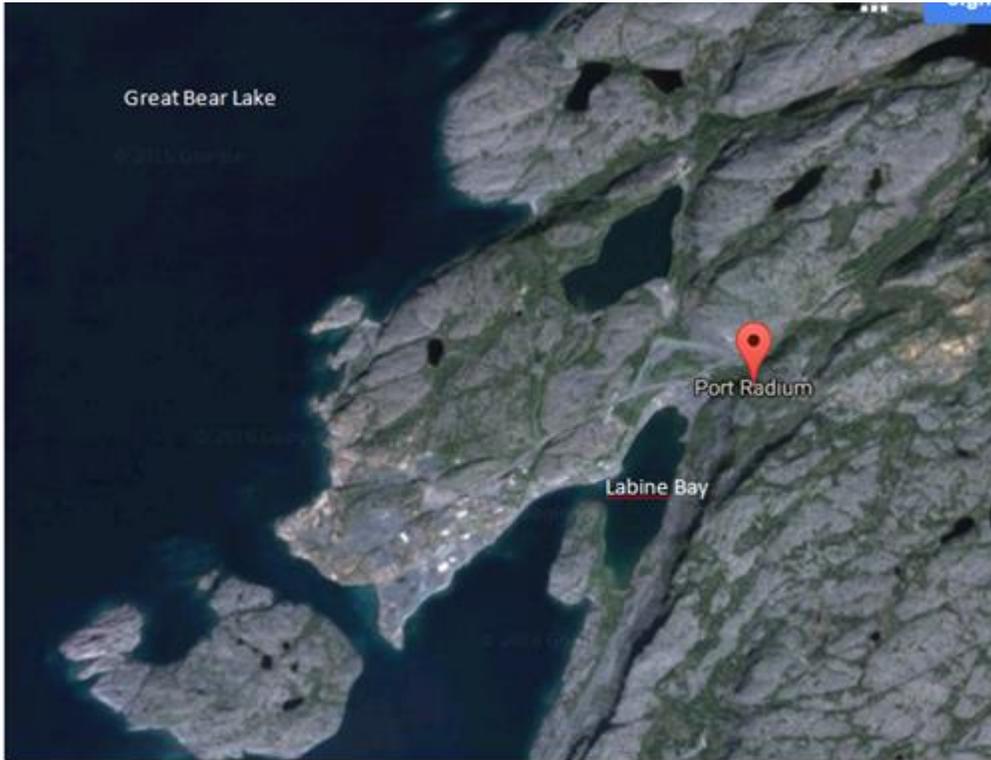


Figure 7.15: Aerial view of Port Radium mine in 2002



7.1.2.2 Rayrock

The Rayrock site is located in the Northwest Territories, approximately 145 km northwest of Yellowknife. Uranium mining and milling occurred at the Rayrock site from 1957 until 1959 when it was abandoned (see figure 7.14). The licensed site area is 206 hectares and contains an estimated 80,000 tonnes of tailings. Under a licence issued by the Atomic Energy Control Board (reissued as a CNSC licence in 2001), INAC decommissioned and rehabilitated the Rayrock site (which includes capping the tailings) in 1996. Performance monitoring and reporting of the results have been ongoing since 1996. INAC sampled surface water in 2014.

For the sampling period, most of the radionuclide concentrations were below detection limits and in all cases were below Health Canada's drinking water criteria.

In 2017, INAC undertook a field program to collect additional data to support the updated human health and ecological risk assessment (HHERA). In 2018, INAC (now known as Crown-Indigenous Relations and Northern Affairs Canada [CIRNAC]) submitted an updated HHERA that was reviewed by the CNSC and other government agencies. In 2019, CIRNAC submitted a final remediation action plan and application to amend the current licence to CNSC staff for review. Due to the COVID-19 pandemic, remediation work was postponed and CNSC staff are in the process of amending and renewing CIRNAC's licence to complete the remediation and some of the post-remediation work prior to renewing the licence for a longer period of time.

Figure 7.16: Aerial view of Rayrock mine



7.1.3 Ontario

7.1.3.1 Elliot Lake area

There are 12 inactive uranium mine sites and 10 uranium tailings management areas 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. Decommissioning of the last remaining Elliot Lake uranium mines – the Stanleigh, Quirke, Panel, Stanrock and Denison mine sites – was essentially complete by the end of 1999. All of the sites have been substantively decommissioned; all mine features have been capped or blocked, all facility structures have been demolished, and all sites landscaped and revegetated.

The uranium ore in the Elliot Lake area is classified as low grade (containing less than 0.1% triuranium octoxide). 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. With most of the Elliot Lake tailings management areas, therefore, some degree of effluent treatment system is associated with each site.

All of the tailings management areas 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, Pronto and Milliken mine sites and their associated tailings management areas. Rio Algom Ltd. is also responsible for the Buckles mine site; however, the tailings from Buckles were disposed of at the Nordic tailings management area. Denison Mines Inc. is responsible for the Denison, Stanrock and Can-Met mine sites and their tailings management areas. Two of the former mine sites – Denison and Stanrock – currently have CNSC licences.

In 2004, Rio Algom Ltd. consolidated all of its Elliot Lake mine sites under one CNSC licence governed by the CINFR under the NSCA.

7.1.3.1.1 Effluent treatment and environmental monitoring

At Elliot Lake, the TMAs use a mixture of both dry and wet covers. Four of the areas (Lacnor, Nordic, Pronto and Stanrock) are engineered with dry covers; vegetation has been established over the tailings at all of these sites. Active water treatment is required at all of the dry TMAs 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 at these sites for many more years, as the acid-generating potential of the tailings becomes 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 sites with dry covers.

With respect to environmental monitoring, the licensees have implemented two programs at their TMAs: the Tailings Management Area Operational Monitoring Program and the Source Area Monitoring Program. The first collects data to track tailings management area performance and supports decisions regarding their management and discharge compliance. 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: the Serpent River Watershed Monitoring Program and the In-Basin Monitoring Program. The Serpent River Watershed Monitoring Program 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 comprises more than 70 lakes and nine sub-watersheds, which cover an area of 1,376 km² and drain into Lake Huron via the Serpent River. Its companion program, the In-Basin Monitoring Program, focuses on the risks to biota feeding at the tailings management areas by monitoring their physical, chemical and ecological conditions, and ecological changes.

