Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Regulatory Oversight Report

Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities and Research Reactors in Canada: 2020

Rapport de surveillance réglementaire

Rapport de surveillance réglementaire des installations de traitement de l'uranium et des substances nucléaires ainsi que des réacteurs de recherche au Canada : 2020

Public Meeting

Réunion publique

Scheduled for:

December 15 or 16, 2021

Prévue pour :

15 ou 16 décembre 2021

Submitted by:

CNSC Staff

Soumis par :

Le personnel de la CCSN

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Canada

Summary

This Commission member document (CMD) pertains to the *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities and Research Reactors in Canada: 2020*.

There are no actions requested of the Commission. This CMD is for information only.

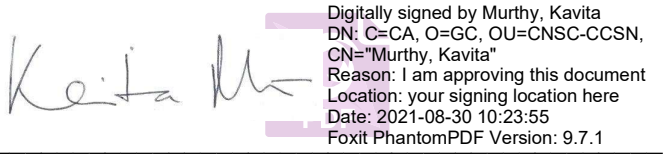
Résumé

Ce document à l'intention des commissaires (CMD) porte sur le *Rapport de surveillance réglementaire des installations de traitement de l'uranium et des substances nucléaires ainsi que des réacteurs de recherche au Canada : 2020*.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

Signed/signé le

August 30, 2021



Kavita Murthy

Director General

Directorate of Nuclear Cycle and Facilities Regulation

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Direction de la réglementation du cycle et des installations nucléaires

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CHANGES TO 2020 REGULATORY OVERSIGHT REPORT

As with other 2020 Regulatory Oversight Reports (ROR) produced by the Canadian Nuclear Safety Commission (CNSC), changes have been made to this report as a result of recommendations from the Commission and feedback from intervenors. CNSC staff made the following changes to the *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities and Research Reactors in Canada: 2020*:

- Performance reporting of research reactors is done on a 3-year frequency. These facilities were previously part of the RORs for Nuclear Research Reactors and Particle Accelerator Facilities, and will henceforth be included in this ROR.
- Indigenous groups and their traditional and/or treaty territories are acknowledged at the beginning of the ROR and presentation.
- The executive summary is replaced with a plain language summary.
- Further details on all Safety and Control Areas is added.
- Greater use of hyperlinks is made as content is already readily available online (e.g. CNSC external website, past regulatory oversight reports, etc.).
- Data provided for IEMP includes an explanation on changes to analytical techniques.
- The amount of time that intervenors were given to review the regulatory oversight report increased from 30 to 60 days.
- The presentation only includes content already presented in the written report and is limited to about 45 minutes.
- Additionally, intervenor comments are grouped in themes in the presentation rather than being dispositioned individually in a supplemental Commission Member Document.

PLAIN LANGUAGE SUMMARY

The *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities and Research Reactors in Canada: 2020* provides information on the safety performance of the nuclear facilities named in the title. The report is based on the work of Canadian Nuclear Safety Commission (CNSC) staff to ensure safety and protection for the people and the environment for licenced uranium and nuclear substance processing facilities (UNSPF), as well as research reactors (RRs). Over the reporting periods covered, all facilities continued to operate safely; monitoring data shows that the food grown nearby is safe to eat, and the water is safe to drink. There were no releases that could have harmed human health or the environment.

This report also provides an update on CNSC staff regulatory activities pertaining to public information, community engagement, and aspects of the CNSC's Independent Environmental Monitoring Program that relate to UNSPF and RR. Where possible, trends are shown and information is compared to previous years.

This report provides information on the following licenced facilities in Canada:

- Uranium processing facilities
  - Cameco Corporation Blind River Refinery in Blind River, ON
  - Cameco Corporation Port Hope Conversion Facility in Port Hope, ON
  - Cameco Fuel Manufacturing Inc. in Port Hope, ON
  - BWXT Nuclear Energy Canada Inc. in Toronto, ON
  - BWXT Nuclear Energy Canada Inc. in Peterborough, ON
- Nuclear substance processing facilities
  - SRB Technologies (Canada) Inc. in Pembroke, ON
  - Nordion (Canada) Inc. in Ottawa, ON
  - Best Theratronics Ltd. in Ottawa, ON
- Research reactors
  - École Polytechnique de Montréal SLOWPOKE-2 in Montréal, QC
  - McMaster Nuclear Reactor in Hamilton, ON
  - Royal Military College of Canada SLOWPOKE-2 in Kingston, ON
  - Saskatchewan Research Council SLOWPOKE-2 in Saskatoon, SK

Each year, CNSC inspectors complete inspections at these facilities. The number of inspections and what is inspected depend on the individual site and how it has been performing. The CNSC uses a risk-informed approach when planning inspections. Over the respective reporting periods, CNSC staff performed a total of 28 inspections at the UNSPF and RRs. These inspections resulted in the issuance of 47 notices of non-compliance (NNC), which were all related to issues identified as low risk. In addition, to ensure non-proliferation obligations were met, 39 International Atomic Energy Agency (IAEA) initiated safeguards verification activities and 1 CNSC-initiated safeguards field activity were performed at the UNSPF and RRs. These regulatory activities resulted in the issuance of 3 NNCs, which were all related to issues identified as low risk. All NNCs are described in section 6 and section 7.2.2 of this CMD.

The CNSC uses 14 Safety and Control Areas (SCAs) to evaluate the performance of each licensee, for which the resulting performance ratings are included in this report. Particular focus is placed on the radiation protection, environmental protection, and conventional health and safety SCAs, as these give a good overview of safety performance.

The SCA ratings in this report were derived from the results of compliance activities conducted by CNSC staff. These activities included onsite and virtual inspections, technical assessments, reviews of reports submitted by licensees, reviews of events and incidents, and ongoing exchanges of information with licensees. For the periods reported in this Commission Member Document, CNSC staff rated all SCAs as “satisfactory” for all facilities contained in this report, and confirmed that all were operating safely.

CNSC staff’s efforts supported the CNSC’s ongoing commitment to meeting consultation and accommodation obligations, and continuing to build relationships with Indigenous peoples with interests in Canada’s UNSPF and RRs.

In summary, workers at each facility were safe and properly protected and there were no releases that could have harmed the surrounding environments or the health and safety of people.

This report is available on the CNSC website, and the documents referenced in it are available to the public upon request by contacting:

Senior Tribunal Officer, Secretariat

Tel.: 613-858-7651 or 1-800-668-5284

Fax: 613-995-5086

Email: interventions@cnsc-ccsn.gc.ca

RÉSUMÉ EN LANGAGE CLAIR

Le *Rapport de surveillance réglementaire des installations de traitement de l'uranium et des substances nucléaires ainsi que des réacteurs de recherche au Canada : 2020* présente de l'information sur le rendement en matière de sûreté des installations nucléaires mentionnées dans le titre. Le rapport repose sur le travail effectué par le personnel de la Commission canadienne de sûreté nucléaire (CCSN) pour préserver la sécurité des personnes et protéger l'environnement à l'égard des installations de traitement de l'uranium et des substances nucléaires (ITUSN) ainsi que des réacteurs de recherche. Au cours des périodes visées par le rapport, toutes les installations ont continué à être exploitées de manière sûre; les données de la surveillance indiquent que les aliments cultivés à proximité sont salubres et que l'eau est potable. Il n'y a eu aucun rejet qui aurait pu nuire à la santé humaine ou à l'environnement.

Le présent rapport fait également le point sur les activités de réglementation du personnel de la CCSN touchant l'information publique, la mobilisation des collectivités et les aspects du Programme indépendant de surveillance environnementale de la CCSN en ce qui concerne les ITUSN et les réacteurs de recherche. Dans la mesure du possible, les tendances sont indiquées et les données sont comparées à celles des années précédentes.

Le présent rapport fournit des renseignements sur les installations autorisées du Canada énumérées ci-dessous :

- Installations de traitement de l'uranium
  - Cameco Corporation, raffinerie de Blind River, Blind River (Ontario)
  - Cameco Corporation, installation de conversion de Port Hope, Port Hope (Ontario)
  - Cameco Fuel Manufacturing Inc., Port Hope (Ontario)
  - BWXT Nuclear Energy Canada Inc., installation de Toronto (Ontario)
  - BWXT Nuclear Energy Canada Inc., installation de Peterborough (Ontario)
- Installations de traitement des substances nucléaires
  - SRB Technologies (Canada) Inc., Pembroke (Ontario)
  - Nordion (Canada) Inc., Ottawa (Ontario)
  - Best Theratronics Ltd., Ottawa (Ontario)
- Réacteurs de recherche
  - Réacteur SLOWPOKE-2 de l'École Polytechnique de Montréal, Montréal (Québec)
  - Réacteur nucléaire McMaster, Hamilton (Ontario)
  - Réacteur SLOWPOKE-2 du Collège militaire royal du Canada, Kingston (Ontario)
  - Réacteur SLOWPOKE-2 du Saskatchewan Research Council, Saskatoon (Saskatchewan)

Chaque année, les inspecteurs de la CCSN réalisent des inspections dans ces installations. Le nombre d'inspections et les éléments inspectés dépendent de chaque site et de son rendement. La CCSN s'appuie sur une méthode qui tient compte du risque lorsqu'elle planifie ses inspections. Au cours des périodes respectives visées par le rapport, le personnel de la CCSN a réalisé un total de 28 inspections aux ITUSN et aux réacteurs de recherche. Ces inspections ont donné lieu à la délivrance de 47 avis de non-conformité (ANC), qui étaient tous liés à des problèmes considérés comme étant à faible risque. En outre, afin d'assurer le respect des obligations en matière de non-prolifération, l'Agence internationale de l'énergie atomique (AIEA) a réalisé 39 activités de vérification des garanties et la CCSN a réalisé 1 activité sur le terrain concernant les garanties aux ITUSN et aux réacteurs de recherche. Ces activités de réglementation ont donné lieu à la délivrance de trois ANC, qui étaient tous liés à des problèmes considérés comme étant à faible risque. Tous les ANC sont décrits à la section 6 et à la section 7.2.2 (en anglais) du présent CMD.

La CCSN utilise 14 domaines de sûreté et de réglementation (DSR) pour évaluer le rendement de chaque titulaire de permis, et les cotes de rendement correspondantes sont incluses dans ce rapport. Le rapport se concentre sur les DSR Radioprotection, Protection de l'environnement et Santé et la sécurité classiques, car ils donnent une bonne indication du rendement en matière de sûreté.

Les cotes attribuées aux DSR dans le présent rapport s'appuient sur les résultats des activités de vérification de la conformité réalisées par le personnel de la CCSN. Ces activités comprenaient des inspections sur le site et virtuelles, des évaluations techniques, des examens des rapports présentés par les titulaires de permis, des examens des événements et incidents, et des échanges continus d'information avec les titulaires de permis. Pour les périodes visées dans ce document à l'intention des commissaires, le personnel de la CCSN a attribué la cote « Satisfaisant » à tous les DSR pour toutes les installations mentionnées dans ce rapport, et a confirmé qu'elles étaient toutes exploitées de façon sécuritaire.

Les efforts du personnel de la CCSN ont appuyé l'engagement continu de la CCSN à respecter ses obligations en matière de consultation et d'accommodement, et à continuer de bâtir des relations avec les peuples autochtones qui s'intéressent aux ITUSN et aux réacteurs de recherche du Canada.

En résumé, les travailleurs de chaque installation étaient en sécurité et adéquatement protégés, et il n'y a eu aucun rejet qui aurait pu nuire aux milieux environnants ou à la santé et à la sécurité des personnes.

Ce rapport est disponible sur le site Web de la CCSN. Les membres du public peuvent obtenir, sur demande, les documents mentionnés dans le rapport en communiquant avec :

Agente principale du tribunal, Secrétariat

Tél. : 613-996-9063 ou 1-800-668-5284

Téléc. : 613-995-5086

Courriel : interventions@cnsc-ccsn.gc.ca

1 INTRODUCTION

Through the application of the *Nuclear Safety and Control Act* (NSCA) [1], and its associated Regulations, the Canadian Nuclear Safety Commission (CNSC) regulates Canada's nuclear industry to protect the health and safety of persons and the environment and to implement Canada's international commitments on the peaceful use of nuclear energy. The CNSC also disseminates objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely, and are required to implement programs that make adequate provision for meeting legislative and regulatory requirements and licence conditions.

This Regulatory Oversight Report (ROR) provides an overview of CNSC regulatory efforts and staff's assessment of UNSPF in Canada for the 2020 calendar year. This report also provides CNSC staff's assessment of RRs from 2018 to 2020, on which the Commission has directed CNSC staff to provide updates every 3 years.

The facilities covered by this report are:

- Uranium processing facilities[1]
  - Cameco Corporation Blind River Refinery (BRR) in Blind River (FFOL-3632.00/2022)
  - Cameco Corporation Port Hope Conversion Facility (PHCF) in Port Hope (FFOL-3631.00/2027)
  - Cameco Fuel Manufacturing Inc. (CFM) in Port Hope (FFOL-3641.00/2022)
  - BWXT Nuclear Energy Canada Inc. (formerly GE Hitachi Nuclear Energy Canada Inc.) in Toronto (BWXT-NEC Toronto) (FFL-3621.00/2030)
  - BWXT Nuclear Energy Canada Inc. (formerly GE Hitachi Nuclear Energy Canada Inc.) in Peterborough (BWXT-NEC Peterborough) (FFL-3620.00/2030)
- Nuclear substance processing facilities[1]
  - SRB Technologies (Canada) Inc. (SRBT) in Pembroke (NSPFOL-13.00/2022)
  - Nordion (Canada) Inc. (Nordion) in Ottawa (NSPFOL-11A.01/2025)
  - Best Theratronics Ltd. (BTL) in Ottawa (NSPFOL-14.00/2029)

[1] Each alpha-numeric expression refers to the licence held by the licensee.

- Research reactors[1]
  - École Polytechnique de Montréal (ÉPM) SLOWPOKE-2 in Montréal (PERFP-9A.01/2023)
  - McMaster Nuclear Reactor (MNR) in Hamilton (NPROL-01.01/2024)
  - Royal Military College of Canada (RMC) SLOWPOKE-2 in Kingston (NPROL-20.00/2023)
  - Saskatchewan Research Council (SRC) SLOWPOKE-2 in Saskatoon (NPROL-19.01/2023)

This report discusses all safety and control areas (SCA), but focuses on radiation protection, environmental protection, and conventional health and safety, as they provide a good overview of safety performance at licensed facilities. The report also provides an overview of licensee operations, licence changes, major developments at licensed facilities and sites, and reportable events. In addition, the report includes information on public information programs, COVID-19 responses by licensees and the CNSC, and engagement with Indigenous groups and communities. The information in this document is complemented by the information provided in the PowerPoint presentation titled *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities and Research Reactors in Canada: 2020* Commission Member Document (CMD) 21-M33.A.

2 URANIUM PROCESSING FACILITIES

Uranium processing facilities are part of the nuclear fuel cycle that includes refining, conversion and fuel manufacturing. The fuel produced is used in nuclear power plants for the generation of electricity.

2.1 Cameco Blind River Refinery

Cameco Corporation owns and operates the Blind River Refinery (BRR) in Blind River, Ontario. The facility is located about 5 km west of the town of Blind River and south of Mississauga First Nation, as shown in figure 2-1.

Figure 2-1: Aerial view of the BRR facility *(Source: Cameco)*

The BRR facility refines uranium concentrates (yellowcake) received from uranium mines worldwide to produce uranium trioxide (UO_3), an intermediate product of the nuclear fuel cycle. The primary recipient of the UO_3 product is Cameco's Port Hope Conversion Facility (PHCF).

In 2020, CNSC staff conducted 3 inspections at BRR that covered 7 SCAs. Table B-1 of Appendix B lists these inspections and the 4 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that Cameco's BRR was operated safely in 2020 and in accordance with its licensing basis.

In September 2020, CNSC staff received Cameco's application for a 10 year renewal of its fuel facility operating licence for BRR. Its current licence expires on February 28, 2022 and a Commission hearing is scheduled from November 24-25, 2021.

2.2 Cameco Port Hope Conversion Facility

Cameco Corporation owns and operates Port Hope Conversion Facility (PHCF), which is located in Port Hope, Ontario, situated on the north shore of Lake Ontario, approximately 100 km east of Toronto. Figure 2-2 shows an aerial view of the PHCF facility in Port Hope.

Figure 2-2: Aerial view of the PHCF facility *(Source: Cameco)*

PHCF converts UO_3 powder produced by Cameco's BRR into uranium dioxide (UO_2) and uranium hexafluoride (UF_6). UO_2 is used in the manufacture of Canada Deuterium Uranium (CANDU) reactor fuel, while UF_6 is exported for further processing before being converted into fuel for light-water reactors.

In 2020, CNSC staff conducted 3 inspections at PHCF that covered 9 SCAs, as well as compliance verification activities associated with the Vision in Motion (VIM) project. Table B-2 of Appendix B lists these inspections and the 8 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that Cameco's PHCF was operated safely in 2020 and in accordance with its licensing basis.

Vision in Motion

VIM is Cameco's project to clean up and renew the site. The project is being carried out under Cameco's operating licence, FFOL-3631.00/2027. Licence condition 16.1 requires that "*The licensee shall implement and maintain a program to carry out clean-up, decontamination and remediation work*". Cameco postponed some non-essential VIM work to limit the amount of contractors' onsite during the COVID-19 pandemic. In 2020, Cameco carried out VIM work that included:

- Preparation and transfer of stored wastes to the CNSC licensed Canadian Nuclear Laboratories (CNL) *Port Hope Project Long Term Waste Management Facility*.
- Removed interior equipment and accumulated waste materials in Building 27 (the former UF_6 plant).

- Installation of infrastructure, including new storm water management systems and the new hydrogen station were substantially completed. Commissioning is planned for 2021. The Ontario Ministry of the Environment, Conservation and Parks (MECP) Environmental Compliance Approval amendment for stormwater was received and the new stormwater system at the south end of the facility began operation.
- Conducted species at risk desktop studies and species surveys in VIM work areas.
- Conducted a subsurface geotechnical drilling investigation in the location of proposed storm water infrastructure.

In December 2020, Cameco provided an update to the Commission (CMD 20-M36.1) on the VIM project.

2.3 Cameco Fuel Manufacturing Inc.

Cameco Fuel Manufacturing Inc. (CFM) is a wholly owned subsidiary of Cameco Corporation. CFM operates 2 facilities: a nuclear fuel fabricating facility licensed by the CNSC in Port Hope, Ontario; and a metals manufacturing facility in Cobourg, Ontario, which manufactures fuel bundle and reactor components (non-nuclear activities). This latter facility is not licensed by the CNSC and is not discussed further in this report. Figure 2-3 shows an aerial view of the CFM facility in Port Hope.

Figure 2-3: Aerial view of the CFM facility *(Source: Cameco)*

The CFM facility manufactures fuel pellets from natural UO_2 powder and assembles nuclear reactor fuel bundles. The finished fuel bundles are primarily shipped to Canadian nuclear power reactors.

In 2020, CNSC staff conducted 3 inspections at CFM that covered 5 SCAs. Table B-3 of Appendix B lists these inspections and the 9 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that CFM was operated safely in 2020 and in accordance with its licensing basis.

In December 2020, CNSC staff received Cameco's application for a 1 year renewal of its fuel facility operating licence for CFM. Its current licence expires on February 28, 2022. CNSC staff's CMD and Cameco's hearing documents will be available on the CNSC website or upon request to the Secretariat after September 17, 2021 and written interventions may be submitted until November 16, 2021. The Commission will conduct a hearing in writing to consider submissions from Cameco and CNSC staff, as well as interventions from the Public and Indigenous groups.

2.4 BWXT Nuclear Energy Canada Inc.

BWXT Nuclear Energy Canada Inc. (BWXT-NEC) produces nuclear fuel and fuel bundles used by Ontario Power Generation's Pickering and Darlington nuclear generating stations. BWXT-NEC has licensed operations in 2 locations: Toronto and Peterborough, Ontario. Figures 2-4 and 2-5 show aerial views of the BWXT-NEC facilities.

Figure 2-4: Aerial view of the BWXT Toronto facility *(Source: Google Maps)*

Figure 2-5: Aerial view of the BWXT Peterborough facility *(Source: Google Maps)*

The Toronto facility produces CANDU nuclear fuel pellets using uranium dioxide (UO_2) supplied from PHCF. The Peterborough facility manufactures CANDU nuclear fuel bundles, using the uranium pellets from Toronto and zircaloy tubes manufactured in-house. The Peterborough facility also runs a fuel services business involved with the manufacturing and maintenance of equipment for use in nuclear power plants.

In 2020, CNSC staff conducted 4 inspections at BWXT-NEC that covered 4 SCAs. Table B-4 of Appendix B lists these inspections and the 4 resulting NNCs are highlighted in section 6 and section 7 of this CMD.

Significant facility modifications included changes in Peterborough to include automation equipment dealing with sorting and stacking of fuel pellets received from the Toronto facility. All facility modifications were conducted under the facility change control process and CNSC staff are satisfied that the BWXT-NEC facilities were operated safely in 2020 and in accordance with its licensing basis.

2.4.1 2020 BWXT-NEC Licence Renewal

In March 2020, the Commission conducted public hearings in Toronto, Ontario and Peterborough, Ontario on the renewal of BWXT-NEC's operating licence. CNSC staff assessment of the renewal application was presented publicly during this hearing as CMD 20-H2.A and CMD 20-H2.B. As well, CNSC staff submitted CMD 20-H2.C in response to several undertakings provided to the Commission for more information.

In April 2020, the Commission announced a Continuation of Hearing and directed CNSC staff to collect additional soil samples of beryllium on properties adjacent to BWXT-NEC's Peterborough facility. CNSC staff completed the resampling and provided a supplementary submission to the Commission as CMD 20-H2.D and CMD 20-H2.E.

In December 2020, the Commission made a decision on the BWXT-NEC licence renewal application as documented in the Record of Decision 20-H2. In its decision, the Commission decided to renew BWXT-NEC's licence into 2 facility specific licences (FFL-3621.00/2030 and FFL-3620.00/2030) for a period of 10 years. As the decision details, the Commission also permitted the conduct of pelleting operations at the Peterborough facility with conditions (e.g. updated safety analysis report and final commissioning report) and accepted BWXT-NEC's proposed new financial guarantee. Further, the Commission issued several directions to CNSC staff on Indigenous and public engagement, the status of which is reported in sections 7.2 and 7.3 of this CMD.

3 NUCLEAR SUBSTANCE PROCESSING FACILITIES

Nuclear substance processing facilities process nuclear substances for a variety of end uses in industrial or medical applications. The nuclear substances can be used for lighting self-luminous emergency and exit signs, sterilizing items for sanitary reasons such as surgical gloves, and providing cancer diagnosis and treatment.

3.1 SRB Technologies (Canada) Inc.

SRB Technologies Inc. (SRBT) operates a Class IB facility manufacturing gaseous tritium light sources (GTLS) on the outskirts of Pembroke, Ontario, located approximately 150 km northwest of Ottawa. The nuclear facility has been in operation since 1990 and employs approximately 40 employees. Figure 3-1 shows an aerial view of the SRBT facility.

Figure 3-1: Aerial view of the SRBT facility *(Source: SRTB)*

The SRBT facility processes tritium gas (HT) to produce sealed glass capsules coated with phosphorescent powder and filled with HT to generate continuous light. Examples of such GTLS include signs, markers and tactical devices. SRBT distributes its products in Canada and internationally.

In 2020, CNSC staff conducted 2 inspections at SRBT that covered 2 SCAs. Table B-5 of Appendix B lists these inspections and the 3 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that SRBT was operated safely in 2020 and in accordance with its licensing basis.

CNSC staff will be prepared to receive SRBT's application for a nuclear substance processing facility licence in 2021, as it is due for renewal in June 2022.

3.2 Nordion (Canada) Inc.

Nordion (Canada) Inc. is located in Ottawa, Ontario, and is licensed to operate a Class IB nuclear substance processing facility. Figure 3-2 shows an aerial view of the Nordion facility.

Figure 3-2: Aerial view of the Nordion facility (highlighted in blue) *(Source: Google Maps)*

The facility is composed of 2 major production operations. One operation involves the processing of radioisotopes used in nuclear medicine (medical isotopes) such as yttrium-90. The other operation involves manufacturing sealed sources (cobalt-60 (Co-60)) used in cancer therapy and irradiation technologies (gamma technologies).

In April 2018, BWX Technologies Ltd. (BWXT) announced an agreement to acquire Nordion's medical isotope business. The acquisition was completed in August 2018, as a wholly owned subsidiary of BWXT, BWXT Medical Ltd (BWXT-MED). Nordion will continue to operate the medical isotope facility until such time as BWXT-MED obtains a separate Class IB nuclear substance processing facility operating licence (NSPFOL) for which a licensing hearing took place in June 2021.

In 2020, CNSC staff conducted 2 inspections at Nordion that covered 7 SCAs. Table B-6 of Appendix B lists these inspections and the 3 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that Nordion was operated safely in 2020 and in accordance with its licensing basis.

3.3 Best Theratronics Ltd.

Best Theratronics Ltd. (BTL) owns and operates a medical device manufacturing facility in Ottawa, Ontario. Figure 3-3 shows an aerial view of the BTL facility.

Figure 3-3: Aerial view of the BTL facility *(Source: Google Maps)*

BTL manufactures cyclotrons and medical equipment, including Co-60 based external beam radiation therapy units and cesium-137 self-contained irradiators for blood irradiation. BTL is licensed by the CNSC for the development and testing of Co-60 teletherapy devices, the manufacturing of self-shielded irradiators, the storage of nuclear substances, and construction and testing of particle accelerators (cyclotrons) with beam energies ranging from 15 to 70 MeV.

In 2020, CNSC staff conducted 2 inspections at BTL that covered 2 SCAs. Table B-7 of Appendix B lists these inspections and the 6 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that BTL was operated safely in 2020 and in accordance with its licensing basis.

4 RESEARCH REACTOR FACILITIES

This section of the ROR discusses CNSC's regulatory oversight and licensee performance of the small RRs in Canada, including McMaster Nuclear Reactor (MNR) and 3 SLOWPOKE-2 reactors: École Polytechnique de Montréal (ÉPM), Saskatchewan Research Council (SRC) and Royal Military College of Canada (RMC).

CNSC staff first reported on nuclear research reactor (RR) facilities in 2015, in the *ROR for Nuclear Processing, Small Research Reactor and Class 1B Accelerator Facilities: 2015*. These facilities were then reported on again in 2018 during the *ROR for Research Reactors and Class 1B Accelerators: 2016-2017*, and are now on a 3-year reporting frequency. This ROR covers reporting years 2018-2020. In 2021, for operational efficiency, CNSC staff decided to henceforth include the report on RRs in this report.

The small RRs operating in Canada are designed to operate at low power, ranging from 0.02 MW for the SLOWPOKE-2 reactors to 5 MW for the MNR. The SLOWPOKE-2 reactors are self-limiting in power and temperature, without the need for operator intervention or automatic trip systems. They also use natural circulation for cooling, eliminating the need for complex cooling systems. These small RRs are typically used for academic purposes, medical isotope production, neutron radiography and neutron activation analysis for a number of industries including mining and geological surveys. Figure 4-1 shows a model of a SLOWPOKE-2 reactor core.

Figure 4-1: Model of a SLOWPOKE-2 reactor core *(Source: RMC)*

They do not release liquid effluents, and the airborne releases are extremely small. A conservative evaluation of the dose to the public through airborne releases results in less than 1 µSv/year, which is less than a thousandth of the regulatory dose limit of 1 mSv for a member of the public. As a point of reference, the average effective dose to persons from natural background radiation in Canada is estimated at 1.8 mSv/year.

With their inherent safety characteristics and low power, these reactors present a very low risk.

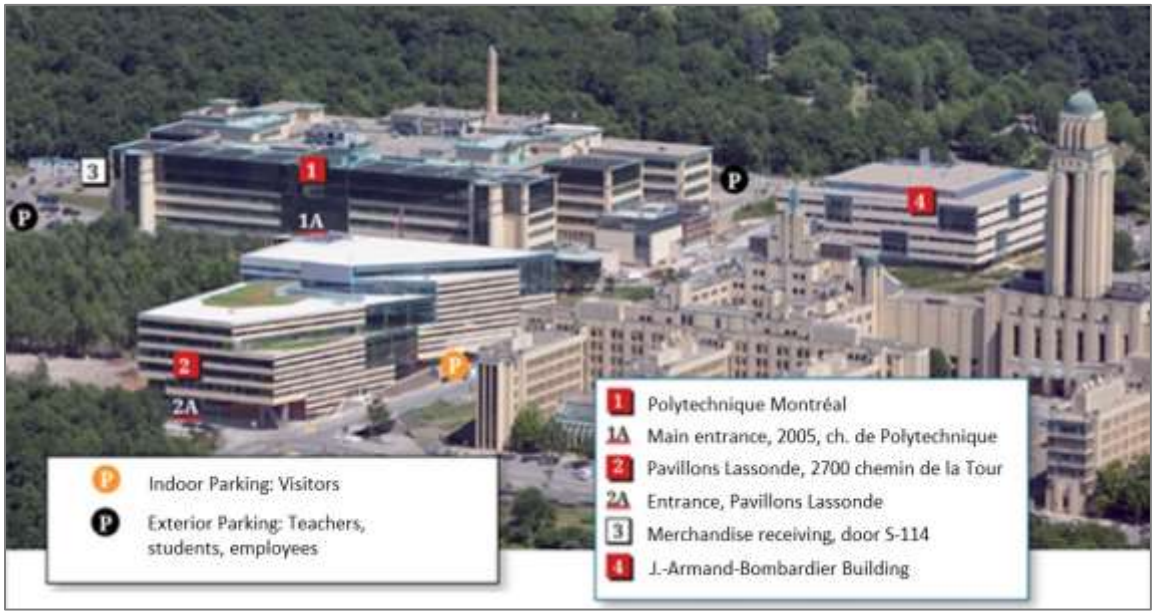
4.1 École Polytechnique de Montréal SLOWPOKE-2

La version française est incluse à l'annexe O.

ÉPM operates a SLOWPOKE-2 reactor in Montréal, Québec, for which a licence was issued by the CNSC in 2016, for a period of 7 years. The reactor was initially commissioned in 1976 and the fuel was replaced in 1997 with low-enriched uranium (LEU) fuel. ÉPM expects to operate the reactor until 2032. The reactor is used for research, neutron analysis, teaching and isotope production. The ÉPM campus is shown in figure 4-2.

The ÉPM SLOWPOKE-2 facility includes a Subcritical Assembly, located in a room next to the reactor. The assembly consists of natural uranium bars and neutron sources that are manually inserted into graphite blocks. The Subcritical Assembly has been used in the past for teaching and research purposes. However, it has not operated since 2012.

Figure 4-2: Aerial view of ÉPM *(Source: ÉPM Website)*



CNSC staff conducted 2 inspections at ÉPM from 2018-2020 that covered 10 SCAs. Table B-8 of Appendix B lists these inspections and the 4 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that ÉPM was operated safely over the 2018–2020 period and in accordance with its licensing basis. No operational issues or events were reported over the 2018–2020 period.

CNSC staff will be prepared to receive ÉPM's application for a SLOWPOKE-2 reactor operating licence in 2022, as it is due for renewal in July 2023.

4.2 McMaster Nuclear Reactor

McMaster University operates the MNR, a medium flux reactor in Hamilton, Ontario. A licence was issued by the CNSC in 2014 for a period of 10 years. The reactor became operational in 1959, and was upgraded in the 1970's to operate at 5 MW, up from the 1 MW maximum. The reactor is used for research, materials testing, teaching and isotope production.

This pool-type reactor uses LEU as fuel and has the added safety feature of a full containment building. The reactor produces iodine-125 (I-125) for medical use in Canada and for international markets. The MNR is also used for neutron radiography, which is performed on a daily basis for the testing of aircraft engine components. In addition to supporting the research work of McMaster University physics and engineering undergraduate and post-graduate students, the MNR is used for the irradiation of more than 10,000 mineral and other samples every year for various applications such as biomedical research, material science and geological surveys. Figure 4-3 shows an image of the MNR containment building, and figure 4-4 provides an overhead view of the MNR in operation.

Figure 4-3: MNR containment building *(Source: MNR)*

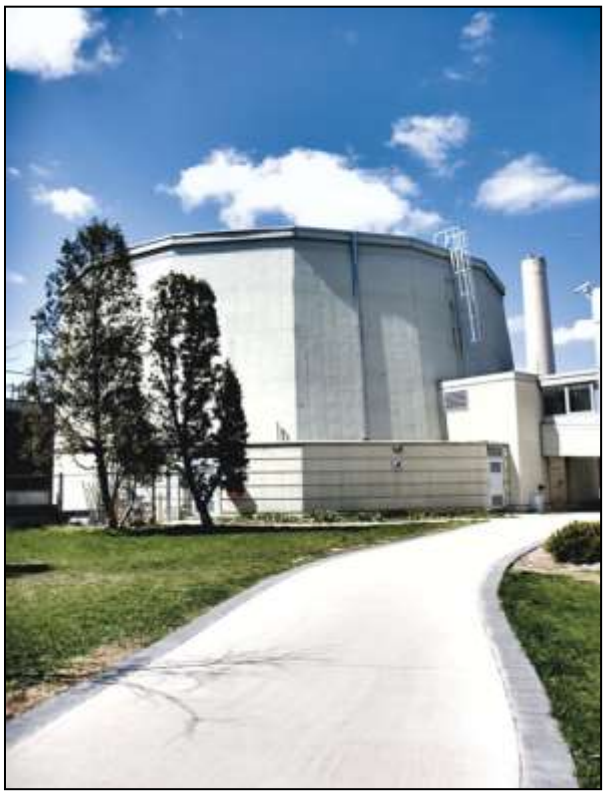


Figure 4-4: Overhead view of the MNR in operation *(Source: MNR)*

CNSC staff conducted 3 inspections at MNR from 2018-2020 that covered 13 SCAs, as well as the Public and Information Disclosure Program. Table B-9 of Appendix B lists these inspections and the 6 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that MNR was operated safely over the 2018–2020 period and in accordance with its licensing basis.

4.3 Royal Military College of Canada SLOWPOKE-2

The RMC operates a SLOWPOKE-2 facility, at the RMC complex in Kingston, Ontario. The licence was issued by the CNSC in 2013 for a period of 10 years.

This facility is comprised of the reactor room, with the reactor and control room located on the first floor and laboratories on the first and second floors of the Sawyer Science and Engineering Building, Module 5. This building is shown in figure 4-5, indicated by the red dot.

Figure 4-5: Aerial view of the RMC SLOWPOKE-2 facility *(Source: RMC)*

This facility is used for neutron activation analysis, analysis of fissile materials, neutron radiography and radioscopy, and education in radiation protection at the post-graduate level. The reactor has been in operation since 1985. The core is fueled with LEU.

The type of operations remained the same over the review period. RMC has undertaken a project to refuel the SLOWPOKE-2 reactor as the fuel core has attained its end of life, and the project is on schedule for completion by the end of 2021. CNSC staff are engaged in the review of the project and the refueling operations.

CNSC staff conducted 2 inspections at RMC from 2018-2020 that covered 11 SCAs, along with the Public Information and Disclosure Program. Table B-10 of Appendix B lists these inspections and the 2 resulting NNCs are highlighted in section 6 of this CMD.

CNSC staff are satisfied that RMC was operated safely over the 2018–2020 period and in accordance with its licensing basis.

CNSC staff will be prepared to receive RMC's application for a SLOWPOKE-2 reactor operating licence in 2022, as it is due for renewal in July 2023.

4.4 Saskatchewan Research Council SLOWPOKE-2

SRC was operating the SLOWPOKE-2 facility, for which a 10 year licence was issued by the CNSC in 2013. The reactor came on line in 1981, and was shut down for decommissioning in April 2019. In December 2019, following a public hearing, a licence amendment was approved (Record of Decision 19-H100) by the Commission, allowing SRC to begin decommissioning.