Both programs run in five-year cycles and began in 1999. The fifth cycle of the report was completed in 2022, and the CNSC completed its review in 2023.

The CNSC reviewed the results of the various monitoring programs that Rio Algom Ltd. and Denison Mines Inc. implemented and found that overall, environmental conditions are improving at the Elliot Lake sites. More specifically, water quality is improving and environmental impacts, such as lower taxonomic richness and abundance in the benthic communities, are now only evident immediately downstream of the Quirke, Denison and Stanleigh tailings management areas. Although lakes further afield are in good environmental health, sediment contaminant levels continue to be slightly elevated, which is to be expected.

These sites will continue to require monitoring and active management until effluents meet discharge criteria without treatment, then will require some form of ongoing (permanent) care and maintenance.

7.1.3.2 Agnew Lake

The Agnew Lake mine, located about 25 km northwest of Nairn Centre, Ontario, ceased operation in 1983. The former underground uranium mine site was decommissioned and monitored by Kerr-Addison Mines Ltd. from 1983 until 1988. The site was then turned over to the Province of Ontario in the early 1990s. The Ontario Ministry of Mines (MINES) (formerly the Ontario Ministry of Northern Development and Mines [MNDM]) holds a CNSC licence for the Agnew Lake Tailings Management Area (TMA). The TMA is estimated to hold 1.35 million m³ of material deposited and covers approximately 13 hectares, surrounded by the West Dam and East Barrier dyke.

Repair to the cover of the TMA is planned, and the MNDM has proposed adding niobium ore and tailings classified as NORM from the former Beaucage Mine near North Bay, Ontario, to cover these tailings. The MNDM proposes that the placement of the niobium waste will provide shielding for the existing tailings, and the soil cover over the niobium waste will prevent contact with the niobium waste and reduce gamma doses to background levels.

Figure 7.17: Agnew Lake tailings management area



7.1.3.3 Bancroft area

Uranium tailings 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.

7.1.3.3.1 Dyno

The Dyno idle mine property is located at Farrel Lake, about 30 km southwest of Bancroft, Ontario. The mill circuit at Dyno operated between April 1958 and April 1960. The property consists of an abandoned and sealed underground uranium mine, a mill that has been largely demolished, a tailings area, a dam (see figure 7.16) and various roadways. The site licence was renewed in 2018 for a period of 15 years.

In 2022, EnCana West Ltd. was absorbed into Oviniv Canada UVP. A new CNSC licence was issued to the new company, which expires in 2033.

Figure 7.18: Main tailings dam, Dyno mine site



7.1.3.3.2 Madawaska

The Madawaska mine property is located 6 km southwest 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. Approximately 4 million tonnes of waste, covering an area of about 13 hectares at a depth ranging from 6 to 15 m, containing about 9×10^{13} Bq of nuclear material, remain at the location.

In 2022, EnCana West Ltd. was absorbed into Oviniv Canada UVP. A new CNSC licence was issued to the new company, which expires in 2033.

7.1.3.3.3 Bicroft

The uranium tailings stored at the Bicroft tailings storage site resulted from processing low-grade uranium ore at the Bicroft mine from 1956 to 1962 (see figure 7.17). Remediation work done includes the vegetation of exposed tailings in 1980 and dam upgrades in 1990 and 1997. In 2005, the Barrick Gold Corporation was issued a CNSC licence for the Bicroft tailings management site. The effluents discharge results generally meet the Ontario Provincial Water Quality Objectives, with a few exceptions. Therefore, as part of its licence application, Barrick conducted a screening-level human health and ecological risk assessment to demonstrate that there is no unreasonable risk to health, safety and the environment, and to support a five-year surface water sampling program.

Figure 7.19: South tailings basin spillway at Bicroft tailings storage facility

7.2 Historic contaminated lands

Sites contaminated with very low-level uranium- and radium-contaminated soil resulting from early industrial practices (1930s to 1950s) were identified in the 1970s and have been subject to Government of Canada oversight through the LLRWMO since 1982. Under a GoCo model, AECL is responsible for the LLRWMO, but CNL delivers this work on behalf of AECL. The work comprises remediations of sites along the Northern Transportation Route (NTR) that are impacted with uranium ore residues (that the majority of which are below the threshold to be categorized as LLW and are NORM), and sites in the Greater Toronto Area (GTA) that are contaminated with radium.

Progress continues to be achieved in discharging Canada's historic LLW liabilities. A key objective is for CNL to significantly reduce or eliminate liabilities is that by 2032 through detailed classification and characterization and the safe execution of remediation projects. CNL is facilitating the cost-effective long-term management of historic LLW, in keeping with the policy direction provided by AECL.

Since the Seventh Review Meeting, the following progress has been achieved:

- Phase 1 (of 3 phases) of the clean up of impacted sites along the NTR has been completed. Planning, characterization and Indigenous and community engagement are proceeding to Phase 2. The plan is to have remedial work completed through phases 2 and 3 at all remaining identified sites along the NTR by 2030.
- Selective characterization and remediation have been undertaken in the GTA in response to requests of support from property owners as triggered through their property development activities. The plan is to have completed remedial work at all remaining identified sites in the GTA by 2032.

7.2.1 Port Hope Area Initiative

On March 29, 2001, an agreement was signed between the Government of Canada (represented by the Minister of Natural Resources) and the Ontario communities of Port Hope, Hope Township and Clarington for the construction of long-term WMFs for historic LLW and for the cleanup of contaminated sites in the Port Hope area. The wastes were estimated at about 2 million m³ of LLW and contaminated soils, in which radium-226, uranium and arsenic are the primary contaminants.

With this agreement, the Government of Canada began the Port Hope Area Initiative (PHAI) to evaluate and implement a long-term solution to manage the wastes from the Port Hope area sites. This initiative was divided into two projects that align with municipal boundaries. The Port Hope Project entails the cleanup and long-term management of wastes from various contaminated sites in the Municipality of Port Hope (formerly the Town of Port Hope and Hope Township). The Port Granby Project involves implementing a long-term management approach for radioactive wastes at the previous Port Granby WMF in the Municipality of Clarington (see figure 7.18).

Both projects come under the responsibility of AECL but are being delivered by CNL under a GoCo model.