The SRC SLOWPOKE-2 facility was located at 422 Downey Road, within the Innovation Place Research Park in Saskatoon, Saskatchewan, as shown by the red circle in figure 4-6. Prior to decommissioning, the facility consisted of a reactor room, a laboratory and a waste storage room. The facility was used for neutron activation analysis, delayed neutron analysis and teaching in conjunction with the University of Saskatchewan.

Figure 4-6: SRC SLOWPOKE-2 facility *(Source: Google Maps)*

On August 15, 2019, the highly-enriched uranium (HEU) fuel was removed from the reactor pool in the presence of IAEA, CNSC and the United States Department of Energy (US DOE) representatives. The HEU fuel was loaded into a transport flask and sealed by the IAEA for safeguards purposes, and the fuel was transported to US DOE's Savannah River Site in South Carolina.

CNSC staff conducted a remote Type II compliance inspection of SRC from July 8 to 10, 2020. The inspection verified that the decommissioning activities were conducted safely and in compliance with the NSCA, its associated Regulations, the licence, Detailed Decommissioning Plan (DDP) and supporting documentation. Figure 4-7 shows the SRC pool and overflow channels filled with grout, as part of the decommissioning activities.

Figure 4-7: SRC pool and overflow channels filled with grout during decommissioning *(Source: SRC)*

As highlighted in section 6 of this CMD, CNSC staff raised 1 NNC with regards to waste characterization reports, which was resolved in the following weeks with the submission of additional waste characterization details and SRC's End State Report for the decommissioning of the SRC reactor facility.

SRC completed decommissioning activities in 2020. There are no nuclear activities, nuclear substances, equipment nor contamination above the unconditional release limits present in the building. The building can be repurposed for any non-nuclear activities without any restrictions. SRC have requested the revocation of the non-power reactor operating licence and requested a licence to abandon a nuclear facility on October 27, 2020. A Commission hearing in writing is tentatively scheduled for August 2021.

If approved, the SRC SLOWPOKE-2 facility will be released from CNSC regulatory control, and the financial guarantee held for the decommissioning of the facility will be released.

In total, CNSC staff conducted 2 inspections at SRC from 2018-2020 that covered 7 SCAs. Table B-11 of Appendix B lists these inspections and the aforementioned NNC is highlighted in section 6 of this CMD.

CNSC staff are satisfied that SRC was operated safely over the 2018–2020 period and in accordance with its licensing basis.

5 CNSC REGULATORY OVERSIGHT

The CNSC performs regulatory oversight of licensed facilities to verify compliance with the requirements of the NSCA and associated Regulations made under the NSCA, each site's licence and licence conditions, and any other applicable standards and regulatory documents (REGDOCs).

CNSC staff use the SCA framework to assess, evaluate, review, verify and report on licensee performance. The SCA framework includes 14 SCAs, which are subdivided into specific areas that define its key components. Further information on the CNSC's SCA framework can be found on the CNSC's website.

5.1 Regulatory Activities

CNSC staff conducted risk-informed regulatory oversight activities at Canada's UNSPF (2020) and RRs (2018-2020). Table 5-1 presents the licensing and compliance verification efforts from CNSC staff for these facilities for the reportable years. Of note is the high number for BWXT-NEC and SRC licensing activities. The BWXT-NEC person-days for licensing activities are higher due to licence renewal efforts for the Toronto and Peterborough facilities, while the SCR numbers were higher due to the decommissioning of the facility and the requested licence to abandon, as described in section 4.4 of this report.

Table 5-1: CNSC inspections, safeguards verification activities, and licensing and compliance verification efforts, UNSPF (2020) and research reactors (2018-2020)

Facility Type	Site	Number of inspections	Person-days for compliance verification activities	Person-days for licensing activities	Number of IAEA-initiated safeguards verification activities	Number of CNSC-initiated safeguards field activities
UNSPF	BRR	3	243.10	92.67	7	0
	PHCF	3	269.13	17.17	11	0
	CFM	3	175.93	24.20	4	0
	BWXT-NEC	4	247.33	525.73	10	0
	SRBT	2	87.37	11.83	0	0
	Nordion	2	124.33	0.73	0	0
	BTL	2	160.10	6.53	0	0
RRs	ÉPM	2	68.30	26.90	2	1
	MNR	3	231.43	76.1	0	0
	RMC	2	85.77	21.27	2	0
	SRC	2	167.43	287.73	3	0

Compliance Verification

The CNSC ensures licensee compliance through verification, enforcement and reporting activities. CNSC staff implement compliance plans for each site by conducting regulatory activities including inspections, desktop reviews and technical assessments of licensee programs, processes and reports.

Appendix B contains a list of CNSC inspections carried out at each uranium and nuclear substance processing facility and RR for the applicable reporting years, 2020 and 2018-2020 respectively. All findings in these inspections were considered low-risk and did not have an impact on safety at the facilities.

Although some SCAs were not the focus of inspections from 2018-2020, CNSC staff performed desktop compliance verification of the various SCAs by reviewing licensee's compliance reporting submissions (such as annual and quarterly compliance monitoring reports) and specific program documentation.

Licensing

CNSC staff activities for licensing include drafting new or amended licences, preparing CMDs, and drafting or revising Licence Control Handbooks (LCH).

As CNSC regulatory documents are published, CNSC staff update the LCHs as applicable for each site, taking into consideration the licensee's implementation plans. Appendix C provides a list of changes to uranium and nuclear substance processing facility and RR licences and LCHs. CNSC staff verify the implementation as part of ongoing compliance verification activities. Appendix D provides a list of CNSC regulatory documents implemented at UNSPF and RRs and used by CNSC staff for compliance verification. Appendix E presents the financial guarantee amounts for each facility.

IAEA Safeguards Activities

Under the terms of the Canada-IAEA safeguards agreements, the IAEA performs verification activities to confirm that all nuclear material in Canada remains in peaceful use. The CNSC regulatory framework requires Canadian operators to provide the access, assistance, and information required for the IAEA to complete its activities. CNSC staff ensure operator compliance with these requirements.

5.2 Performance Ratings 2020

CNSC staff assign performance ratings to licensees based on the results from regulatory oversight activities.

These ratings are either "satisfactory (SA)" or "below expectation (BE)" for the UNSPF (2020) and RRs (2018-2020). The "fully satisfactory (FS)" rating is no longer in use. It is important to recognize that a rating of SA in the current ROR instead of FS used in a previous ROR does not indicate a reduction in performance. The simplified rating approach allowed CNSC staff to focus on the performance of the facilities. This approach is consistent with a neutral and fair approach that the CNSC strives to implement in its regulatory oversight. In 2020, the Commission agreed with the use of this approach for the RORs [2].

For 2020, CNSC staff have rated the performance in each SCA as "satisfactory" (SA) for all UNSPF and RRs. Appendix F provides SCA ratings for each licensee from 2016 to 2020.

6 THE CNSC'S ASSESSMENT OF SAFETY AT URANIUM AND NUCLEAR SUBSTANCE PROCESSING FACILITIES AND RESEARCH REACTORS

The CNSC regulates all aspects of safety at nuclear sites in Canada, including risks to workers, the public and the environment. All 14 SCAs are assessed and discussed in the following paragraphs. Detailed information is provided on radiation protection, environmental protection, and conventional health since these 3 SCAs are considered the most indicative of safety performance at the UNSFP and RRs. In particular, the SCAs of radiation protection and conventional health and safety are a good measure of the safety of workers, while the SCA of environmental protection is an appropriate measure relative to the safety of people and the environment.

6.1 Management System

The management system SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

CNSC staff assess performance in the management system SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. The specific areas assessed within the management system include organization, planning and controlling business activities, resource management, communication, safety culture, change management, information management, work management, problem identification and resolution, performance assessment, improvement, and management review.

NNCs from inspections related to the management system SCA were issued for the following licensees over the reporting period:

- 1 NNC at Nordion based on implementation measures to ensure records are complete and traceable in accordance with CSA Standard N286-12 *Management systems for nuclear facilities* [3].
- 2 NNCs at BTL based on the accessibility of records related to facility maintenance and their approved supplier list.
- 1 NNC at ÉPM in 2020, relating to the timely implementation of corrective actions.

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained and implemented satisfactory management system programs for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.2 Human Performance Management

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry on their duties.

CNSC staff assess performance in the human performance management SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. For this SCA, CNSC staff verify that licensees are in compliance with REGDOC-2.2.2, *Personnel Training* [4] and their documented personnel training programs.

NNCs from inspections related to the human performance management SCA were issued for the following licensees over the reporting period:

- 1 NNC at BRR on the documentation related to the systematic approach to training (SAT) implemented on site.
- 3 NNCs at SRBT based on findings related to the SAT-based personnel training program.
- 4 NNCs at BTL related to training requirements for SAT-based positions.
- 1 NNC at MNR related to the Training and Qualification Plan for the MNR Emergency Organization in 2018.

- 3 NNCs at MNR related to program documentation in 2020, which was assessed for the first time against the requirements of REGDOC-2.2.2, *Personnel Training* [4].

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have implemented and maintained effective programs specific to personnel training and have met regulatory requirements. CNSC staff will continue to verify that licensees are in compliance with their programs and procedures as part of ongoing regulatory oversight activities.

6.3 Operating Performance

The operating performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

CNSC staff assess performance in the operating performance SCA by verifying that policies, programs, methods and procedures are in place for the safe operation and maintenance of nuclear facilities. Verification of compliance with the requirements of this SCA are included as part of CNSC's compliance verification activities ranging from desktop reviews of annual reports, reviews of event reports, related corrective actions, and planned or reactive inspections.

NNC from inspections related to the operating performance SCA were issued for the following licensee over the reporting period:

- 1 NNC at Nordion based on implementation measures to ensure that events are reported to the CNSC in accordance with REGDOC-3.1.2: *Reporting Requirements for Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [5].

The licensee has taken all necessary corrective actions to address the above noted NNC. The finding was of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude through compliance verification activities that UNSPF and RRs have implemented and maintained effective operating programs in order to ensure licensed activities are conducted safely and in compliance with regulatory requirements. CNSC staff will continue to monitor licensee performance through regulatory oversight activities pertaining to this SCA.

6.4 Safety Analysis

The safety analysis SCA covers the maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

CNSC staff assess performance in the safety analysis SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. CNSC staff verify that licensees maintain safety analysis report (SARs) to include updated information on the description of the facility and the measures in place to protect the safety of the workers, the public and the environment, under normal operations, abnormal operations and accident conditions. CNSC staff asses the SARs to ensure they provide an assessment of the potential consequences and demonstrate the safety case through defense in depth.

There were no NNCs from inspections related to the safety analysis SCA for the licensees covered in this report, over the reporting period. CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained satisfactory ratings in the safety analysis SCA for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.5 Physical Design

The physical design SCA relates to activities that impact the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

CNSC staff assess performance in the physical design SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. CNSC staff verify the physical design SCA requirements by ensuring the implementation of national codes and standards for structural design and maintaining Authorized Inspection Agency formal agreements including pressure-retaining programs where applicable.

NNCs from inspections related to the physical design SCA were issued for the following licensee over the reporting period:

- 2 NNCs at PHCF related to updating and implementing documentation for the pressure boundary program.

The licensee has taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained satisfactory ratings in the physical design SCA for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.6 Fitness for Service

The fitness for service SCA covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that verify all equipment is available to perform its intended design function when called upon to do so.

CNSC staff assess performance in the fitness for service SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. CNSC staff verify that the programs cover activities that affect the physical condition of systems, components and structures over time. Specific areas are assessed within this SCA to ensure that the fitness for service programs are supported by detailed procedures on preventative maintenance, measuring and testing of equipment and new equipment validation.

NNC from inspections related to the fitness for service SCA were issued for the following licensee over the reporting period:

- 1 NNC at CFM related to the completion of scheduled gauge verifications.

The licensee has taken all necessary corrective actions to address the above noted NNC. The finding was of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained satisfactory ratings in the fitness for service SCA for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.7 Environmental Protection

Protection of the environment and the public are linked in the SCA of environmental protection. This SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances, and the effects on the environment from facilities or as a result of licensed activities.

NNCs from inspections related to the environmental protection SCA were issued for the following licensees over the reporting period:

- 1 NNC at PHCF related to conducting documented visual inspections of the cooling water intake operating system and related fish barriers to ensure that existing mitigation measures remain effective at reducing and/or preventing fish impingement and entrainment.
- 1 NNC at CFM based on a finding related to fenceline gamma monitoring.

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

Currently, all licensees covered by this ROR have acceptable environmental protection programs in place to ensure the protection of the public and the environment. CNSC staff rated the environmental protection SCA at all UNSPF and RRs as "satisfactory".

Appendix G provides the total annual releases of radionuclides for the UNSPF and RRs from 2016 to 2020. Appendix H contains data on dose to the public from 2016 to 2020. Appendix I contains supplemental environmental data for all licensees.

Effluent and emissions control (releases)

All UNSPF and RRs implement effluent monitoring programs commensurate with the risks of their operations. Airborne and waterborne releases of radioactive and hazardous substances at UNSPF and RRs remained below regulatory limits in 2020.

Action levels

Action levels are a tool used to ensure that licensees are operating their facility appropriately and in accordance with their approved program (s) and within the design and operational parameters of their wastewater treatment and air pollution control systems.

Action levels serve as an early warning system to ensure that licensees are carefully monitoring their operation and performance, to ensure release limits are not exceeded. Action level exceedances are reportable to the CNSC.

Each licensee is responsible for identifying the parameters of its own program(s) to represent timely indicators of potential losses of control of the program(s). These licensee-specific action levels may also change over time, depending on operational and radiological conditions.

If an action level is reached, it triggers the licensee to determine the cause, notify the CNSC and, if applicable, take corrective action to restore the effectiveness of the environmental protection program. It is important to note that occasional action level exceedances indicate that the action level chosen is likely an adequately sensitive indicator of a potential loss of control of the program.

Licensee performance is not evaluated solely on the number of action level exceedances in a given period, but also on how the licensee responds and implements corrective actions to enhance program performance and prevent reoccurrence. Licensees are required to periodically review their action levels to validate their effectiveness.

The following environmental action level exceedances were reported to the CNSC:

- On March 13, 2020, 1 action level exceedance occurred at PHCF where the uranium concentration (160 µg U/L) exceeded the sanitary sewer discharge action level (100 µg U/L). This occurrence was due to groundwater infiltration from a heavy precipitation event. Cameco has implemented corrective actions and are continuing to repair and upgrade sections of the sanitary sewer network as part of the VIM project.
- On March 17, 2021, BWXT-NEC Toronto reported that they had been applying the release limits for pH (6.0-9.5) set by the City of Toronto sewer use bylaw which is less restrictive than their CNSC accepted action levels for liquid effluent (6.65-9.0). As a result, there were 27 instances of exceedances of the lower pH action level. The exceedances were in the range of 6.01-6.63 with 26 exceedances occurring in 2020 and 1 instance of exceedance in 2019.

  None of the releases exceeded the City of Toronto sewer use bylaw (6.0-9.5) requirements and there were no potential environmental impacts associated with these exceedances. An investigation was completed and corrective actions were identified. CNSC staff are in the process of reviewing the corrective actions submitted by the licensee.

CNSC staff have assessed that there was no impact to workers, the public or the environment as a result of these action level exceedances. CNSC staff reviewed the licensees' corrective actions in relation to the exceedances and are satisfied with the licensee's responses.

Environmental management system

The CNSC requires each licensee to develop and maintain an environmental management system (EMS) that provides a framework for integrated activities related to environmental protection. EMS are described in environmental management programs and include activities such as the establishment of annual environmental objectives, goals and targets. Licensees conduct internal audits of their programs at least once a year. As part of regular compliance verification, CNSC staff review and assess these objectives, goals and targets. CNSC staff determined that the UNSPF and RRs established and implemented their EMS in compliance with CNSC regulatory requirements.

Assessment and monitoring

CNSC staff verify that UNSPF and RRs have environmental monitoring programs commensurate with the risks of the operations at each of its facilities. The environmental monitoring programs are designed to monitor releases of radioactive and hazardous substances, and to characterize the quality of the environment associated with the licensed facility. CNSC staff determined that the UNSPF and RRs established and implemented environmental monitoring programs in compliance with CNSC regulatory requirements where applicable.

Environmental risk assessment

Licensees develop environmental risk assessments (ERAs) to analyze the risks associated with contaminants in the environment as a result of licensed activities. ERAs provide the basis for the scope and complexity of environmental monitoring programs at the UNSPF and RRs.

ERAs for UNSPF CNSC staff use CSA standard N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [6], to help determine whether licensees are in compliance with regulatory requirements for protection of the environment and human health. CSA N288.6-12 specifically states: "Facility ERAs should be reviewed on a 5-year cycle or more frequently if major facility changes are proposed that would trigger a predictive assessment" [6]. CNSC staff expect licensees to periodically review ERAs for their facilities, as appropriate. BRR, CFM, and SRBT submitted revised ERA's in 2020 that were in compliance with CSA N288.6-12 [6].

ERAs for RRs

As part of the 2013 licence renewal of the SLOWPOKE-2 facilities, CNSC staff completed a sector specific environmental risk assessment to determine potential impacts to human health and the environment as a result of the operations of the SLOWPOKE-2 facilities. In CNSC staff's assessment, the maximum dose to members of the public that was estimated under normal operations was 0.08 µSv/year. This is several orders of magnitude below the regulatory public dose limit of 1 mSv/yr (1000 µSv/year). In addition, CNSC staff assessed the dose rates to non-human ecological receptors and the results were orders of magnitude lower than conservative benchmarks. For the MNR facility, a conservative evaluation of the dose to the public through airborne releases results in less than 1 µSv/year, which is less than a thousandth of the regulatory dose limit of 1 mSv for a member of the public. In light of these results, no impacts to human health and the environment are expected from the normal operation of RR facilities in Canada.