Large, near-surface, long-term management facilities have been constructed to manage the wastes from each cleanup project: the Port Hope long-term WMF and the Port Granby long-term WMF. The Port Hope long-term WMF, with an estimated design capacity of 1.8 million m³, accepts a variety of wastes from the area. These include wastes from the major unlicensed sites in the municipality of Port Hope, including the former municipal landfill and the harbour. Other wastes, such as contaminated roadways and soils from private properties, are also included, along with wastes from the previous Welcome WMF and eligible historic wastes from the Cameco Port Hope Conversion Facility. Wastes from consolidation sites and temporary storage sites within the community that are being temporarily managed under the LLRWMO scope of work are also included, along with non-radiologically contaminated industrial wastes, as requested by the municipality and provided for in the agreement.

The Port Hope long-term WMF has been constructed as an expanded site at the existing Welcome WMF in the Municipality of Port Hope, which contained an estimated 550,000 m³ of LLW and contaminated soils. An environmental assessment process has been completed for this project, and on November 15, 2012, the CNSC issued a 10-year licence to AECL for the Port Hope Project. This project, as well as the Port Granby long-term WMF, is moving forward through a phased approach.

The Port Hope Project is currently in its implementation phase (Phase 2), which includes the construction of the new long-term WMF and associated water treatment plant, remediation of the existing facility and contaminated sites in the area of Port Hope, followed by the closure of the long-term WMF. The waste water treatment plant for the proposed long-term WMF was completed in 2016 and is now operational. Construction of the containment mound commenced in the summer of 2016. The first cell was completed in late 2017. On-site waste placement from the Welcome WMF began in 2017 and was followed by the placement of wastes from sites within the community in 2018. Remediation of the Welcome WMF was completed in 2019 and the final cell of the WMF was completed in 2021. The remediation of the Port Hope sites is slated for completion in 2030–31. Following this, the WMF will be closed and capped, and the project will move into Phase 3 for monitoring and surveillance.

The Port Granby long-term WMF, with a revised design capacity of around 900,000 m³, accepts wastes only from the existing Port Granby WMF located in the Municipality of Clarington. The site selected for these wastes is immediately northwest of the existing facility and away from the Lake Ontario shoreline. An environmental assessment process was completed for this project on November 29, 2011, and the CNSC issued a 10-year licence to AECL for the Port Granby Project.

The implementation phase (Phase 2) for the Port Granby project is now complete with closure and completion of the capping of the WMF in 2022. Restoration continued through 2023 and the project has now moved into Phase 3 monitoring and surveillance.

Figure 7.20: Port Granby mound below closed and capped with the wastewater treatment facility in the foreground and the mound at the top of the picture



7.2.2 Port Hope contaminated sites

The PHAI is a Government of Canada funded project to clean up historical LLW in the Municipality of Port Hope and Clarington. Over 1,000 contaminated sites have been identified in Port Hope. The sites include residential and commercial properties that are not licensed and four licensed sites that were used as temporary storage sites until the construction of the long-term WMF. Due to the low levels of radioactive material found at the unlicensed sites, there is minimal risk to the health and safety of the public and environment. However, there are restrictions on disturbing the soil on these properties which require administrative permitting controls before digging. Once remediation activities are completed, there are to be no land restrictions on residential properties.

The licensed sites are well known by the community and municipality and will not be further developed until the LLW is remediated and placed in the long-term WMF. Some LLW also exists in some roadway beds and underground infrastructure that will be remediated over several years, as upgrades and repairs to roads and underground infrastructure are required.

The initially estimated volume of contaminated soil in Port Hope was 1.2 million m³; however, the number of residential properties identified with LLW more than doubled the original estimate. The revised estimated volume is 1.9 million m³. The Government of Canada remains confident that the Port Hope Long-Term WMF will be able to accommodate the additional contaminated soil.

7.2.3 Deloro mine site

The Deloro mine site began operation as an underground gold mine in the 1860s, and the historical mining, refining and manufacturing operation closed in 1961. The mining and industrial operations resulted in large volumes of by-products that were deposited on the Deloro site as waste. This waste legacy includes soil, sediment, groundwater and surface water that are contaminated with arsenic, cobalt, copper, nickel and small quantities of LLW. Arsenic is the main contaminant of concern at the Deloro site. LLW materials containing uranium and its decay products from historic refining operations in Port Hope constitute up to 6 % of the waste and coexist with the non-radioactive hazardous wastes.

The site is under the care and control of the Province of Ontario for the long-term management of contaminated sediments, soils and waste. The province implemented a comprehensive environmental monitoring program and a comprehensive environmental remediation program. In August 2019, the CNSC released the Deloro mine site from CNSC regulatory control. Due to the elevated levels of arsenic, the site will continue to be under the Ontario provincial regulatory regime, which requires the continuation of post-closure monitoring and maintenance activities indefinitely.

Figure 7.21: Aerial view of Young's Creek area



Annex 8 – Decommissioning Activities

8.1 Chalk River Laboratories

The CRL site is located in Renfrew County, Ontario, on the shore of the Ottawa River, 160 km northwest of Ottawa. The site, which has a total area of about 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 northeastern boundary of the site. The Petawawa military reserve abuts the CRL property to the southeast.

The CRL site was established in the mid-1940s and has a history of hosting 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.

To date, the pace of decommissioning at CRL has been constrained by the availability of waste disposal routes. Priority has been given to hazard reduction and the mitigation of risk at facilities that represent a high hazard and risk, and to demolish low-hazard structures for which waste routes are available. Major activities completed since the Seventh Review Meeting include:

- total of 117 buildings and structures decommissioned since 2015
- abatement of asbestos and other hazardous materials in many facilities, including the NRX annex and reactor hall, B250 (Chemistry and Tritium Lab) and B200 Series (NRX Rod Bays, Thorium Fuel Reprocessing and Plutonium Plant)
- decommissioning of B457 (Supply Warehouse) and B412 (Manufacturing Shop)
- decommissioning of B440 (Emergency Process Cooling Water NRU)
- decommissioning of supervised area buildings B568, B581, B571, B413, B420