Protection of people

The CNSC requires licensees to demonstrate that the health and safety of the public are protected from exposures to hazardous (non-radiological) substances released from their facilities. Licensees use effluent and environmental monitoring programs to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health. CNSC staff receive reports of discharges to the environment in accordance with reporting requirements outlined in the licence and the LCH. Based on assessments of the programs at the uranium and nuclear substance processing facilities, CNSC staff concluded that the public continues to be protected from facility emissions of hazardous substances.

Estimated dose to the public

The maximum dose to the public from licensed activities is calculated by considering monitoring results from air emissions, liquid effluent releases and gamma radiation. The CNSC's requirement for following the as low as reasonably achievable, taking into account social and economic factors (ALARA) principle, means that licensees must monitor their facilities and keep doses to the public below the annual public dose limit of 1 millisievert (mSv)/year prescribed in the *Radiation Protection Regulations* [8].

Table H-1 of Appendix H compares estimated public doses from 2016 to 2020 for the UNSPF and RRs. Estimated doses to the public from all these facilities continued to be well below the regulatory annual public dose limit of 1 mSv/year.

Conclusion on environmental protection

CNSC staff concluded that the UNSPF and RRs have implemented their environmental protection programs satisfactorily for the applicable reportable years. The licensees' programs are effective in protecting the health and safety of people and the environment. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.8 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations* [8]. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained ALARA.

NNCs from inspections related to the radiation protection SCA were issued for the following licensees over the reporting period:

- 1 NNC at BRR related to the implementation of measures to ensure employees, contractors, and visitors adhere to whole body monitoring protocols.
- 2 NNCs at CFM based on findings related to radiation warning signage.

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility. CNSC staff rated the radiation protection SCA at all UNSPF and RRs as "satisfactory".

Appendix J contains data on dose to workers for the UNSPF and RRs from 2016 to 2020.

Application of ALARA

CNSC staff confirmed that all UNSPF and RRs continued to implement radiation protection measures to keep radiation exposures and doses to persons ALARA. The CNSC requirement for licensees to apply the ALARA principle has consistently resulted in these doses staying well below regulatory dose limits.

Worker dose control

The design of radiation protection programs includes the dosimetry methods and the determination of workers who are identified as nuclear energy workers (NEWs). These designs vary, depending on the radiological hazards present and the expected magnitude of doses received by workers. The dose statistics provided in this report are primarily for NEWs, with the inherent differences in the design of radiation protection programs among licensees taken into consideration. Additional information on the total number of monitored persons, including workers, contractors and visitors, is provided in Appendix J. CNSC staff confirmed that all UNSPF and RRs monitored and controlled the radiation exposures and doses received by all persons present at their licensed facilities, including workers, contractors and visitors. Direct comparison of doses received by NEWs among facilities does not necessarily provide an appropriate measure of a licensee's effectiveness in implementing its radiation protection program, since radiological hazards differ across these facilities due to complex and varying work environments.

Radiation protection program performance

CNSC staff conducted regulatory oversight activities at UNSPF and RRs to verify that the licensees' radiation protection programs complied with regulatory requirements. These oversight activities included inspections, desktop reviews, and compliance verification activities specific to radiation protection. Through these activities, CNSC staff confirmed that all these licensees have effectively implemented their radiation protection programs, to control occupational exposures to workers and keep doses ALARA.

Action levels

The following radiation protection action level exceedance was reported to the CNSC:

- In July 2020 at BRR, a worker's dosimeter recorded a skin dose of 26.4 mSv, which exceeded Cameco's monthly skin dose action level of15 mSv. Cameco's investigation determined that the dose was mostly non-personal due to the dosimeter being lost for a period of time in a processing area. A dose change request was pursued by Cameco and approved by the CNSC. CNSC staff are satisfied with Cameco's responses to the action level exceedance.

Radiological hazard control

CNSC staff verified that UNSPF and RRs continued to implement adequate measures to monitor and control radiological hazards in their facilities. These measures included delineation of zones for contamination control purposes and in-plant air-monitoring systems. Licensees demonstrated that they have implemented workplace monitoring programs to protect workers. The licensees have also demonstrated that levels of radioactive contamination were controlled within their facilities throughout the year.

Conclusion on radiation protection

CNSC staff concluded that the UNSPF and RRs have effectively implemented and maintained their radiation protection programs for the applicable reportable years. The licensees' programs are effective in ensuring the health and safety of persons working in their facilities. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.9 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect workers.

Based on regulatory oversight activities, CNSC staff rated the performance of all UNSPF (2020) and RRs (2018-2020) for the conventional health and safety SCA as "satisfactory".

Appendix K contains health and safety information for each UNSPF and RR from 2016 to 2020.

Performance

Employment and Social Development Canada (ESDC) and the CNSC regulate conventional health and safety programs at UNSPF and RRs. Licensees submit hazardous-occurrence investigation reports to both ESDC and the CNSC, in accordance with their respective reporting requirements. CNSC staff monitor compliance with regulatory reporting requirements and, when a concern is identified, consult with ESDC staff.

Licensees are required to report to the CNSC as directed by section 29 of the *General Nuclear Safety and Control Regulations* [9]. These reports include serious illnesses or injuries incurred or possibly incurred as a result of a licensed activity.

A key performance measure for the conventional health and safety SCA is the number of lost-time injuries (LTIs) that occur per year. An LTI is an injury that takes place at work and results in the worker being unable to return to work to carry out their duties for a period of time. There were no LTIs at the UNSPF in 2020 or the RRs from 2018-2020.

Practices

Licensees are responsible for developing and implementing conventional health and safety programs for the protection of their workers. These programs must comply with Part II of the *Canada Labour Code* [10].

CNSC staff conducted desktop reviews and inspections at all UNSPF (2020) and RRs (2018-2020) to verify compliance of the licensees' conventional health and safety programs with regulatory requirements.

NNCs from inspections related to the conventional health and safety SCA were issued for the following licensees over the reporting period:

- 1 NNC at PHCF, related to ensuring employees are alerted when mandatory training is missed, and measures are taken to reduce or eliminate non-conformances to training requirements.
- 3 NNCs at CFM, related to non-radiological workplace hazard signage, personnel roles and responsibilities documentation, and legibility of lockout tags used for the control of hazardous energy

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff concluded, based on regulatory oversight activities, that the UNSPF and RRs have met all regulatory requirements for this specific area.

Awareness

Licensees are responsible for ensuring that workers have the knowledge to identify workplace hazards and take the necessary precautions to protect against these hazards. This is accomplished through training and ongoing internal communications with workers.

During inspections, CNSC staff verify that workers are trained to identify hazards at the facilities. CNSC staff confirmed that UNSPF and RRs have effectively implemented their conventional health and safety programs to keep workers safe.

Conclusion on conventional health and safety

CNSC staff concluded that the UNSPF and RRs have implemented their conventional health and safety programs satisfactorily for the applicable reportable years. The programs are effective in protecting the health and safety of persons working in these facilities. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.10 Emergency Management and Fire Protection

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions.

CNSC staff assess performance in the emergency management and fire protection SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. Specific areas assessed within this SCA include how licensees respond to conventional and nuclear events, both onsite and offsite, and events that can affect the facility. CNSC staff ensure that comprehensive fire protection programs are also in place to minimize the risk to the health and safety of persons and to the environment from fire, through appropriate fire protection system design, fire safety analysis, fire safe operation and fire prevention.

NNCs from inspections related to the Emergency Management and Fire Protection SCA were issued for the following licensees over the reporting period:

- 1 NNC at PHCF related to the placement of an emergency exit sign.
- 2 NNCs at MNR in 2018, regarding documentation of the emergency management program

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained satisfactory ratings in the emergency management and fire protection SCA for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.11 Waste Management

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This SCA also covers the planning for decommissioning.

CNSC staff assess performance in the waste management SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. CNSC staff ensure that the licensees properly manage wastes throughout the lifecycle of a nuclear facility, which includes the maintenance of an up-to-date waste inventory and waste tracking. The CNSC requires that licensees have a decommissioning plan and financial guarantee to ensure that the health, safety, and security of workers, the public, and the environment remains protected.

NNCs from inspections related to the waste management SCA were issued for the following licensees over the reporting period:

- 1 NNC at Nordion related to waste inventory record keeping.
- 1 NNC at SRC during the 2020 decommissioning inspection to provide characterization reports of the waste to the CNSC.

The licensees have taken all necessary corrective actions to address the above noted NNCs. The findings were of low safety significance and did not affect the health and safety of workers, people or the environment, or the safe operation of the facilities.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained and implemented satisfactory waste management programs for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.12 Security

The security SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

CNSC staff assess performance in the security SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. Specific areas assessed within this SCA include programs and procedures relating to access control, response arrangements, security practices, cyber security and drills and exercises. CNSC staff ensure that the security programs in place prevent the loss, unauthorized removal and sabotage of nuclear substances, nuclear materials, prescribed equipment and information.

Security inspections and details of security arrangements with the licensees are confidential. NNCs from inspections related to the security SCA were issued for the following licensees over the reporting period:

- 2 NNCs at PHCF
- 2 NNCs at CFM
- 1 NNC at BWXT-NEC Peterborough
- 3 NNCs at ÉPM in 2019
- 2 NNCs at RMC in 2019

The licensees have taken corrective actions to address the above noted NNCs, and most have been addressed. Remaining items are scheduled for completion in 2021, subject to limitations associated with the COVID-19 pandemic. The findings were of low safety significance and did not affect the health and safety of workers, people and the environment, or the safe operation of the facility.

CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained and implemented satisfactory security programs for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.13 Safeguards and Non-Proliferation

The safeguards and non-proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons* (NPT).

CNSC staff assess performance in the safeguards and non-proliferation SCA by verifying licensee compliance through desktop reviews and in-field activities, including participation in IAEA verification activities. CNSC staff verify that licensees meet Canada's international safeguards obligations as well as other measures arising from the NPT. CNSC staff ensure that the licensees have implemented and maintained effective programs to allow the implementation of both safeguards measures and non-proliferation commitments.

NNCs from inspections and safeguards verification activities related to the safeguards and non-proliferation SCA were issued for the following licensees over the reporting period:

- 1 NNC at BWXT-NEC (Toronto & Peterborough) related to not using the Canadian obligation code on the Inventory Change Document.
- 2 NNCs at BRR related to its accountability scale where Cameco was requested to assess its calibration and maintenance practices, include the use of standard weights for calibration, and implement clear position markings for the placement of tote bins.
- 1 NNC at PHCF requesting that actions be taken to ensure that calibration requirements are consistently being met at the UF_4 drumming station.

The licensees have taken the necessary actions to address the above noted NNCs. The findings did not affect the health and safety of workers, the public, or the environment, or the safe operation of the facility. CNSC staff continue to monitor the facilities compliance to the REGDOC 2.13.1: *Safeguards and Nuclear Material Accountancy* [11], including the implementation of scale calibration procedures.

The licensees require a licence, separate from the licensing of their operations, for the import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* [12].

CNSC staff conclude that the UNSPF[2] and RRs have met regulatory requirements and have maintained and implemented satisfactory safeguards and non-proliferation programs for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

6.14 Packaging and Transport

The packaging and transport SCA covers the safe packaging and transport of nuclear substances to and from the licensed facilities. CNSC staff assess performance in the packaging and transport SCA by verifying compliance of licensee documents and programs through desktop reviews and through compliance verification inspections that are planned or reactive. CNSC staff ensure that all elements of package design, package maintenance, and the registration for use of certified packages are in compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* (PTNSR 2015) [13] and *Transportation of Dangerous Goods Regulations* [14].

[2] The safeguards and non-proliferation SCA is not applicable to SRBT as there is no licence condition for the facility. SRBT manages a small quantity of depleted uranium (below exemption quantity as per the *Nuclear Substances and Radiation Devices Regulations*), used as storage media for tritium, not for its radioactive properties.

There were no NNCs from inspections related to the packaging and transport SCA for the licensees covered in this report, over the reporting periods. CNSC staff conclude that the UNSPF and RRs have met regulatory requirements and have maintained satisfactory ratings in the packaging and transport SCA for the applicable reportable years. CNSC staff will continue to monitor performance through regulatory oversight activities pertaining to this SCA.

7 EVENTS AND OTHER MATTERS OF REGULATORY INTEREST

7.1 Reportable Events

Detailed requirements for reporting unplanned situations or events at UNSPF and RRs to the CNSC are included in the applicable LCH. CNSC REGDOC-3.1.2: *Reporting Requirements for Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [5] came into force for UNSPF and RRs in January 2019. Over the period covered by this report, licensees complied with the requirements for submission of these reports.

Appendix L provides a list of the reportable events which occurred over the review period. For these events, CNSC staff are satisfied with the corrective actions taken by licensees.

7.1.1 Uranium and Nuclear Substance Processing Facilities

There were 24 events reported for the UNSPF in 2020.

BRR

- On April 24, 2020, Cameco reported a fire in the yard area involving totes containing contaminated combustible materials (CCMs) in storage awaiting incineration. This event promoted the activation of the emergency response team which effectively worked along with the Blind River Fire Department and Mississauga First Nations Fire Department to extinguish the fire. Investigations were completed and confirmed there were no adverse impacts to the environment or to the health and safety of people as a result of this event. Cameco has since implemented several corrective actions to prevent or mitigate a recurrence of this event. CNSC staff are satisfied with Cameco's responses including corrective actions taken.
- Cameco reported a total of 2 transportation related events. On February 17, 2020, the BRR received a shipment of CCM that had a couple of bags which were partially open. On November 3, 2020, a transport hit a moose while returning to BRR. The trailer was transporting empty UO_3 tote bins when the accident occurred. There was no damage to the trailer, UO_3 tote bins and no injuries. Traffic accidents are to be reported to the CNSC even when the packages are not directly affected. The required event reports for these events were submitted in accordance with the regulatory requirements. They have been reviewed by CNSC staff and found satisfactory.

PHCF

- Cameco reported a total of 3 releases to Port Hope Harbour in 2020. On March 3, 2020, precipitation accumulation was mechanically pumped from a construction area to the harbour enclosure without suspended solids removal per Ontario Ministry of the Environment, Conservation and Parks (MECP) environmental control requirements. Cameco suspended this activity as soon as the issue was identified. On August 27, and October 12, algae build up on surface water intake screens caused cooling water pumps to shut down, which resulted in municipal water discharge to the harbour without the normal dilution from surface water. In all 3 cases, investigations were completed, and corrective actions were implemented to proactively avoid further issues.
- On July 22, 2020, a fluorine leak at a purge line gasket resulted in a UF_6 stack peak of 1600 g/h fluorides. The plant responded appropriately with all safety systems performing as designed. Ambient air monitoring stations (lime candle) results were reviewed and found to be within baseline conditions. There were no impacts to the environment or to the health and safety of people attributed to this event.
- On November 8, 2020, the Emergency Response Team was activated as a precaution as a result of a small hydrogen fluoride leak on the UF_6 plant electrolyte makeup tank regulator. The leak was isolated and there were no injuries or exposures as a result of this event. Corrective actions and follow up were documented by Cameco. There were no impacts to the environment or to the health and safety of people attributed to this event.
- On December 11, 2020, a UF_6 operator suffered an injury to their right thumb when it was pinched between a flange and the hood of the drum dryer. The employee was attended to by the site nurse and was subsequently taken to the hospital for follow up care. The investigation was documented by Cameco and follow up corrective actions were implemented.
- Cameco reported a total of 2 transportation related events in 2020. On June 29, Cameco was notified that a truck transporting a full cylinder was involved in a vehicle accident at the Port of Montreal. The material originated from the PHCF; however, the shipment was in the control of Orano at the time. On November 3, Cameco was notified of sea containers that had shifted during transit between the PHCF and Europe. This resulted in damaged flat racks, but the load was not compromised as a result of the incident. There were no injuries and no releases of nuclear material for both events.

CFM

- In 2020 there was 1 reportable event when an exterior liquid hydrogen tank began venting excessively. An investigation into the event identified that pressure had built up in the tank due to low hydrogen usage, and confirmed that all safety systems functioned as intended. The primary corrective action taken was to manage the tank level more closely in preparation, and during, low usage periods, such as future planned maintenance shutdowns.

There were no impacts to the environment, the health and safety of workers or the public. CNSC staff are satisfied with Cameco's response to this event and consider this event closed.

BWXT

- In January 2020, BWXT-NEC reported a sprinkler impairment at the Peterborough facility that lasted until May 2020. BWXT-NEC submitted a 21 day report with corrective actions as required, as well as a coordination plan with GE Canada Inc., as the owner of the site, implementing the corrective actions involving common infrastructure. BWXT-NEC implemented several interim fire safety measures during this sprinkler impairment including posting of notices on all affected building entryways, suspension of hot work in areas where sprinklers were impaired, establishment of fire watch, notification to the Peterborough fire department and regulatory updates to CNSC on progress in dealing with the sprinkler impairment. There were no impacts to the environment, the health and safety of workers or the public. CNSC staff are satisfied with BWXT-NEC's response to this event and consider this event closed.

Nordion

- On March 11, 2020, the fire alarm sounded in Nordion's Kanata Operations Building (KOB) initiating an evacuation. It was determined to be a false alarm due to a high heat sensor reading. The fire department arrived at the Nordion site and left once it was determined to be a false alarm. It was determined that the heat sensor was operating normally. Corrective actions are currently being assessed to ensure heat build-up remains below sensor activation.
- On April 6, 2020, there was a false low flow alarm from the fire protection system that lead to evacuation of the KOB and the fire department arriving on site. It was determined that the alarm was caused by a false low flow detector alarm in the sprinkler system. A new sensor was installed as this was the most probable point of failure and cause of the false alarm.
- On April 21, 2020, fire alarm panel wires were damaged during construction work by a contractor, resulting in the fire alarm system being temporarily disabled. Corrective actions were taken by the contractor and Nordion initiated a corrective and preventative action (CAPA) to implement broader corrective actions.
- Nordion reported 4 events related to missing or damaged Type A packages[3]. On September 22 and December 2, 2020, a Type A package was reported missing in transit, however, the packages were located by the carrier in each case. On September 17, 2020, a Type A package was reported missing in transit and not found, however, radioactivity decayed below exemption quantities. On May 12, 2020, a Type A package was damaged during transit and was to be repaired or removed from the fleet. No implications resulted as these events were of low risk.

[3] Type A package is designed in accordance with the applicable requirements of the IAEA regulations.

- On February 25, 2020, an incoming Type B package[4] was received with a loose lid on the leak proof insert. Feedback was provided to the consignor to ensure packages are prepared appropriately.
- On April 20, 2020, a shipment of Co-60 sealed sources was exported from Canada. The shipment inadvertently contained 1 incorrect source. This resulted in the shipment marginally exceeding the allowed activity for the CNSC export licence, EL-SS-12823-US. This also caused the wrong sealed source tracking information to be submitted resulting in a non-compliance with the PTNSR 2015, licence conditions of EL-SS-12823-US and section 4.2 of Nordion's LCH regarding reporting of sources prior to shipments. Nordion has revised their internal procedures to implement more robust requirements for independent verification of sources during loading operations. Nordion is also investigating improvements to the processes and tools to assess the reportability of incidents as part of corrective actions related to this occurrence.
- On July 13, 2020, it was determined that Nordion had conducted imports of thoriated welding rods without obtaining CNSC import licenses. At the time the thoriated welding rods were approved as an inventory item, the requirement for a CNSC import licence when ordering from non-Canadian suppliers was not identified and noted on the Item Master. A review of all inventory items was completed to identify any other items that may require regulatory approvals prior to ordering. No further items found.

BTL

- On May 22, 2020, a pull station was activated outside of the vacuum lab due to smoke that was accumulating within the facility from torching work of the ongoing roof replacement project. The building was evacuated and the fire department responded to the alarm activation. The fire department confirmed the small roof fire was extinguished. The investigation identified that an expansion joint caught fire. This may have gone unseen due to the conditions created when exhausting smoke from the facility. The incident and lessons learned were discussed with the Emergency Response Committee and the roof contractors.

CNSC staff are satisfied that UNSPF responded appropriately to the events and implemented appropriate corrective actions in response to each event.

[4] Type B package is classified as either a Type B(U) or a Type B(M) package in accordance with the IAEA regulations and is designed in accordance with the applicable requirements of those regulations.

7.1.2 Research Reactors

There were 2 events reported for the RRs over the last 3 years.

MNR

- On July 24, 2020, MNR reported that the reactor had been operated for approximately 8 hours with one of its trip signals impaired on "Flapper Position". The flapper is a device at the bottom of the reactor pool which automatically triggers alternate core cooling (from forced cooling to convective) in case of a reduction in cooling flow. A position sensor on the flapper trips the reactor when it senses that the flapper has actuated to the low flow position. A pushrod is associated with this sensor to actuate a switch on the reactor bridge and trigger a reactor trip. This pushrod had been damaged during reactor maintenance and did not assure its trip signal function during one shift. Several other trip signals were available and in-service during the duration of the impairment, which mitigated the risk associated with this event. No condition occurred during the operation of the reactor that would have required actuation of this trip signal. A root cause investigation was completed and submitted to CNSC and a corrective action plan was initiated. CNSC staff assessed the event and the corrective action plan and are satisfied that the event has been resolved satisfactorily. There were no consequences associated with this event, and the increased risk associated with the unavailability of a one trip signal was mitigated by the redundancy of safety systems.

ÉPM

- ÉPM reported on August 12, 2020 that the reactor operator had operated the ÉPM SLOWPOKE-2 reactor for more than a month after their Reactor Operator Certificate had expired. CNSC staff administered the recertification of the operator shortly after ÉPM requested it. CNSC staff also reviewed ÉPM's corrective action plan to ensure the event would not happen again. The risk associated with this event was low, there were no consequences as a result of this event, and this matter was resolved to the satisfaction of the CNSC.

CNSC staff are satisfied that RR licensees responded appropriately to the events and implemented appropriate corrective actions in response to each event.

7.2 Public Engagement

The area of public engagement has 2 aspects, those of activities carried out directly by CNSC staff, and of activities carried out by licensees.

7.2.1 CNSC

The NSCA mandates the CNSC to disseminate objective scientific, technical and regulatory information to the public concerning its activities and the activities it regulates. CNSC staff fulfill this mandate in a variety of ways, including the publishing of RORs and through 'Meet the Regulator' sessions. CNSC staff also seek out other opportunities to engage with the public and Indigenous groups, often participating in meetings or events in communities with interest in nuclear sites. These allow CNSC staff to answer questions about the CNSC's mandate and role in regulating the nuclear industry.

Due to the ongoing COVID-19 pandemic, CNSC outreach in 2020 was reduced from previous years and was limited to virtual events including hosting and participating in webinars.

CNSC awarded participant funding to assist Indigenous peoples, members of the public and stakeholders in reviewing this ROR and submitting comments to the Commission. Participant funding recipients are listed in Appendix N.

7.2.1.1 CNSC Activities – BWXT-NEC Peterborough

In December 2020, the Commission renewed BWXT-NEC's operating licence for Peterborough and Toronto. In its Record of Decision [15] the Commission directed CNSC staff to conduct an information session in Peterborough, Ontario, to explain the beryllium resampling results to the community and to answer any questions that the community may have. CNSC staff provided a memo to the Commission in February 2021 that addressed the Commission's direction where CNSC staff committed to reporting on these outreach activities in this CMD.

CNSC staff completed several public outreach activities associated with BWXT-NEC's licence renewal and beryllium resampling including:

- CNSC staff, with MECP support, presented on March 11, 2021 to the BWXT-NEC Peterborough Community Liaison Committee, which has a diverse membership including neighbours, representatives from the Prince of Wales Public School and Peterborough Public Health, the Metis Nation of Ontario and Dr. Julian Aherne. CNSC staff's presentation was well received and all questions raised were answered.
- On March 31, 2021, 2 public webinars were held, with 1 session in the morning and 1 session in the evening. CNSC staff provided a presentation on the licence renewal, beryllium sampling and answered questions from participants. A total of 128 people participated. The most popular means by which participants found out about the webinar was through the mail drop. There was a noticeable increase in the level of understanding of the participants about the CNSC and beryllium based on before and after polling questions.

- In April 2021, CNSC staff had an initial meeting with Dr. Aherne to discuss outstanding issues on beryllium sampling and the Independent Environmental Monitoring Program (IEMP) sampling plan was developed. Additional meetings are being planned to follow up on issues discussed at the time of writing this report.
- In May 2021, CNSC staff also presented to the Peterborough Board of Health on the role of the CNSC, the licence renewal as well as on the results of the beryllium resampling. The board is comprised of local elected representatives as well as Indigenous representatives. Peterborough Public Health members were also present including the Medical Officer of Peterborough.
- IEMP at Peterborough was completed in June 2021. Key stakeholders in the Peterborough area were notified of the planned IEMP sampling campaign in June.

Several actions from this outreach were rolled into regular compliance activities to ensure ongoing engagement. These included, formalizing continuous discussions with Curve Lake First Nation (CLFN) on BWXT-NEC related matters (see section 7.3.1.1 of this CMD), follow up meetings with Dr. Aherne on environmental sampling, updating of the CNSC web page for BWXT-NEC on an as needed basis and continuing to reply in a timely fashion to questions and concerns from members of the public and Indigenous groups related to BWXT-NEC.

In conclusion, CNSC staff has successfully carried out the planned activities that were outlined in CNSC staff's Peterborough Public Engagement Plan in a timely fashion. Outreach activities were well received and deemed effective based on polling feedback. CNSC staff are committed to continuing to share information of interest that relates to BWXT-NEC and to continue to engage with the public, Indigenous groups and other interested parties.

7.2.2 Uranium and Nuclear Substance Processing Facilities

All uranium and nuclear processing facility licensees are required to maintain and implement public information and disclosure programs (PIDP), in accordance with REGDOC-3.2.1, *Public Information and Disclosure* [16]. These programs are supported by disclosure protocols that outline the type of facility information to be shared with the public as well as details on how that information is to be shared. This ensures that timely information about the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities, is effectively communicated to the public.

All licensees of UNSPF have approved PIDP. NNCs from inspections related to PIDP were issued for the following licensee over the reporting period:

- At BWXT-NEC (Toronto & Peterborough), 1 NNC related to Community Liaison Committee membership being representative of target audience and 1 NNC related to media strategy and communication products.

The licensee has taken all necessary corrective actions to address the NNCs.

In 2020, licensees faced many challenges due to the COVID-19 pandemic, and had to adapt their public information programs accordingly. This included moving away from traditional in-person meetings and events, and offering webinars and increased digital communications whenever possible.

This included:

- Providing web updates on the pandemic and other items of interest;
- Providing updates to the local public and stakeholders through regular newsletters (both virtual and direct mail);
- Engaging with local/national media to provide operational and facility updates; and
- In lieu of in-person events and sponsorship, creating new community support funds which could be accessed by important local efforts and organizations.

7.2.3 Research Reactors

As with uranium and nuclear processing facility licensees, all RR licensees are required to maintain and implement PIDP.

Upon review of these sites for the years 2018-2020, CNSC staff determined that all 4 RR licensees continue to have approved PIPD. RR licensees SRC, MNR, ÉPM and RMC have been deemed in compliance for the years 2018-2020 based on CNSC staff's reviews of their annual compliance reports and supplied supplemental information.

It was identified that some of the licensees' PIDP still require revisions in order to ensure they meet REGDOC 3.2.1, however the programs as they currently exist have been deemed sufficient until this time.

CNSC staff will work to ensure all RR licensees have updated their PIPD, in accordance with REGDOC 3.2.1, and that these requirements are included in their respective LCHs.

7.3 Indigenous Consultation and Engagement

As an agent of the Government of Canada and as Canada's nuclear regulator, the CNSC recognizes and understands the importance of consulting and building relationships with Indigenous peoples in Canada. CNSC staff are committed to building long-term relationships with Indigenous groups (see Appendix M) who have interest in CNSC-regulated facilities within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build relationships and trust. The CNSC's Indigenous consultation and engagement practices, which include information sharing and funding support (through the CNSC's Participant Funding Program (PFP)) to assist Indigenous peoples in meaningfully participating in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation.

7.3.1 CNSC Staff Engagement Activities

The UNSPF in Canada fall within the traditional and/or treaty territories of many Indigenous communities (see Appendix M). CNSC staff efforts in 2020 supported the CNSC's ongoing commitment to meet its consultation obligations and build relationships with Indigenous peoples with interests in Canada's uranium and nuclear processing facilities. CNSC staff continued to work with Indigenous communities and organizations to identify opportunities for formalized and regular engagement, including meetings and workshops, throughout the lifecycle of these facilities. Through this engagement, CNSC staff welcomed the opportunity to discuss and address topics of interest and concern related to CNSC-regulated activities to interested Indigenous communities.

In addition, to ensure that interested Indigenous communities were made aware of this 2020 ROR, CNSC staff provided them with a notice of the PFP opportunity to review and comment on it, as well as the opportunity to submit a written intervention and/or appear before the Commission as part of the Commission meeting. CNSC staff also sent copies of this report to all Indigenous communities and organizations who had requested that they be kept informed of activities at the facilities covered in the report.

7.3.1.1 BWXT-NEC Peterborough

In December 2020, the Commission renewed BWXT-NEC's operating licence for Peterborough and Toronto. In its Record of Decision [15], the Commission provided direction to CNSC staff and BWXT-NEC on Indigenous engagement. CNSC staff committed to reporting on this Indigenous engagement in this CMD.

Following the renewal, CNSC staff provided the Record of Decision document to all Indigenous groups that participated as intervenors during the Commission Hearing. In addition, in February 2021, the CNSC and CLFN signed a Terms of Reference to provide a forum through which to collaborate and address areas of interest or concern regarding CNSC regulated facilities and activities, such as BWXT-NEC. Since February 2021, CNSC staff have held monthly meetings with CLFN and provided updates with regards to BWXT-NEC's activities.

Formal emails were also sent on February 26, 2021 to inform interested Indigenous groups of the 2021 IEMP sampling campaigns planned near the BWXT-NEC site in Peterborough, and their input on the IEMP sampling plan. As CLFN had previously demonstrated interest in participating during the sampling activities, meetings were organized to discuss the IEMP and the sampling plan on February 8 and May 7, 2021. A webinar on IEMP was also held on April 28, 2021 for all CLFN community members interested in learning more about the program and CNSC's collaboration with CLFN. CLFN also invited community members to participate in sampling activities through their newsletter. IEMP sampling activities were conducted in June 2021 with the participation of CLFN observers. CNSC staff will also share IEMP results with all interested Indigenous groups once they are made available.

CLFN has emphasized the importance for CNSC and BWXT-NEC to continue sharing information and allowing CLFN to participate in CNSC's processes, including the CNSC's IEMP. CNSC staff are committed to continue sharing information of interest that relates to BWXT-NEC and to respond to any concerns Indigenous groups may have.

7.3.1.2 Research Reactors

RRs are low risk facilities, and the CNSC has not been made aware of any specific interest or concerns from Indigenous groups in relation to these licensed facilities and activities. However, CNSC staff are committed to providing any information and engaging Indigenous groups with regards to these facilities should interest be expressed.

7.3.2 Licensee Engagement Activities

In 2020, CNSC staff continued to monitor the engagement work conducted by the UNSPF licensees to ensure that they actively engage and communicate with Indigenous groups who have interest in their facilities.

CNSC staff confirm that the licensees have Indigenous engagement and outreach programs. Throughout 2020, the UNSPF licensees met and shared information with interested Indigenous communities and organizations. These efforts have included emails, letters, meetings, site visits and tours, as well as community visits, upon request. The CNSC encourages the UNSPF licensees to continue to develop relationships and engage with Indigenous groups who have expressed an interest in the licensee's activities.

7.4 CNSC Independent Environmental Monitoring Program

Where applicable, the licensee of each nuclear facility shall develop, implement and maintain an environmental monitoring program to demonstrate that the public and the environment are protected from emissions resulting from the licensee's licensed activities. The licensees submit the results of these monitoring programs to the CNSC to ensure compliance with applicable requirements, as set out in the applicable regulations.

The CNSC implements its IEMP to independently verify that the public and the environment around licensed nuclear facilities are protected. The IEMP is separate from, but complementary to the CNSC's ongoing compliance verification program. Under the IEMP, samples are taken from public areas around licensed facilities. The concentrations of radioactive and hazardous substances in those samples are measured and analyzed, and the results are compared against relevant guidelines, limits and objectives.

In 2020, CNSC staff conducted independent environmental monitoring at Cameco's BRR, PHCF, and CFM sites. The 2020 IEMP results, which are posted on the CNSC's IEMP web page, demonstrate that the public, Indigenous groups and the environment around these facilities are protected, and that no adverse environmental or health effects are expected as a result of these facility operations. In addition, these results are consistent with the results submitted by the licensees and demonstrate that the licensees' environmental protection programs continue to protect the health and safety of people and the environment.

7.4.1 BWXT-NEC Peterborough Sampling

Further to the BWXT-NEC licence renewal hearing in March 2020, the CNSC conducted soil resampling for beryllium, as directed by the Commission in its Notice of Continuation, at sites adjacent to BWXT-NEC's Peterborough facility, with a special focus on the property where the Prince of Wales Elementary School is located. The soil samples were analyzed at the CNSC lab, and the results did not indicate any significant changes in concentrations of beryllium in the soil in Peterborough. The CNSC provided a supplemental submission (CMD 20-H2.D) on the resampling results for the Commission's consideration in BWXT-NEC's licence renewal request. Based on CNSC staff's assessment, the IEMP results indicate that the public and the environment surrounding the BWXT-NEC facility remains protected from facility emissions.

In the BWXT-NEC Record of Decision 20-H2 [15], the Commission directed CNSC staff to carry out an IEMP campaign near the Peterborough facility in 2021. In addition, CNSC staff are analyzing all future IEMP soil samples using the partial digestion analysis opposed to the full digestion analysis method. This decision was made since partial digestion of soil better reflects the bioavailability of elements and allows a direct comparison to soil standards and guidelines which are based on partial digestion.

Recognizing the importance of trust building and communication with host communities, the Commission directed CNSC staff to engage Indigenous communities, members of the public, stakeholders, and municipal officials, in future Peterborough IEMP sampling campaigns. Efforts to date are summarized in sections 7.2.1.1 and 7.3.1.1 of this CMD.

7.5 COVID-19 Response

7.5.1 CNSC

On March 15, 2020, the CNSC activated the Business Continuity Plan (BCP) in response to the COVID-19 pandemic. Effective March 16, 2020, all CNSC staff in Ottawa and at regional and site offices were directed to work from home. Travel to sites for inspection was suspended until approved COVID-19 protocols were in place. On-site inspection activities planned for 2020 were reviewed and reprioritized.

In April 2020, CNSC staff reviewed all planned on-site compliance activities on a risk-informed basis to determine an appropriate path forward. CNSC staff identified planned compliance activities well suited to be delivered by other means (remote verification methods, desktop review of documents and licensee submissions, etc.) and adjusted planned activities accordingly. Licensee changes drove many changes to CNSC oversight.

The CNSC developed a pandemic-related Pre-Job Brief as additional instructions to be delivered by CNSC Directors and Supervisors to inspectors prior to performing any on-site oversight activities. The CNSC provided personal protective equipment to inspectors prior to any on-site activity. The Pre-Job Brief clearly outlines the rights of individual employees to not attend an in-person inspection if they do not feel it is safe to do so.

Compliance activities of nuclear fuel cycle facilities continued remotely and on-site oversight activities have since resumed on a risk-informed basis in observance of relevant COVID-19 health protocols. In 2020, some inspections were rescheduled or postponed for certain SCAs where on-site presence was necessary; however, the majority of inspections continued remotely or were conducted using a hybrid virtual/in-person approach, in order to minimize in-person time on site.

CNSC staff continue to conduct oversight activities during the COVID-19 pandemic to ensure the protection of the environment, and the health and safety of people. Specific oversight activities completed in 2020 during the pandemic are outlined in Appendix B of this report.

7.5.2 UNSPF and Research Reactors

In response to the COVID-19 pandemic, UNSPF and RRs implemented various measures to reduce operations, activate BCPs, and have non-essential staff work remotely, where possible. Licensees instituted measures to minimize the spread of COVID-19 by making workers wear face masks and limiting the size of groups of employees in any areas.