The implementation of a GoCo model at CRL provides an opportunity for AECL to significantly accelerate the decommissioning activities at the site. Until 2026, CNL will continue to focus on the early reduction of liabilities in the supervised area footprint, building a skilled workforce, removing redundant buildings, and clearing space for science and technology and supporting facilities. In the controlled area, the schedule for reducing risk in high-hazard facilities will rely on the construction of the proposed NSDF to provide a final waste disposal path. Planned goals and milestones include continuing to deliver against the commitments made in 2015 for the first 10 years of the GoCo arrangement:

- sustaining improved performance in environmental and safety standards
- placing the NRU reactor in a storage-with-surveillance state
- reducing the footprint of the controlled area in keeping with the decommissioning plan
- decommissioning and demolishing the remaining 3 of more than 120 buildings committed in the supervised and controlled areas
- site remediation activities will progress and be coordinated with the proposed NSDF availability and need for cover material during the facility's operations

CNL is self-performing most decommissioning activities to gain efficiencies and reduce risks associated with redundant, high-hazard facilities. In the supervised area, integrated teams are developing decommissioning skills on low-hazard buildings, which will prepare them for higher hazard work in the controlled area. With this progressive approach, decommissioning teams continue to learn and build on relatively low-risk experience, before moving on to more difficult areas, as they become more proficient in the treatment and management of industrial and radiological hazards. This approach also supports the acceptance and adaptation of site-wide program controls to enable an accelerated decommissioning schedule.

International decommissioning experience gained on multiple sites has demonstrated that the development of a trained and experienced workforce with flexibility to move between buildings as conditions require is a key step to safely accelerating decommissioning scopes of this magnitude. Additionally, the development of a core team and capabilities will reduce incidents and costs, particularly those associated with multiple subcontractors performing multiple scopes of work on a congested site amid other ongoing missions. Decommissioning is coordinated with capital project timelines to provide the space required for both permanent new facilities and temporary enabling facilities.

Until the proposed NSDF is operational, decommissioning in the controlled area will focus on minimizing radiological waste and removing areas and facilities of high concern. This will be based on health, safety and environmental risk evaluations. Early emphasis will be on removing facilities in the controlled area to support temporary infrastructure and access requirements, which will enable future decommissioning and demolition work. During this period, all non-releasable waste from the controlled area will be placed in interim storage.

Additional interim waste storage capacity has been developed as required to address any gaps. Any adjustment required to the planned sequence of work will be evaluated during the development of CNL's annual plans, taking new information into consideration as capital projects progress, mission requirements change and the potential for risk reduction increases or decreases.

CNL plans to commence large-scale demolition work in the controlled area with the availability of the proposed NSDF which is anticipated in 2030. Work will be closely coordinated with the start of larger scale environmental restoration efforts, which will need to supply soil to the proposed NSDF concurrently with building debris. With the establishment of environmental remediation and cleanup criteria, CNL will move seamlessly between building demolition and any soil remediation required. CNL will further advance schedules and reduce costs by using the same personnel and equipment already mobilized for demolition.

8.2 Douglas Point Waste Management Facility

The Douglas Point WMF is located at the site of the former Douglas Point NGS on the Bruce nuclear site. The station, which consists of a 200-MW CANDU reactor, was put into service in 1968. It was owned by AECL and operated by Ontario Hydro (now OPG) until 1984. During this operational period, the station generated 17×10^9 kW hours of electricity and attained a capacity of 87.3 %.

The main components of Douglas Point 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 was 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.

Douglas Point was permanently shut down on May 5, 1984, and placed in SWS state, an interim safe and sustainable shutdown state. The Douglas Point NGS then became the Douglas Point WMF.

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 CRL for storage in February 1985. Non-radioactive hazardous materials, such as combustible and flammable materials, laboratory supplies and oils, were identified and removed. The transfer of spent 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 were reduced to a few locations. Radiological surveys were performed at the completion of each decommissioning activity.

A three-phase approach has been established for reactor decommissioning. Phase 1 brought the facility to a safe, sustainable shutdown state. Phase 2 is a period of SWS. Final decommissioning occurs in Phase 3. Following acceptance of a licence amendment in November 2020, the Douglas Point WMF has commenced phase 3 of decommissioning. The licence is valid for 10 years and includes all decommissioning activities for the site but excludes the final reactor dismantling. This will be the subject of a follow up hearing once the surrounding systems have been removed and access is permitted to finalize the methodology to dismantling the reactor. This follow up hearing is expected to occur beyond 2026.

8.3 Gently-1 Waste Management Facility

The Gently-1 WMF consists of a permanently shut down, partially decommissioned prototype reactor and associated structures and ancillaries. This facility is presently in the long-term SWS phase of a deferred decommissioning program. Located on the south bank of the St. Lawrence River, about 15 km east of Trois-Rivières, Quebec, the Gently complex accommodates both the Gently-1 WMF and the Gently-2 NGS, a CANDU 600-MW unit, which shut down in 2012 (for more information on Gently-2, see annex 8.4).

The Gently-1 NGS consists of a CANDU BLW-250 reactor that 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 layup state in 1980 and the decision to not rehabilitate the station was made in 1982.

The main components of Gently-1 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 uranium dioxide 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, then pumped through inlet and outlet headers and feeder pipes in a closed circuit. The steam generated by the reactor core was separated from the liquid coolant in the steam drum before being delivered to the turbine generator.

The decision to permanently shutdown the reactor was made in 1984. A two-year decommissioning program began in April of that year to bring Gently-1 to an interim safe and sustainable shutdown state that is equivalent to SWS. The moderator (heavy water) 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 spent fuel from wet storage in the reactor pool to dry storage in the purpose-built canister storage area 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 upon the completion of each decommissioning activity.

A three-phase approach has been established for reactor decommissioning. Phase 1 brought the facility to a safe, sustainable shutdown state. Phase 2 is a period greater than 30 years of SWS. Final decommissioning, approximately 10 years, occurs in Phase 3. The Gently-1 WMF is currently in Phase 2. CNL have completed the removal of the dry active waste and continued with the industrial hazard removal. The spent fuel currently in dry storage at the Gently-1 facility is being consolidated onto the Chalk River site over the next two years and will complete in 2025. In addition, a license amendment submission to permit full decommissioning is being finalized for submission in late 2024-25 with a hearing expected in 2025. This license application will be requesting to accelerate the decommissioning of the facility into the early 2030's.