The state of reduced operations included only work to ensure sites, facilities, equipment, and grounds were maintained and kept safe and compliant with regulatory requirements. For facility activities that were not put on hold, the licensee worked to follow all public health guidelines and additional safety protocols. All facilities maintained appropriate security measures throughout this period.

Each facility continues to evaluate new information and risk related to COVID-19 at their sites and local communities. CNSC staff are informed as changes are made by licensees to adhere to any new guidelines made available by the provincial health authorities.

8 OVERALL CONCLUSIONS

CNSC staff concluded that UNSPF in 2020 and the RRs in Canada from 2018-2020 operated safely. This assessment is based on CNSC staff's verification of licensee activities, including inspections, reviews of reports submitted by licensees, and reviews of events supported by follow-up and general communication with the licensees.

The performance ratings in all 14 SCAs for the facilities were rated as "satisfactory".

CNSC staff's compliance verification activities confirmed that:

- radiation protection programs at all facilities were effective and adequately controlled radiation exposures, keeping doses ALARA
- environmental protection programs at all facilities were effective in protecting people and the environment
- conventional health and safety programs at all facilities continued to protect workers

CNSC staff concluded that the licensees discussed in this report made adequate provision for the health and safety of workers, as well as for the protection of the public and the environment, and for meeting Canada's international obligations on the peaceful use of nuclear energy.

CNSC staff will continue to provide regulatory compliance oversight to all licensed facilities.

REFERENCES

[1] *Nuclear Safety and Control Act*, S.C. 1997, c. 9.

[2] CNSC, *Minutes of the Canadian Nuclear Safety Commission (CNSC) Meeting held on December 8, 9 and 10, 2020*, April 2021.

[3] CSA Group, CSA N286-12 *Management systems for nuclear facilities*, 2012.

[4] CNSC, REGDOC-2.2.2, *Personnel Training*, Ottawa, Canada, 2016.

[5] CNSC, REGDOC-3.1.2: *Reporting Requirements for Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*, Ottawa, Canada, 2018.

[6] CSA Group, CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*, 2012.

[7] CNSC, Memo, *CNSC Staff Position Regarding the Environmental Protection Requirements for SLOWPOKE-2 Facilities*, 2013, e-Doc 4059738.

[8] *Radiation Protection Regulations*, SOR/2000-203.

[9] *General Nuclear Safety and Control Regulations*, SOR/2000-202.

[10] *Canada Labour Code*, R.S.C., 1985, c. L-2.

[11] CNSC, REGDOC-2.13.1: *Safeguards and Nuclear Material Accountancy*, Ottawa, Canada, 2018.

[12] *Nuclear Non-proliferation Import and Export Control Regulations*, SOR/2000-210.

[13] *Packaging and Transport of Nuclear Substances Regulations*, SOR/2015-145.

[14] *Transportation of Dangerous Goods Regulations*, SOR/2001-286.

[15] CNSC, Record of Decision, *Application for the Renewal of the Fuel Facility Licence for BWXT's Toronto and Peterborough Facilities (DEC 20-H2)*, 2020.

[16] CNSC, REGDOC-3.2.1, *Public Information and Disclosure*, Ottawa, Canada, 2018.

[17] CNSC, REGDOC-3.6, *Glossary of CNSC Terminology*, Ottawa, Canada, 2019.

[18] CSA Group, CSA N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*, 2019 [10].

[19] Ministry of the Environment, Conservation and Parks, *Ontario's Ambient Air Quality Criteria*, 2019.

[20] Health Canada, *Guidelines for Canadian Drinking Water Quality*, 2017.

[21] CSA Group, CSA N288.7 *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*, 2015.

[22] Canadian Council of Ministers of the Environment, *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, 1999.

[23] Canadian Council of Ministers of the Environment, *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*, 1999.

[24] Ministry of the Environment, *Soil, Groundwater, and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*, Table 3: Full Depth Generic Site Condition Standards in a Non-Portable Groundwater Condition for Industrial/Commercial/Community Property Use (Fine to Medium Textured Soils), April 15, 2011

[25] Province of Ontario. *Water management: policies, guidelines, provincial water quality objectives - Table of PWQOs and Interim PWQOs*. Retrieved from https://www.ontario.ca/page/water-management-policies-guidelines-provincial-water-quality-objectives

[26] CNSC, Appendix R of CNSC REGDOC-1.6.1, *Regulatory Quantities for Typical Radionuclides, Sewer*, 2017.

ACRONYMS AND ABBREVIATIONS

AIEA	l'Agence internationale de l'énergie atomique
ALARA	as low as reasonably achievable, taking into account social and economic factors
ANC	avis de non-conformité
BCP	Business Continuity Plan
BE	below expectations
Bq	becquerel
BRR	Blind River Refinery
BTL	Best Theratronics Ltd.
BWXT	BWX Technologies Ltd.
BWXT-MED	BWXT Medical Ltd.
BWXT-NEC	BWXT Nuclear Energy Canada Inc.
CAD	Canadian dollar
Cameco	Cameco Corporation
CANDU	Canada Deuterium Uranium
CCM	contaminated combustible materials
CCME	Canadian Council of Ministers of the Environment
CFM	Cameco Fuel Manufacturing Inc.
cm	centimetre
CLFN	Curve Lake First Nation
CMD	Commission Member Document
CNL	Canadian Nuclear Laboratories
CCSN	Commission canadienne de sûreté nucléaire
CNSC	Canadian Nuclear Safety Commission
Co-60	cobalt-60
CSA	Canadian Standards Association (now CSA Group)

CVC	Compliance verification criteria
DDP	Detailed Decommissioning Plan
DRL	derived release limit
DSR	domaines de sûreté et de réglementation
EBRL	exposure based release limits
ECCC	Environment and Climate Change Canada
EMS	environmental management system
ÉPM	École Polytechnique de Montréal SLOWPOKE-2
ERA	environmental risk assessment
ERT	Emergency Response Team
ESDC	Employment and Social Development Canada
FFL	fuel facility licence
FFOL	fuel facility operating licence
FS	fully satisfactory
g	gram
GBq	gigabecquerel
GCDWQ	Guidelines for Canadian Drinking Water Quality
GTLS	gaseous tritium light source
h	hour
HEU	highly-enriched uranium
HT	tritium gas
HTO	hydrogenated tritium oxide or tritiated water
HNO_3	nitric acid
I-125	iodine-125
ITUSN	installations de traitement de l'uranium et des substances nucléaires
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program

kg	kilogram
Km	kilometre
KOB	Kanata operations building
L	litre
LCH	licence conditions handbook
LEU	low-enriched uranium
LTI	lost-time injury
m^3	cubic metres
MBq	megabecquerel
MeV	megaelectronvolt
mg	milligram
mg/L	milligram per litre
MECP	Ontario Ministry of the Environment, Conservation and Parks
MNR	McMaster Nuclear Reactor
mSv	millisievert
N	nitrogen
NEW	nuclear energy worker
NNC	notice of non-compliance
NOx	nitrogen oxides
NO_2	nitrogen dioxide
Nordion	Nordion (Canada) Inc.
NPROL	Non-power research reactor operating licence
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NSCA	*Nuclear Safety and Control Act*
NSPFOL	nuclear substance processing facility operating licence
PERFP	Permis d'exploitation d'un réacteur nucléaire de faible puissance
PFP	Participant Funding Program

PHCF	Port Hope Conversion Facility
PIPD	public information and disclosure programs
ppm	parts per million
PTNSR 2015	*Packaging and Transport of Nuclear Substances Regulations, 2015*
REGDOC	regulatory document
RMC	Royal Military College of Canada SLOWPOKE-2
RR	Research reactor
ROR	regulatory oversight report
SA	satisfactory
SAT	systematic approach to training
SCA	safety and control area
SRBT	SRB Technologies (Canada) Inc.
SRC	Saskatchewan Research Council SLOWPOKE-2
T_2	tritiated gas
TBq	terabecquerel
µg	microgram
µSv	microsievert
UF_6	uranium hexafluoride
UOIT	University of Ontario Institute of Technology
UNSPF	uranium and nuclear substance processing facilities
UO_2	uranium dioxide
UO_3	uranium trioxide
US DOE	United States Department of Energy
VIM	Vision in Motion

GLOSSARY

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology* [17], which includes terms and definitions used in the *Nuclear Safety and Control Act* [1] and the Regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

A. Links to Licensee Websites

Licensee	Website	2020 Annual Compliance Reports
BRR	camecofuel.com/business/blind-river-refinery	2020 Annual Compliance Report
PHCF	camecofuel.com/business/port-hope-conversion-facility	2020 Annual Compliance Report
CFM	camecofuel.com/business/cameco-fuel-manufacturing	2020 Annual Compliance Report
BWXT-NEC Toronto and Peterborough	nec.bwxt.com	2020 Annual Compliance Report
SRBT	srbt.com	2020 Annual Compliance Report
Nordion	nordion.com	2020 Annual Compliance Report
BTL	theratronics.ca	2020 Annual Compliance Report
ÉPM	https://www.polymtl.ca/phys/slowpoke	2018 Annual Compliance Report 2019 Annual Compliance Report 2020 Annual Compliance Report
MNR	https://nuclear.mcmaster.ca/facility/nuclear-reactor/	2018 Annual Compliance Report 2019 Annual Compliance Report 2020 Annual Compliance Report
RMC	https://www.rmc-cmr.ca/en/chemistry-and-chemical-engineering/slowpoke-2-facility	2018 Annual Compliance Report 2019 Annual Compliance Report 2020 Annual Compliance Report
SRC[5]	https://www.src.sk.ca/services/slowpoke-2	2018 Annual Compliance Report 2019 Annual Compliance Report

[5] No annual compliance report (ACR) was provided by SRC for 2020, as decommissioning of the facility was completed in 2020. SRC submitted an End-State Decommissioning Report in support of their request for a licence to abandon a nuclear facility.

B. CNSC Inspections

Table B-1: Inspections, BRR, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
CAMECO-BRR-2020-01	Fitness for service, Emergency Management and Fire Protection, Radiation Protection, Conventional Health and Safety, Waste Management)	September 14-16, 2020	1
CAMECO-BRR-2020-02	Environmental Protection	September 14-16, 2020	0
CAMECO-BRR-2020-03	Human Performance Management (Training)	October 19-21, 2020	1

Table B-2: Inspections, PHCF, 2020

Inspection Title	Safety and control areas covered	Inspection date	Number of NNCs
CAMECO-PHCF-2020-01	Pressure Boundary and Operating Performance	July 13-16, 2020	2
CAMECO-PHCF-2020-02	Safety Analysis, Fitness for Service, Radiation Protection, Environmental Protection, Conventional Health and Safety, Emergency Management and Fire Protection, Waste Management, Other: Vision in Motion Project	August 10-13, 2020	3
CAMECO-PHCF-2020-03	Security	October 26, 2020	2

Table B-3: Inspections, CFM, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
CAMECO-CFM-2020-01	Radiation Protection (primary focus), Conventional Health and Safety	February 26-27, 2020	5
CAMECO-CFM-2020-02	Security	October 27, 2020	2
CAMECO-CFM-2020-03	Fitness for Service (primary focus), Radiation Protection, Waste Management, Conventional Health and Safety	October 26-29, 2020	2

Table B-4: Inspections, BWXT-NEC Toronto and Peterborough, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
BWXT-2020-01	Security	February 20-21, 2020	1
BWXT-2020-02	Public Information and Disclosure Program	August 15-16, 2020	2
BWXT-2020-03	Emergency Management and Fire Protection	September 30-October 1, 2020	0
NPECD-BWXT-2020-11	Nuclear Non-proliferation Import and Export Control	November 25-26, 2020	1

Table B-5: Inspections, SRBT, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
SRBT-2020-01	Human Performance Management	January 27-28, 2020	3
SRBT-2020-02	Radiation Protection	October 27-28, 2020	0

Table B-6: Inspections, Nordion, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
NORDION-2020-01	Management Systems	September 29-October 1, 2020	1
NORDION-2020-02	Operating Performance, Fitness for Service, Radiation Protection, Environmental Protection, Conventional Health and Safety and Waste Management	November 16-19, 2020	2

Table B-7: Inspections, BTL, 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
BTL-2020-02	Management System	November 2-4, 2020	2
BTL-2020-03	Human Performance Management	November 2-4, 2020	4

Table B-8: Inspections, ÉPM 2018 - 2020

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
2019-DSN-ÉPM-01	Security	April 30, 2019	3
ÉPM-SLWPK-2020-01	Conventional Health and Safety, Management System, Operating Performance, Fitness for Service, Radiation Protection, Environmental Protection, Waste Management, Emergency Management & Fire Protection, and Public and Information Disclosure Program	February 13, 2020	1

Table B-9: Inspections, MNR 2018 –20

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
MNR-2018-01	Management System, Environmental Protection, Waste Management, Fitness for Service, Radiation Protection, Security, Operating Performance, Conventional Health and Safety, Human Performance Management, Emergency Management & Fire Protection, and Public and Information Disclosure Program	November 15, 2018	2
2019-NSD-MCMU-01	Security	October 22, 2019	0
MNR-2020-01	Human Performance Management – Personnel Training	March 9-10, 2020	4

Table B-10: Inspections, RMC 2018 –20

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
RMC-SLWPK-2019-01	Management System, Environmental Protection, Waste Management, Fitness for Service, Radiation Protection, Security, Operating Performance, Conventional Health and Safety, Human Performance Management, Emergency Management & Fire Protection, and Public and Information Disclosure Program.	February 21, 2019	0
2019-NSD-RMC-01	Security	October 24, 2019	2

Table B-11: Inspections, SRC 2018 –20

Inspection title	Safety and control areas covered	Inspection date	Number of NNCs
SRC-2019-01	Operating Performance, Radiation Protection, Safeguards and Non-Proliferation and Security	August 15-16, 2019	0
SRC-2020-01	Decommissioning activities, Environmental Protection, Radiation Protection, Waste Management	July 8-10, 2020	1

Note: Security inspection reports contain sensitive information and will not be made public.

C. Significant Changes to Licence and Licence Conditions Handbook

Table C-1: Changes to the licence

Licensee	Date	Facility licence	Summary of changes
BWXT-NEC Toronto	December 19, 2020	FFOL-3620.01/2020	New renewed licence FFL-3621.00/2030 was published
BWXT-NEC Peterborough	December 19, 2020	FFOL-3620.01/2020	New renewed licence FFL-3620.00/2030 was published
SRC	December 6, 2019	NPROL-19.01/2023	A licence amendment was approved to authorize the decommissioning of the SRC SLOWPOKE-2 reactor facility.[6]

Table C-2: Changes to the LCH

Licensee	Date	Facility licence	Summary of changes
BRR	August 11, 2020	FFOL-3632.00/2020	• Significant revision. Partially modernized LCH developed in conjunction with LCHs for CFM and PHCF. • Improve consistency between Cameco CFM, BRR, and PHCF LCHs • Restructured each SCA with Preamble, Compliance Verification Criteria (CVC), and Guidance sections • Updated to current Licensing Basis publications (e.g., CSA standards, REGDOCs, codes, etc.) • Updated licensee documents • Added reaffirmation year for CSA standards • Removed outdated/duplicated CVC text that is covered by licensing basis publications (e.g., reporting requirements covered by REGDOC-3.1.2)
PHCF	July 31, 2020	FFOL-3631.00/2027	• Significant revision. Partially modernized LCH developed in conjunction with LCHs for BRR and CFM. • Improve consistency between Cameco CFM, BRR, and PHCF LCHs.

[6] SRC has most recently applied for a licence to abandon, which will be the subject of a 2021 proceeding.