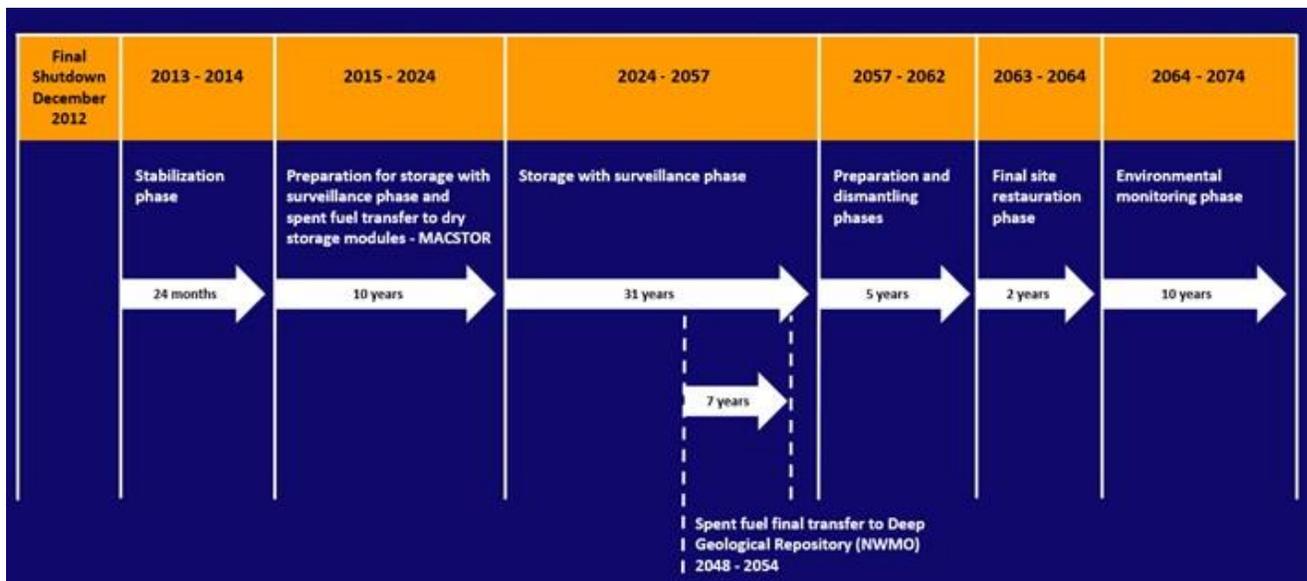
8.4 Gently-2 Nuclear Generating Station

Following the decision by the Government of Quebec and upon Hydro-Québec's (H-Q) recommendation, Gently-2's commercial operation ended on December 28, 2012. The station was placed in a guaranteed shutdown state and decommissioning activities are being undertaken. HQ has adopted a deferred decommissioning strategy approach. The activities under this strategy are divided into several phases, the first three of which are:

1. stabilization phase (2013–14)
2. Storage with surveillance (SWS) preparation phase (2015–24)
3. SWS phase (2024–57)

Figure 8.1 shows the schedule of major decommissioning activities for Gently-2, and the following subsections outline these activities.

Figure 8.1: Schedule for major decommissioning activities at Gently-2 NGS



8.4.1 Stabilization phase

During this phase, which took place in 2013–14, station reconfiguration was planned and the reactor core was completely defueled.

The main activities were as follows:

- removal of spent fuel from the reactor and its storage in a spent fuel bay
- final drainage of heavy water circuits (coolant and moderator) and their storage
- final drainage of large volume systems (light water, oil)
- shutdown of systems that are no longer required
- introduction of monitoring programs for the next phase (environment, radioprotection, safety)

8.4.2 Storage with surveillance preparation phase

This current phase, planned from 2015–24, consists of completing the transfer of spent fuel stored in a bay to the dry storage facility at the Gentilly-2 NGS's site. This phase included the encapsulation of defective spent fuel bundle that had been stored in an auxiliary bay since the beginning of the plant's operation. This activity was completed at the end of 2020. Also, two additional dry storage modules were built to store all the spent fuel. Other activities planned for this phase mainly involve the establishment of a program for preventive maintenance, the aging management of systems, structures and components, and environmental monitoring. Finally, all nuclear and conventional systems that are no longer required have been or will be laid-up.

8.4.3 Storage-with-surveillance phase

The former NGS will be in SWS for approximately 33 years, from 2024 to 2057, before preparation and execution of dismantling activities are undertaken. The transfer of spent fuel to the planned national long-term storage site is scheduled to begin in 2048. Final site restoration will be completed in 2064, then followed by an environmental monitoring phase that is expected to last 10 years.

8.5 Gunnar Mine Site

The Gunnar Remediation Project is located on the southern tip of the Crackingstone Peninsula along the north shore of Lake Athabasca, approximately 25 km southwest of Uranium City, Saskatchewan. The Gunnar mine site has been abandoned since 1964, and it was not adequately decommissioned. The Gunnar site consists of open and underground mine pits, mining infrastructure, three mine tailings deposits and waste rock piles. The total volume of mine tailings at the site is 4.4 million tonnes, and the total volume of waste rock is approximately 2.2 to 2.7 million tonnes. The Province of Saskatchewan's Ministry of Energy and Resources owns the site; it subsequently appointed the SRC as project manager to oversee the ongoing management and remediation of the Gunnar mine site.

In January 2015, the Commission issued a licence to the SRC for the Gunnar Remediation Project following a public hearing. The SRC's licence is valid until November 30, 2024. The remediation work is divided into three phases. Phase 1, which is now complete, involved characterizing and monitoring the on-site waste and developing remediation plans. Phase 2 consists of implementing the remediation plans. Phase 3 will be the long-term monitoring and maintenance to ensure the site remains stable and safe.

The SRC is currently in Phase 2 of the project and has implemented the following remediation work:

- 100% completion of cover systems for Gunnar Main and Central tailings, preparatory work began in 2023 to begin grading, excavating and construction of the Langley Bay tailings area cover system in 2024.
- Construction of two landfills for the disposal of radioactive and hazardous waste. Legacy waste sweeps and consolidation have been completed.
- Waste piles grading, excavation and placement at both Gunnar Main and Central tailings has been completed.
- All mine openings have been remediated and capped.