Licensee	Date	Facility licence	Summary of changes
			• Restructured each SCA with Preamble, CVC, and Guidance sections • Updated to current Licensing Basis publications (e.g., CSA standards, REGDOCs, codes, etc.) • Updated licensee documents • Added reaffirmation year for CSA standards • Removed outdated/duplicated CVC text that is covered by licensing basis publications (e.g., reporting requirements covered by REGDOC-3.1.2) • Removed reference to Centre Pier as that has been removed from Cameco's care and control.
CFM	August 20, 2020	FFOL-3641.00/2022	• Significant revision. Partially modernized LCH developed in conjunction with LCHs for BRR and PHCF. • Improve consistency between Cameco CFM, BRR, and PHCF LCHs. • Restructured each SCA with Preamble, CVC, and Guidance sections • Updated to current Licensing Basis publications (e.g., CSA standards, REGDOCs, codes, etc.) • Updated licensee documents • Added reaffirmation year for CSA standards • Removed outdated/duplicated CVC text that is covered by licensing basis publications (e.g., reporting requirements covered by REGDOC-3.1.2) • Restructured and updated appendices • Included hyperlinks
SRBT	February 6, 2020	NSPFOL-13.00/2022	• Editorial and formatting changes • Added hyperlinks to acts and regulations • Updated building floor plan

Licensee	Date	Facility licence	Summary of changes
			• Updated new revisions of REGDOCs • Update on transition plan with CSA standards • Updated radiation protection and environmental protection action levels • Removal of CN property wells from groundwater sampling locations
SRC	April 10, 2019	NPROL-19.01/2023	• Revised to reflect updates to the licensed activities, under Part I Section 4.4, and revisions to the tables in Part II Section 4.1 (Operations) • Clarified the licensed activities for the removal/replacement of fuel, or defueling of the reactor, given SRC's application to decommission the facility. • References to the DDP were also added.
RMC	June 11, 2019	NPROL-20.00/2023	• Editorial changes, referenced new REGDOCs and standards • Section 1.1: Replaced INFO-0795 with REGDOC-3.5.3 • Section 1.5: Introduced REGDOC-3.2.1 • Section 2.1: Introduced N286-12 and REGDOC-2.1.2 • Section 3.2: Introduced REGDOC-2.2.2 • Section 4.3 & 4.4: Introduced REGDOC-3.1.2 • Section 14.1: Introduced REGDOC-2.13.1 • Section 16.1: Compliance verification criteria replaced to reflect current information on refueling project • Appendix B: Referred to REGDOC-3.6 for CNSC definitions and terminology • Appendix D: Renamed as Appendix C, introduced spreadsheet to track current document versions, updated list of documents

Licensee	Date	Facility licence	Summary of changes
			• Appendix E: Removed, replaced with reference to REGDOC-3.1.2 in sections 4.3 & 4.4 • Appendix G: Removed, relocated tables under sections 8.1 and 10.1

D. Regulatory Document Implementation

Table D-1: Regulatory Documents – BRR

Document Number	Document Title	Version	Status
REGDOC-2.12.3	*Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1*	2020	Implemented in 2020
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2020
REGDOC-3.2.1	*Public Information and Disclosure*	2018	Implemented in 2020

Table D-2: Regulatory Documents – PHCF

Document Number	Document Title	Version	Status
REGDOC-2.12.3	*Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1*	2020	Implemented in 2020
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2020
REGDOC-3.2.1	*Public Information and Disclosure*	2018	Implemented in 2020

Table D-3: Regulatory Documents – CFM

Document Number	Document Title	Version	Status
REGDOC-2.12.3	*Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1*	2020	Implemented in 2020
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2020
REGDOC-3.2.1	*Public Information and Disclosure*	2018	Implemented in 2020

Table D-4: Regulatory Documents – BTL

Document Number	Document Title	Version	Status
REGDOC-2.8.1	*Conventional Health and Safety*	2019	Implemented in 2020
REGDOC-2.1.2	*Safety Culture*	2018	Implemented in 2020
REGDOC-3.2.1	*Public Information and Disclosure*	2018	Implemented in 2020

Table D-5: Regulatory Documents - ÉPM

Document Number	Document Title	Version	Status
REGDOC-2.1.2	*Management System: Safety Culture*	2018	Implemented in 2019
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2019
REGDOC-3.1.2	*Reporting Requirements, Volume I: Non-Power Reactor Class I* *Nuclear Facilities and Uranium Mines and Mills*	2018	Implemented in 2019

Table D-6: Regulatory Documents - MNR

Document Number	Document Title	Version	Status
REGDOC-2.1.2	*Management System: Safety Culture*	2018	Implemented in 2019
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2019
REGDOC-3.1.2	*Reporting Requirements, Volume I: Non-Power Reactor Class I* *Nuclear Facilities and Uranium Mines and Mills*	2018	Implemented in 2019

Table D-7: Regulatory Documents - RMC

Document Number	Document Title	Version	Status
REGDOC-3.5.3	*Nuclear Criticality Safety, Version 1.1*	2018	Implemented in 2019
REGDOC-3.2.1	*Public Information and Disclosure*	2018	Implemented in 2019
CSA N286-12	*Management system requirements for nuclear facilities*	2017	Implemented in 2019
REGDOC-2.1.2	*Management System: Safety Culture*	2018	Implemented in 2019
REGDOC-2.2.2	*Personnel Training*	2016	Implemented in 2019
REGDOC-3.1.2	*Reporting Requirements, Volume I: Non-Power Reactor Class I* *Nuclear Facilities and Uranium Mines and Mills*	2018	Implemented in 2019
REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	Implemented in 2019

E. Financial Guarantees

Table E-1: Financial guarantees, uranium processing facilities

Facility	Amount (CAD)
BRR	$48,000,000
PHCF	$128,600,000
CFM	$21,000,000
BWXT-NEC Toronto	$45,568,100
BWXT-NEC Peterborough	$6,803,500

Table E-2: Financial guarantees, nuclear substance processing facilities

Facility	Amount (CAD)
SRBT	$727,327
Nordion	$45,124,748
BTL	$1,800,000

Table E-3: Financial guarantees, research reactors

Facility	Amount (CAD)
ÉPM	$1,421,296
MNR	$11,701,106
RMC	N/A[7]
SRC	$5,760,000[8]

[7] This SLOWPOKE-2 facility is owned by National Defence and is therefore the property of the Crown. The costs associated with future decommissioning of this facility are the responsibility of National Defence.
[8] No decommissioning activities remain, so a financial guarantee is no longer required. CNSC staff have recommended the release of the financial guarantee funds, which will occur if a licence to abandon is granted (CMD 21-H104).

F. Safety and Control Area Ratings

Please note that licensees were only rated as "satisfactory (SA)" or "below expectation (BE)" for the UNSPF (2020) and RRs (2018-2020). The "fully satisfactory (FS)" rating was not used, consistent with the approach used for the 2019 RORs. It is important to recognize that a facility that received an SCA rating of FS in previous RORs and now has a rating of SA, does not necessarily indicate a reduction in performance. The simplified rating approach considerably reduced the effort that is often needed to reach a consensus on a final rating.

Table F-1: SCA ratings, Blind River Refinery, 2016 –20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	FS	FS	FS	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-2: SCA ratings, Port Hope Conversion Facility, 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	BE	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-3: SCA ratings, Cameco Fuel Manufacturing Inc., 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-4: SCA ratings, BWXT Nuclear Energy Canada Inc. Toronto and Peterborough, 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-5: SCA ratings, SRB Technologies (Canada) Inc., 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	FS	FS	FS	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	FS	SA	FS	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation[9]	N/A	N/A	N/A	N/A	N/A
Packaging and transport	SA	SA	SA	SA	SA

[9] Specific IAEA reporting and verification activities are held in abeyance.

Table F-6: SCA ratings, Nordion (Canada) Inc., 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	FS	FS	FS	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	FS	FS	FS	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-7: SCA ratings, Best Theratronics Ltd., 2016–20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-8: SCA ratings, École Polytechnique de Montréal SLOWPOKE-2, 2016 –20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-9: SCA ratings, McMaster Nuclear Reactor, 2016 –20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	FS	FS	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-10: SCA ratings, Royal Military College of Canada SLOWPOKE-2, 2016 –20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table F-11: SCA ratings, Saskatchewan Research Council SLOWPOKE-2, 2016 –20

SCAs	2016 rating	2017 rating	2018 rating	2019 rating	2020 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

G. Total Annual Releases of Radionuclides Directly to the Environment

The CNSC is making radionuclide release data more readily accessible to the public as part of its commitment to Open Government and its mandate to disseminate this information to the public. This Appendix reflects the continued commitment to provide data, within the regulatory oversight reports, on the total annual release of radionuclides.

CNSC staff have commenced publishing annual releases of radionuclides to the environment from nuclear facilities on the CNSC Open Government Portal.

Uranium processing facilities

Direct releases of radionuclides to the environment from uranium fuel refinery, manufacturing and conversion facilities are primarily limited to uranium released to the atmosphere. As uranium is more chemically toxic than radiologically toxic, releases are monitored as total uranium. As a result, the annual load is reported in kilograms. Of these facilities, only Cameco's Blind River Refinery has direct releases to surface water with the relevant radionuclides being uranium and radium-226.

Table G-1: Total annual load of relevant radionuclides released to atmosphere or surface waters for uranium processing facilities, 2016–20

Facility and year	Annual uranium release to air (kg)	Annual uranium released in liquid effluent to surface waters (kg)	Total radium-226 released in liquid effluent to surface waters (MBq)
Blind River Refinery			
2016	1.0	1.2	0.92
2017	0.8	1.9	1.04
2018	1.2	1.9	1.05
2019	2.0	2.7	2.10
2020	2.8	4.8	1.40
Port Hope Conversion Facility			
2016	34.3	N/A	N/A
2017	31.5	N/A	N/A
2018	34.1	N/A	N/A
2019	48.5	N/A	N/A
2020	44.4	N/A	N/A
Cameco Fuel Manufacturing			
2016	0.73	N/A	N/A
2017	0.58	N/A	N/A

Facility and year	Annual uranium release to air (kg)	Annual uranium released in liquid effluent to surface waters (kg)	Total radium-226 released in liquid effluent to surface waters (MBq)
2018	1.26	N/A	N/A
2019	1.09	N/A	N/A
2020	0.92	N/A	N/A
BWXT Nuclear Energy Canada Inc. Toronto			
2016	0.0108	N/A	N/A
2017	0.0074	N/A	N/A
2018	0.0063	N/A	N/A
2019	0.0071	N/A	N/A
2020	0.0080	N/A	N/A
BWXT Nuclear Energy Canada Inc. Peterborough			
2016	0.000004	N/A	N/A
2017	0.000002	N/A	N/A
2018	0.000002	N/A	N/A
2019	0.000004	N/A	N/A
2020	0.000003	N/A	N/A

MBq = megabecquerel; N/A = not applicable

Nuclear substance processing facilities

SRB Technologies (Canada) Inc.

Direct releases to the environment for SRBT are limited to atmospheric releases of tritium. There are no direct releases to surface waters.

Table G-2: Total annual load of relevant radionuclides released to atmosphere, SRBT, 2016–20

Year	Tritium	
	Tritiated water or HTO (GBq)	Elemental tritium or T_2 (GBq)
2016	6.29E+03	2.27E+04
2017	7.20E+03	1.76E+04
2018	1.07E+04	2.24E+04
2019	1.19E+04	1.99E+04
2020	9.75E+03	1.54E+04

GBq = gigabecquerel; HTO = hydrogenated tritium oxide; T_2 = tritiated gas

Nordion (Canada) Inc.

Direct radionuclide releases to the environment at Nordion are limited to atmospheric releases.

Table G-3: Total annual load of relevant radionuclides released to the atmosphere, Nordion, 2016–20

Year	Cobalt-60 (GBq)	Iodine-125 (GBq)	Iodine-131 (GBq)	Xenon-133 (GBq)	Xenon-135 (GBq)	Xenon-135m (GBq)
2016	0.006	0.21	0.35	7,277	4,299	5,421
2017	0.0034	0.0012	0.0008	0	0	0
2018	0.002	0	0.006	0	0	0
2019	0.00002	0	0	0	0	0
2020	0	0	0	0	0	0

GBq = gigabecquerel

Best Theratronics Ltd.

BTL does not have any airborne or liquid radiological releases.

Research Reactors

McMaster Nuclear Reactor

Direct releases to the environment at the McMaster Nuclear Reactor are limited to small residual releases to the atmosphere. There are no direct releases to surface waters.

Table G-4: Total annual releases to air from McMaster Nuclear Reactor, 2016 –20

Year	Argon-41 (Bq)	Iodine-125 (Bq)	Gross Beta/Gamma (Bq)
2016	7.1E+11	2.5E+08	5.0E+05
2017	6.9E+11	8.2E+08	1.3E+06
2018	7.7E+11	4.0E+08	1.9E+05
2019	8.4E+11	1.3E+08	6.4E+05
2020	6.9E+11	1.3E+08	3.6E+05

École Polytechnique de Montréal SLOWPOKE-2

Negligible airborne and no liquid radiological releases.

Royal Military College of Canada SLOWPOKE-2

Negligible airborne and no liquid radiological releases.

Saskatchewan Research Council SLOWPOKE-2

Negligible airborne and no liquid radiological releases.

H. Public Dose Data

This Appendix contains information on the estimated dose to the public around UNSPF and RRs. Regulatory release limits known as derived release limits or DRLs are site-specific calculated releases that could, if exceeded, expose a member of the public of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/year, pursuant to subsection 1(3) of the *Radiation Protection Regulations* [8]. DRLs are calculated using CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities* [18].

Considering the fact that the radiological releases from all the sites covered by this ROR have remained small fractions of the DRLs applicable to those sites, the contribution to the dose to the public from these releases remains a very small fraction of the prescribed limit for the general public.

Table H-1 below provides a public dose comparison of the UNSPF and RRs. At BRR and Nordion, the dose to public increased in 2020 compared to previous years due to the new DRL values that were applied at these facilities.

Table H-1: Public dose comparison table (mSv), uranium and nuclear substance processing facilities and research reactors, 2016–20

Facility	Year					Regulatory limit
	2016	2017	2018	2019	2020	
BRR	0.005	0.005	0.005	0.005	0.009	**1 mSv/year**
PHCF	0.020	0.153[10]	0.173	0.127	0.117	
CFM	0.023	0.022	0.030	0.027	0.020	
BWXT-NEC Toronto	0.0007	0.0175	0.0004	0.023	0.0057	
BWXT-NEC Peterborough	<0.001	<0.001	<0.001	0.0115	<0.001	
SRBT	0.0046	0.0033	0.0038	0.0021	0.0024	
Nordion	0.0021	0.000052	0.000067	0.00087	0.00122	
BTL[11]	N/A	N/A	N/A	N/A	N/A	
SLOWPOKE-2 Facilities (ÉPM, RMC, SRC)[12]	0.00008	0.00008	0.00008	0.00008	0.00008	
MNR	<0.001	<0.001	<0.001	<0.001	<0.001	

N/A = not applicable; mSv = millisievert

[10] In 2016, PHCF updated the dose calculations related to releases to water and the fenceline gamma locations used for reporting the dose to the public. The amounts in 2017 and 2018 look higher than in previous years, but there has not been an actual increase in emissions/dose from the facility. The results represent a much more conservative estimate of dose to the public, as the gamma monitoring location at the facility fenceline is now closer to the operating facility than the previous location, resulting in the increase shown in the table. For this reason, the results beginning in 2017 cannot be compared with previous years' results.

[11] No activities occur inside the BTL facility that result in the release of radioactive material to the environment.

[12] These values were estimated by CNSC staff using a sector specific environmental risk assessment model.

I. Environmental Data

This Appendix provides environmental data for the UNSPF and RRs.

Blind River Refinery

Atmospheric emissions

BRR monitors uranium, nitrogen oxides (NO_x), nitric acid (HNO_3) and particulates released from the facility stacks. The monitoring data in Table I-1 demonstrates that atmospheric emissions from the facility continued to be effectively controlled as annual averages were consistently well below their respective licence limits between 2016 and 2020. No action levels for air emissions were exceeded at any time in 2020.

Table I-1: Air emission monitoring results (annual averages), BRR, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit
Dust collection and exhaust ventilation stack: uranium (kg/h)	0.00005	0.00004	0.00005	0.00005	0.00005	**0.1**
Absorber stack: uranium (kg/h)	0.00001	0.00001	0.00001	0.00001	0.00001	**0.1**
Incinerator stack: uranium (kg/h)	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	**0.01**
NO_X + HNO_3 (kg NO_2/h)	1.6	1.8	2.3	3.3	3.2	**56.0**
Particulate (kg/h)	0.006	0.008	0.010	0.012	0.010	**11.0**

HNO_3 = nitric acid; kg/h = kilogram per hour; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides
Note: Results less than detection limit are denoted as "<".

Liquid effluent

There are 3 sources of allowable liquid effluent from the BRR facility: plant effluent, storm water runoff and sewage treatment plant effluent. These effluents are collected in lagoons and treated, as required, prior to discharge into Lake Huron. Cameco monitors uranium, radium-226, nitrates and pH in liquid effluents to demonstrate compliance with their respective licence limits. No action levels for liquid effluents were exceeded at any time in 2020.

Table I-2 summarizes the average monitoring results from 2016 to 2020. For 2020, the liquid discharges from the facility continued to be within their respective licensed limits.

Table I-2: Liquid effluent monitoring results (annual averages), BRR, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit
Uranium (mg/L)	0.01	0.01	0.01	0.01	0.01	**2**
Nitrates (mg/L)	11	14	20	21	19	**1,000**
Radium-226 (Bq/L)	0.01	0.01	0.01	0.01	0.01	**1**
pH (min)	7.3	7.3	7.3	7.2	7.0	**Min 6.0**
pH (max)	8.6	8.2	8.5	8.4	8.4	**Max 9.5**

Bq/L = becquerel per litre; mg/L = milligram per litre

Uranium in ambient air

The concentrations of uranium in the ambient air, as monitored by Cameco's sampling network around BRR, continued to be consistently low. In 2020, the maximum concentration of uranium in ambient air measured was 0.0077 µg/m^3 (east yard), which is well below MECP's Ambient Air Quality Criteria (AAQC) for uranium of 0.03 µg/m^3 [19].

Groundwater monitoring

Cameco has an extensive groundwater monitoring program in place around the facility with 35 monitoring wells: 14 wells located inside the perimeter fence and 21 outside the fenceline. Though not used as a potable water source, uranium concentrations from all the groundwater monitoring wells in 2020 were below Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ) for uranium [20].

The average uranium result from all groundwater samples analyzed decreased in 2020 compared to 2019, as shown in Table I-3. This decrease is attributable in part to a lower recorded concentration of uranium in monitoring well (BH) #22, located just south of the main UO_3 plant building outside the calcination area. Results at well (BH) #22 remain relatively stable, ranging between 7 and 14 µg/L.

Table I-3: Annual groundwater monitoring results, BRR, 2016–20

Parameter	2016	2017	2018	2019	2020	GCDWQ[13]
Average uranium concentration (µg/L)	1.3	1.2	2.3	2.0	1.4	**20**
Maximum uranium concentration (µg/L)	14.0	11.0	27.0	14.0	14.0	

GCDWQ = *Guidelines for Canadian Drinking Water Quality*; µg/L = microgram per litre

[13] None of the groundwater wells monitored are used for drinking water. The GCDWQ are health based and representative of the Maximum Acceptable Concentrations (MAC)

In 2020, a gap analysis of BRR's groundwater protection program was conducted against CSA Standard N288.7-15 *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [21]. Cameco will be submitting an updated groundwater protection program by August 2021 to address the identified gaps and to meet the requirements of CSA Standard N288.7-15 [21].

Surface water monitoring

Cameco continues to monitor surface water for uranium, nitrate, radium-226 and pH at the location of BRR's outfall diffuser in Lake Huron. The concentrations of uranium, nitrate, radium-226 and the pH levels in the lake remained well below the Canadian Council of Ministers of the Environment (CCME) *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [22]. Table I-4 below provides surface water monitoring results.