The current licence is valid until November 30, 2024, but CNSC staff received an application from SRC to renew the licence in late 2023. If the renewal is granted, the licensee plans on completing the remaining remediation work, then the site will transition to Phase 3, which includes long-term monitoring and maintenance to ensure the site remains stable and safe.

8.6 Nuclear Power Demonstration

The NPD site is located in Renfrew Country in Ontario, adjacent to the west bank of the Ottawa River, approximately 3 km downstream of the Des Joachims Dam and Generating Station, 25 km upstream from CRL

and 15 km from the town of Deep River. The NGS was placed in service in October 1962 and operated by Ontario Hydro (now OPG) until May 1987.

In 1988, operating and compliance responsibilities were transferred from Ontario Hydro to AECL. The NGS was placed into an interim safe and sustainable shutdown phase. This interim storage period is referred to as the SWS phase under the deferred decommissioning strategy. After the reactor shutdown, the heavy water from the primary heat transport and moderator systems was drained and shipped off-site. The reactor was defueled and the fuel bundles were transferred to CRL for storage. 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, and 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.

The NPD site consists of a limited number of structures, including:

- the main building (reactor building/powerhouse) which stores the partially decommissioned 20-MW electrical prototype CANDU reactor and its associated underground services and structures
- the ventilation stack
- the diesel generator enclosure
- two sea containers
- the pressure relief duct
- foundations from previously removed pump houses, emergency vehicle garage, training centre, construction camps, warehouses, dousing tank, transformer and administration wing
- two on-site landfills, which are currently closed

The site is currently licensed as a waste facility and is still owned by AECL, but it is operated by CNL. Since the transition to GoCo model in 2015, CNL is pursuing an accelerated decommissioning approach for the NPD site.

CNL is now proposing *in situ* decommissioning for the NPD site. Although not used widely, this approach has been used at other sites internationally. The technique is intended to minimize radiological exposure to workers, reduce the need for handling and transportation, and minimize risk to workers and the environment.

The proposed *in situ* decommissioning activities include:

- assembling and operating the grout batch mixing plant
- removing the above-ground structure and placing contaminated materials in the below-grade structure
- using grout to seal the below-grade structure, reactor vessel and all of the systems, components and contaminated materials
- installing a concrete cap and engineering barrier over the grouted area
- conducting final restoration of the rest of the site
- preparing for long-term care and maintenance activities

Starting in 2016, as part of an environmental assessment process under the CEAA (2012), CNL started preparing an environmental impact statement for submission to the CNSC for consideration. In conjunction with the required environmental assessment process, CNL will also be requesting a licence amendment from the CNSC to perform the proposed decommissioning activities.

Once the CNSC authorizes the project, it will take approximately two years to decommission the NPD site. After site restoration activities have been completed, the site will enter a period of long-term surveillance under a monitoring program for a period of time established through a safety analysis process.

CNL has not yet submitted its licensing application or safety case in support of *in situ* decommissioning for regulatory review. This application process has been hindered due to the site priority to complete the licensing application for the Near Surface Disposal Facility at the nearby Chalk River Site. Adopting lessons learned from this application, a licence submission for NPD is expected in 2024.

8.7 Saskatchewan Research Council SLOWPOKE-2

SRC operated a SLOWPOKE-2 nuclear research reactor for 37 years between 1981 and 2018. SRC applied to the CNSC for a licence to decommission the nuclear facility in 2019 and it was granted later that year.

The facility was located in the city of Saskatoon, Saskatchewan. The reactor provided a source of neutrons for neutron activation analysis and isotope production, and it was used for teaching purposes in conjunction with the University of Saskatchewan.

The SLOWPOKE-2 reactor was a 20 kW-thermal sealed-container-in-pool type research reactor, cooled and moderated with light water, and operated on HEU. The core was cooled by natural convection and was surrounded by a beryllium reflector. The facility consisted of the reactor room, two rooms for support equipment and a sample storage room. The reactor itself was located in a concrete well underneath the floor of the reactor room.

During decommissioning, the building and remaining structures were surveyed for contamination. The waste from the decommissioning project was segregated, and non-radioactive items were reused and recycled to the extent possible. Decommissioning the facility produced an estimated 8 m³ of solid radioactive waste, which was transported to a licensed radioactive WMF. Water from the reactor pool was purified through ion-exchange columns and released to the city sewers after it was determined to be free of contaminants. The fuel was repatriated to the United States under the Canada-United States agreement to return spent HEU fuel to its country of origin.

The small inventory of non-radioactive, hazardous materials was disposed of in accordance with applicable regulations. In 2021, the Commission revoked the SRC's decommissioning licence and issued a licence to abandon, authorizing the release from CNSC regulatory control.

8.8 Whiteshell Laboratories

Figure 8.2: WL undergoing decommissioning



8.8.1 Background

WL is a nuclear research and test establishment developed in the early 1960s by AECL to investigate higher temperature versions of its CANDU reactor design. In the late 1990s, AECL decided to discontinue research programs and operations at the facility, and the planning for its closure and decommissioning began. The site is still owned by AECL but is now operated by CNL under a GoCo arrangement.

WL is located in Manitoba on the east bank of the Winnipeg River, about 100 km northeast of Winnipeg, 10 km west of Pinawa and 9 km upstream from Lac du Bonnet. The major structures located on the site include WR-1, the main research building (building B300), other research and supporting buildings, and a radioactive waste management area that contains the concrete canister storage facility for the dry storage of spent fuel.

WL is currently licensed under a nuclear research and test establishment licence to decommission that was issued in 2002, renewed in 2008 and amended in 2016. In 2014, the licence was transferred to CNL which became the licensee. The licence was renewed in 2018 and 2019 and is currently valid until December 31, 2024.

During the initial six-year period of the licence to decommission (2002–08), the decommissioning activities focused on the shutdown and decontamination of nuclear and radioisotope laboratory buildings and facilities. Also during this period, two nuclear facilities, the Van de Graaff accelerator and the neutron generator, were completely decommissioned.

CNL continues to decommission the WL. The current licence to decommission expires in December 2024. Major activities completed since the Seventh Review Meeting include the demolition and site remediation of the following facilities:

- Active Liquid Waste Treatment B200
- Combustion Test Facility B303
- Annex to Combustion Test Facility
- Gas Dynamics Research Laboratory B304
- Office Building B402/305

- WR-1 Organic Monitoring B424
- Fire Fighter Training Trailers

For the next licence period, CNL is proposing to extend site closure activities to 2030 at the earliest and decommission the WR-1 using *in situ* decommissioning, which is a different approach to what is currently authorized under the licence and subject to regulatory approval.

For the wastes that are currently on-site, CNL is planning to:

- transport certain LLW from WL to CRL for disposal in the proposed NSDF
- transport ILW to CRL for storage
- transport HLW (spent fuel) to CRL for interim storage until disposal facilities become available
- disposal options for the LLW that resides in unlined soil trenches in the waste management area are being explored such as in-situ disposal, complete removal, and a combination of both

In situ decommissioning is being proposed by CNL for WR-1. This entails removing the above-grade structure and grouting the below-grade components using a concrete based grout. The structure would then be capped with concrete and covered with an engineered barrier. *In situ* decommissioning is intended to isolate the reactor vault and contaminated systems and components inside the below-grade structure. Although not used widely, this approach has been used at other sites internationally. The technique is intended to minimize radiological exposure to workers, reduce the need for handling and transportation and minimize risk to workers and the environment. This proposal is in the regulatory review process and a two-part CNSC hearing is planned in 2025.

8.8.2 Underground Research Laboratory

The URL, located approximately 15 km northeast of WL in Manitoba, was an underground experimental facility used for research on controlled blasting techniques, rock mechanics and hydrological studies associated with potential deep underground disposal of spent fuel and the behaviour of various materials under the conditions of storage in deep-rock formations. No spent fuel or high-level waste was 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. CNSC staff confirmed this during an inspection conducted prior to the revocation of the site's licence to operate in 2003. The URL site was closed in 2015 after selected boreholes, ventilation raises and the main shaft were sealed, and an environmental and post-closure borehole hydraulic and geochemical monitoring program was conducted over a three-year period.

This also included the removal of the 22 post-closure boreholes, contaminated soil and the URL's surface facilities. AECL returned the leased lands to the Province of Manitoba on March 31, 2016.

Annex 9 – Matrix for Canada's Eighth National Report

Type of Liability	Long-term Management (LTM) Policy	Funding of Liabilities	Current Practice / Facilities	Planned Facilities
Spent fuel	National approach for the LTM of spent fuel NWFA, 2002 outlines process and implementation	Long term: <ul style="list-style-type: none"> licensees are required to contribute to segregated funds to finance LTM activities under the NFWA Short term: <ul style="list-style-type: none"> licensees are financially responsible and required to provide a financial guarantee for the decommissioning of interim WMFs for spent fuel under the NSCA 	Spent fuel from power reactors held in interim storage in wet or dry storage facilities located at the waste producers' site Spent fuel from research reactors returned to the fuel supplier or transferred to CRL for storage	Long term: <ul style="list-style-type: none"> NWMO implementation of the APM approach – a DGR for the LTM of spent fuel in Canada Short term: <ul style="list-style-type: none"> interim dry storage facilities constructed as needed
Nuclear fuel cycle waste	Licensees are responsible for the funding, organization, management and operation of their WMFs (<i>Radioactive Waste Policy Framework</i>) Government of Canada accepted responsibility for LTM of historic wastes and funds the management of legacy waste	Licensees are financially responsible and required to provide a financial guarantee for the decommissioning and LTM of the waste they produce	<ul style="list-style-type: none"> managed by licensee (on-site or at a dedicated WMF) managed <i>in situ</i>/above-ground mounds managed in near-surface facilities adjacent to the mines and mills waste from small generators transferred to licensed WMFs for management material decontaminated and recycled/disposed of through conventional means recovery of uranium from recoverable process streams 	<ul style="list-style-type: none"> OPG assessing options for LTM of its LLW and ILW CNL assessing CRL site for hosting LTM facilities for L&ILW LTM of the bulk of Canada's historic waste implemented under the PHAI LTM of uranium mines and mills in near-surface facilities adjacent to the mines and mills CNL assessing options at CRL site for hosting LTM facilities for radioactive wastes
Application wastes	Licensees are responsible for the funding, organization, management and operation of their WMFs	Licensees are financially responsible and required to provide a financial guarantee for the decommissioning and the LTM of the waste that they produce	<ul style="list-style-type: none"> delay and decay returned to manufacturer transferred to licensed WMFs for management 	CNL assessing options at CRL site for hosting LTM facilities for radioactive wastes

Type of Liability	Long-term Management (LTM) Policy	Funding of Liabilities	Current Practice / Facilities	Planned Facilities
Decommissioning	<ul style="list-style-type: none"> Licensees are responsible for the funding, organization, management and implementation of decommissioning activities Licensees to give due consideration to the immediate dismantling approach when proposing a decommissioning strategy (REGDOC-2.11.2) 	Licensees are financially responsible and required to provide a financial guarantee for the decommissioning and LTM of the waste that they produce	Major facilities required to keep decommissioning plans and financial guarantee up to date throughout the lifecycle of a licensed activity (REGDOC-2.11.2 and REGDOC-3.3.1). These are reviewed on a five-year cycle by the licensee and regulator	CNL assessing CRL site for hosting LTM facilities for L&ILW OPG assessing options for LTM of its L&ILW arising from decommissioning
Disused sealed sources	Licensees are responsible for the funding, organization, management and operation of their WMFs Sources tracked through NSSR and SSTS	Licensees are financially responsible and required to provide a financial guarantee for the decommissioning and the LTM of the waste that they produce	<ul style="list-style-type: none"> delay and decay returned to manufacturer transferred to licensed WMF for LTM recycling by reusing, re-encapsulating or reprocessing 	CNL assessing options at CRL site for hosting LTM facilities for radioactive wastes

List of Acronyms and Abbreviations

AECL	Atomic Energy of Canada Limited
ALARA	as low as reasonably achievable
AMPR	<i>Administrative Monetary Penalties Regulations</i>
APM	Adaptive Phased Management
ASDR	l'aire de stockage des déchets radioactifs (radioactive waste storage area)
BP	Bruce Power
CANDU	Canada deuterium-uranium
CANUTEC	Canadian Transport Emergency Centre
CARP	Coordinated Assessment and Research Program
CEAA 2012	<i>Canadian Environmental Assessment Act, 2012</i>
CEA Agency	Canadian Environmental Assessment Agency
CEPA	<i>Canadian Environmental Protection Act</i>
CINFR	<i>Class I Nuclear Facilities Regulations</i>
CIINPER	<i>Class II Nuclear Facilities and Prescribed Equipment Regulations</i>
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CRL	Chalk River Laboratories
CRMN	Canadian Radioactivity Monitoring Network
CSA	Canadian Standards Association
DDP	detailed decommissioning plan
DECOVALEX	Development of Coupled models and their Validation against Experiments
DGR	deep geological repository
DGRRF	Deep Geological Repository Regulators Forum
DGR-SRA	Strategic Research Agenda for Deep Geological Repositories
DRL	derived release limit

DSC	dry storage container
ECCC	Environment and Climate Change Canada
ECM	engineered containment mound
EIS	environmental impact statement
EMA	<i>Emergency Management Act</i>
EMS	environmental management system
EPREV	Emergency Preparedness Review
ERA	environmental risk assessment
EWL	EnCana West Limited
FEP	features, events and processes
FERP	Federal Emergency Response Plan
FNEP	Federal Nuclear Emergency Plan
FPS	fixed point surveillance
GEOSAF	International Project on Demonstration of the Operational and Long-Term Safety of Geological Disposal Facilities for Radioactive Waste
GNSCR	<i>General Nuclear Safety and Control Regulations</i>
GoCo	government-owned, contractor-operated
GSR	General Safety Requirements (IAEA)
GTA	Greater Toronto Area
H-Q	Hydro-Québec
HEU	highly enriched uranium
HHERA	human health and ecological risk assessment
HLW	high-level radioactive waste
IAA	<i>Impact Assessment Act</i>
IAAC	Impact Assessment Agency of Canada
IAEA	International Atomic Energy Agency
IAEED	Internal Audit Evaluation and Ethics Division
ICRP	International Commission on Radiological Protection

IEMP	Independent Environmental Monitoring Program
IGSC	Integration Group for the Safety Case
ILW	intermediate-level radioactive waste
IACWG	International Internal Audit Collaboration Working Group
INAC	Indigenous and Northern Affairs Canada
IPPAS	International Physical Protection Advisory Service
IRRS	Integrated Regulatory Review Service
IRSN	Institut de radioprotection et de sûreté nucléaire
ISRW	Integrated Strategy for Radioactive Waste
ITDB	Incident and Trafficking Database
JEB	John Everett Bates
L&ILW	low- and intermediate-level radioactive waste
LCH	licence conditions handbook
LEU	low-enriched uranium
LLRWMO	Low-Level Radioactive Waste Management Office
LLW	low-level radioactive waste
LLWI	Low-Level Waste Initiative
LSS	life span studies
LTM	long-term management
MACSTOR	modular air-cooled storage
MAGS	modular above-ground storage
MAPLE	Multipurpose Applied Physics Lattice Experiment
MNDM	Ministry of Northern Development and Mines (Ontario)
MoE	Ministry of the Environment
MOU	Memorandum of Understanding
N/A	not available
NB Power	New Brunswick Power Corporation
NCA	nuclear cooperation agreement

NEA	<i>Nuclear Energy Act</i>
BWXT NEC	BWXT Nuclear Energy Canada Inc.
NFWA	<i>Nuclear Fuel Waste Act</i>
NGS	nuclear generating station
NLCA	<i>Nuclear Liability and Compensation Act</i>
NNIECR	<i>Nuclear Non-proliferation Import and Export Control Regulations</i>
NORM	Naturally Occurring Radioactive Material
NPD	Nuclear Power Demonstration
NPP	Nuclear Power Plant
NPRI	National Pollutant Release Inventory
NPT	Non-Proliferation Treaty, Treaty on the Non-proliferation of Nuclear Weapons
NRCan	Natural Resources Canada
NRU	National Research Universal
NRX	National Research Experimental
NSCA	<i>Nuclear Safety and Control Act</i>
NSDF	Near Surface Disposal Facility
NSR	<i>Nuclear Security Regulations</i>
NSRDR	<i>Nuclear Substances and Radiation Devices Regulations</i>
NSSR	National Sealed Source Registry
NTR	Northern Transportation Route
NWMO	Nuclear Waste Management Organization
OECD	Organisation for Economic Cooperation and Development
OPEX	Operating Experience
OPG	Ontario Power Generation Inc.
PCB	polychlorinated biphenyls
PDP	preliminary decommissioning plan
PFP	Participant Funding Program
PHAC	Public Health Agency of Canada

PHAI	Port Hope Area Initiative
PTNSR, 2015	<i>Packaging and Transport of Nuclear Substances Regulations, 2015</i>
R&D	research and development
RMC	Royal Military College
ROR	Regulatory Oversight Report
RPR	<i>Radiation Protection Regulations</i>
RWLF	Radioactive Waste Leadership Forum
SCA	safety and control area
SITEX II	Sustainable Network for Independent Technical Expertise on Radioactive Waste Management
SLOWPOKE	Safe Low-Power Critical Experiment
SMAGS	shielded modular above-ground storage
SMART	specific, measurable, attainable, realistic and timely
SRC	Saskatchewan Research Council
SSF	Sort and Segregation Facility
SSR	Specific Safety Requirements (IAEA)
SSTS	Sealed Source Tracking System
STEM	science, technology, engineering and mathematics
SWS	storage with surveillance
TDGR	<i>Transportation of Dangerous Goods Regulations</i>
THMC	thermal-hydraulic-mechanical-chemical
TLD	thermoluminescent dosimeter
TMA	tailings management area
TMF	tailings management facility
UFC	used fuel container
UMMR	<i>Uranium Mines and Mills Regulations</i>
UNENE	University Network of Excellence in Nuclear Engineering
URL	underground research laboratory

U.S.	United States of America
VLLW	very-low-level radioactive waste
VSLLW	very-short-lived low-level radioactive waste
WL	Whiteshell Laboratories
WMF	waste management facility
WR-1	Whiteshell Reactor-1
WTP	waste water treatment plant
ZED-2	zero energy deuterium-2