Table I-4: Surface water monitoring results at outfall diffuser in Lake Huron, BRR, 2016–20

Parameter		2016	2017	2018	2019	2020	CCME guidelines
Uranium (µg/L)	Average	<0.8	<0.7	<0.7	<0.7	<0.7	**15**
	Maximum	<0.8	<0.7	<0.7	<0.7	<0.7	
Nitrate (mg/L as N)	Average	0.2	0.2	0.1	0.2	0.2	**13**
	Maximum	0.2	0.2	0.2	0.2	0.2	
Radium-226 (Bq/L)	Average	<0.005	0.008	<0.005	0.008	<0.005	**N/A**
	Maximum	<0.005	0.008	<0.005	0.008	<0.005	
pH	Average	7.3	8.0	8.1	8.0	7.9	**6.5–9.0**
	Maximum	7.7	8.3	8.2	8.3	7.9	

Bq/l = becquerel per litre; CCME = *Canadian Council of Ministers of the Environment*; mg/L = milligrams per litre; µg/L = microgram per litre

Note: Results below the detection limit are denoted as "<"

Soil monitoring

Cameco collects soil samples at the 0 to 5 cm depth each year and at the 5 to 15 cm depth every 5 years, in order to monitor uranium concentrations in surface soil for long-term effects of air emissions on soil quality due to deposition of airborne uranium on soil in the vicinity of the BRR facility. The 2020 soil monitoring results remained consistent with the respective concentrations detected in previous years as shown in table I-5; that is, that uranium soil concentrations did not appear to increase in the area surrounding the facility.

The maximum uranium soil concentrations measured near the facility was at Ontario's natural background levels (up to 2.5 µg/g) and well below 23 µg/g, which is the most restrictive soil quality guideline set by the CCME for uranium (for residential and parkland land use) [23]. This data demonstrates that the current BRR operations do not contribute to accumulation of uranium in surrounding soil, and that no adverse consequences to relevant human and environmental receptors are expected.

Table I-5: Soil monitoring results (0–5 cm depth), BRR, µg/g, 2016–20

Parameter	2016	2017	2018	2019	2020	CCME guidelines
Average uranium concentration within 1,000 m	1.5	1.6	2.0	2.1	1.4	**23**
Average uranium concentration outside 1,000 m	0.5	0.6	0.7	1.0	0.7	
Maximum uranium concentration	2.9	2.8	3.7	3.8	2.5	

cm = centimetre; CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Gamma monitoring

A portion of radiological public dose from BRR operations is due to gamma radiation sources. Consequently, monitoring of gamma radiation effective dose rates at the fenceline of the BRR main site and the nearby golf course (the critical receptor location) is essential to ensuring that levels of potential gamma radiation exposure are maintained ALARA. The land immediately outside the perimeter fence continues to be owned and controlled by Cameco. Therefore, Cameco sets an action level for gamma dose rates of 1.0 µSv/h at the north fence only, because the critical receptor location for the gamma component of dose to the public is the neighbouring golf course north of the BRR site. Cameco uses environmental dosimeters which are replaced monthly to measure the effective dose rates for gamma radiation. In 2020, the maximum monthly fenceline gamma measurements at the BRR site was 0.55 µSv/h (east), 0.30 µSv/h (north), 0.90 µSv/h (south) and 1.02 µSv/h (west). All north fenceline results in 2020 were below the action level. These measurements indicate that gamma dose rates are controlled and that the public and Indigenous groups are protected.

Port Hope Conversion Facility

Atmospheric emissions

Cameco monitors uranium, fluorides and ammonia released from the stacks at PHCF. The monitoring data in Table I-6 demonstrates that the atmospheric emissions from the facility continued to be effectively controlled, as annual averages remained consistently below their respective licence limits from 2016 to 2020.

Table I-6: Air emission monitoring results (annual daily average), PHCF, 2016–20

Location	Parameter	2016	2017	2018	2019	2020	Licence limit
UF_6 plant	Uranium (kg/h)	0.0012	0.0011	0.0014	0.0027	0.0025	**0.28**
	Fluorides (kg/h)	0.0100	0.021	0.030	0.018	0.028	**0.65**
UO_2 plant	Uranium (kg/h)	0.0010	0.0005	0.0007	0.0008	0.0006	**0.24**
	Ammonia (kg/h)	1.7	1.4	1.7	2.1	2.0	**58**

UO_2 = uranium dioxide; UF_6 = uranium hexafluoride

Liquid effluent

Cameco's operating licence does not allow the discharge of any process waste water effluent from PHCF. In 2020, there were no process liquid discharges from PHCF. Cameco continues to collect and evaporate rather than discharge process liquid effluent.

Cameco does discharge non-process liquid effluent, such as cooling water and sanitary sewer discharges, from PHCF. Cameco monitors these releases in compliance with the requirements of other regulators that have jurisdiction. In 2016 and early 2017, as part of the licence renewal process, a daily sanitary sewage discharge action level of 100 µg uranium per litre (U/L) and a monthly mean release limit of 275 µg U/L were developed and accepted. The sanitary sewage action level was exceeded on multiple occasions from 2017-2019, however, as a result of Cameco's corrective actions in response to these exceedances, only 1 sanitary sewer action level exceedance occurred in 2020. This action level exceedance is described in the *Action Levels* subsection of section 6.7.

CNSC staff concluded that in 2020, Cameco met its licence requirement not to discharge process wastewater effluent and to keep the sanitary sewer discharges below their respective release limits.

Uranium in ambient air

Cameco measures uranium in the ambient air as Total Suspends Particulate (TSP) at several locations around the PHCF site to confirm the effectiveness of emission abatement systems and to monitor the impact of the facility on the environment. For 2020, the highest annual average concentration (among the sampling stations) of uranium in ambient air measured was 0.003 µg/ m^3, which is well below MECP's Ambient Air Quality Criteria (AAQC) for uranium of 0.03 µg/m^3 [19].

As a follow up requirement of the Vision in Motion project's environmental assessment, Cameco monitors for dust generation during the conduct of soil excavation activities. Cameco reported a total of ten ambient station high volume air sampler (hi-vol) exceedances of total suspended particulate (TSP) in 2020. The measurements were above the Environment and Climate Change Canada (ECCC) and MECP 120 µg/m^3 TSP dust criteria for visibility. The elevated results were attributed to dry conditions and high winds in relation to remediation work being completed adjacent to Cameco property. There were no impacts to the environment or to the health and safety of people.

Groundwater monitoring

The PHCF long-term groundwater monitoring program includes groundwater level monitoring and groundwater sampling at select wells. Cameco samples groundwater quality at the PHCF in the following monitoring wells:

- 12 active pumping wells on a monthly basis
- 52 monitoring wells in the overburden (soil) on a quarterly basis
- 17 monitoring wells in the bedrock on an annual basis

The pump-and-treat wells have been performing as expected. The operation of the pump-and-treat system has resulted in capture of the contaminant plumes originating under the footprint of the UF_6 plant. The pump-and-treat systems continue to reduce the mass of groundwater contaminants entering into the harbour, at rates similar to previous years, as shown in table I-7 below.

Table I-7: Mass (kg) of contaminants removed by pumping wells, PHCF, 2016–20

Parameter	2016	2017	2018	2019	2020
Uranium	22.8	34.0	27.0	27.0	22.0
Fluoride	36.9	61.0	57.0	47.0	47.0
Ammonia	73.6	70.0	66.0	39.0	23.0
Nitrate	42.6	56.0	124.0	69.0	60.0
Arsenic	1.9	3.0	1.0	0.5	0.64

kg = kilogram

In 2020, a gap analysis of PHCF's groundwater protection program was conducted against CSA Standard N288.7-15 [21]. Cameco will be submitting an updated groundwater protection program by October 2021 to address any identified gaps and to meet the requirements of CSA Standard N288.7-15 [21].

Surface water monitoring

The surface water quality in the harbour near the PHCF site has been monitored since 1977 through the analysis of samples collected from the south cooling water intake near the mouth of the Ganaraska River. The trend of surface water quality over time shows improvement since 1977 and very low uranium levels.

Surface water in the harbour is sampled at 13 locations on a quarterly basis. This activity includes the collection of samples at depths slightly below the water surface and slightly above the harbour sediment layer at each location. These sampling locations were restricted beginning in 2018 due to CNL's remedial harbour activities; however, PHCF has continued to conduct ongoing monitoring of the cooling water intake located in the Port Hope harbour near the mouth of the Ganaraska River. Given its proximity to the harbor outlet, the cooling water intake provides a good indication of the overall water quality in the Port Hope harbour under routine/baseline conditions. Unusual and non-routine circumstances such as the 2018 west turning basin wall failure, CNL harbour isolation works and CNL harbour remedial

activities have influenced the Port Hope Harbour water quality. Table I-8 of provides annual average and maximum concentrations of uranium, fluoride, nitrate and ammonia monitored in the harbour water from 2016 to 2020.The maximum uranium concentrations in the cooling water intake have been trending downward in 2020 compared to the previous year.

Table I-8: Harbour water quality, PHCF, 2016–20

Parameter	Value	2016	2017	2018	2019	2020	CCME guidelines
Uranium (µg/L)	Average	2.6	3.3	5.2	5.1	5.0	**15**
	Maximum	10	8.8	31	46	12	
Fluoride (mg/L)	Average	0.15	0.19	0.16	0.092	0.09	**0.12**
	Maximum	0.22	0.29	0.36	0.18	0.15	
Nitrate (mg/L)	Average	0.85	1.0	1.0	0.95	0.92	**13**
	Maximum	1.6	2.2	1.8	1.6	1.7	
Ammonia + ammonium (mg/L)	Average	0.16	0.18	0.13	0.031	0.014	**0.3**
	Maximum	0.58	0.40	0.47	0.21	0.14	

CME = *Canadian Council of Ministers of the Environment*; mg/L = milligrams per litre; µg/g = microgram per gram

Soil monitoring

Cameco's soil monitoring program consists of 5 monitoring locations beyond the facility's fenceline in Port Hope. Three of these locations are within a 0 to 500 m radius zone from the facility, while the remaining 2 monitoring locations are within the 500 to 1,000 m and 1,000 to 1,500 m radius zones. This includes 1 location (waterworks side yard) remediated with clean soil to avoid interference from historical uranium soil contamination. Cameco takes samples annually at various depths within the soil profile to determine whether the concentration of uranium has changed as compared with previous sample results.

The measured average uranium-in-soil concentrations in 2020 have remained similar to those of past years. This suggests that uranium emissions from current PHCF operations do not contribute to accumulation of uranium in soil. Table I-9 provides soil sampling results for the waterworks side yard location from 2016-2020. The results have been well below the most restrictive CCME *Soil Quality Guidelines for the Protection of Environmental and Human Health* [22] for residential and parkland land use (23 µg/g) and within the range of the natural background levels for Ontario (up to 2.5 µg/g).

Cameco has made a commitment to maintain the existing 5 soil monitoring locations and to report the results to the CNSC annually. Reclamation activities, as part of the Port Hope Area Initiative, will provide an opportunity for Cameco to review the locations of its soil monitoring stations throughout the Port Hope community.

Table I-9: Uranium concentrations at waterworks side yard remediated with clean soil (µg/g), PHCF, 2016–20

Soil depth (cm)	2016	2017	2018	2019	2020	CCME guidelines
0–5	1.2	0.8	0.91	0.82	0.91	**23**
5–10	1.1	0.8	0.85	0.74	0.84	
10–15	1.0	0.9	0.98	0.80	0.81	

CCME = *Canadian Council of Ministers of the Environment*; cm = centimetre; µg/g = microgram per gram

Fluoride monitoring

The impact of fluoride emissions from PHCF on the environment is determined each growing season. At that time, samples of fluoride-sensitive vegetation are collected and then analyzed for fluoride content. The vegetation sampling program was modified in 2017, when sampling locations were standardized to Manitoba maple locations where clusters of trees were sampled in the vicinity of PHCF as composite samples versus single location sampling. The results in 2020 as shown in table I-10 below continued to be well below the MECP's Upper Limit of Normal Guideline of 35 parts per million (ppm).

Table I-10: Fluoride concentration in local vegetation, PHCF, 2016–20

Parameter	2016	2017	2018	2019	2020	MECP guidelines*
Fluoride in vegetation (ppm)	3.0	11.0	5.0	5.0	5.0	**35**

MECP = *Ontario Ministry of the Environment, Conservation and Parks*; ppm = parts per million
*****MECP's Upper Limit of Normal Guidelines

Gamma monitoring

A portion of radiological public dose from PHCF operations is due to gamma radiation sources. Consequently, monitoring gamma radiation effective dose rates at the fenceline of the 2 PHCF sites (Site 1 and Site 2) is essential to ensuring that levels of potential gamma radiation exposure are maintained ALARA. The gamma radiation effective dose rates for both sites are measured with environmental dosimeters supplied by a licensed dosimetry service using specific fenceline monitoring locations.

The 2016 annual average of doses for gamma are shown in table I-11 below. The 2017, 2018, 2019, and 2020 maximum monthly doses for gamma are shown in table I-12. Results from 2016 are reported in a separate table as a fenceline gamma monitoring location was included closer to the operating facility in 2017 than previously used in the dose to the public calculations. The results beginning in 2017 should not be compared to previous years due to this change

The measurements indicate that gamma dose rates are ALARA and the public is protected.

Table I-11: Gamma monitoring results, annual average, PHCF, 2016

Parameter	2016	Licence limit
Site 1 (main faciltity) (µSv/h)	0.005	**0.14**
Site 2 (Dorset Street) (µSv/h)	0.054	**0.40**

µSv/h = microsievert per hour

Table I-12: Gamma monitoring results, maximum monthly, PHCF, 2017–20

Station number and site	2017	2018	2019	2020	Licence limit
Station 2 - Sites 1 and 2 (µSv/h)	0.25	0.26	0.20	0.20	**0.57**
Station 13[14]/10 - Site 1 (µSv/h)	0.03[12]	0.07[12]	0.0[12]/0.05	0.11	**0.40[12]/0.61**
Station 21 - Site 2 (µSv/h)	0.08	0.07	0.06	0.09	**0.26**

µSv/h = microsievert per hour

Cameco Fuel Manufacturing Inc.

Atmospheric emissions

Cameco continued to monitor uranium released as atmospheric emissions from the facility. The monitoring data in Table I-13 demonstrates that stack and building exhaust ventilation emissions from the facility continued to be effectively controlled as annual averages remained consistently well below their licence limits between 2016 and 2020.

Table I-13: Air emission monitoring results, CFM, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit
Total uranium discharge through stacks (kg/year)	0.03	0.01	0.01	0.004	0.01	**14**
Total uranium discharge through building exhaust ventilation (kg/year)	0.70	0.57	1.25	1.09	0.92	

kg = kilogram

[14] Denotes values for station number 13. The results at stations 2 and 13 are used for Site 1 public dose calculations prior to July 1, 2019 and stations 2 and 10 are used for Site 1 public dose calculations after July 1, 2019 due to the removal of station 13 at Centre Pier.

Starting in 2018, the annual uranium discharge through building exhaust ventilation was calculated by using a summation of the daily release values with a total sum provided for the year. This capability was built into the CFM facility's new environmental monitoring software and is a better reflection of day-to-day operations compared to using an average result. Previously, the annual value was calculated by adding the quarterly results (2016 and 2017) and using the annual average (2015). This caused the 2018 and subsequent annual results to be higher when compared with those of previous years due to the number of days used in the annual calculation compared to the number of days used in the quarterly calculation. The summation of the daily values is more representative of the actual building ventilation emissions. No action levels for atmospheric emissions were exceeded at any time in 2020.

Liquid effluent

After liquid effluent generated from the production process is collected, an evaporator process is used to remove the majority of the uranium. The condensed liquid is sampled and analyzed prior to a controlled release to the sanitary sewer line. Cameco continues to monitor uranium released as liquid effluent from the facility. The monitoring data in Table I-14 demonstrates that liquid effluent from the facility in 2020 remained consistently well below the licence limit and continued to be effectively controlled. No action levels for liquid effluent were exceeded at any time in 2020.

Table I-14: Liquid effluent monitoring results, CFM, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit
Total uranium discharge to sewer (kg/year)	0.85	0.64	0.84	0.39	0.34	**475**

kg = kilogram

Uranium in ambient air

Cameco operates high-volume air samplers to measure the airborne concentrations of uranium at points of impingement of stack plumes. The samplers are located on the east, north, southwest and northwest sides of the facility. In 2020, the results from these samplers showed that the highest annual average concentration of uranium in ambient air (among the sampling stations) was 0.0024 $\mu g/m^3$. This is well below MECP's Ambient Air Quality Criteria (AAQC) for uranium of 0.03 $\mu g/m^3$ [20].

Groundwater monitoring

CFM has a network of 70 monitoring wells, including 43 overburden, 23 shallow bedrock and 4 deep bedrock wells. Groundwater has been monitored at the site twice a year since 1999 and up to 10 pumping wells and 2 sumps were in operation during 2020. Table I-15 provides annual average and maximum concentrations of dissolved uranium in groundwater from 2016 to 2020.

Table I-15: Dissolved uranium concentrations in groundwater, CFM, 2016–20

Parameter	2016	2017	2018	2019	2020	MOE Standard
Average dissolved uranium concentration (µg/L)	58	73	78	115	107	**420**
Maximum dissolved uranium concentration (µg/L)	1700	1900	2200	2300	2100	

MOE = Ontario Ministry of the Environment; µg/g = microgram per liter

The exceedances of the MOE standard [24] occurred at the same 3 monitoring well locations every year and are related to historic site soil impacts. In the direction of groundwater flow, the closest property boundary (non-residential) is approximately 120 to 140 meters from these 3 monitoring wells. The potential for off-site migration of uranium through groundwater migration is very low. The groundwater monitoring results confirmed that current operations are not contributing to the concentrations of uranium in groundwater on the licensed property.

In 2020, a gap analysis of CFM's groundwater protection program was conducted against CSA Standard N288.7-15 [20]. Cameco will be submitting an updated groundwater protection program by October 2021 to address any identified gaps and to meet the requirements of CSA Standard N288.7 [20].

Surface water monitoring

In 2020, Cameco collected surface water samples at 9 locations in April, June, and October. The sample locations were on and adjacent to the facility, and were analyzed for uranium.

The total uranium concentrations in surface water met the interim Provincial Water Quality Objective (PWQO) of 5 µg/L [25] at all surface water sampling locations except at the intermittent drainage locations SW-4 (April and August 2020) and SW-9 (April and August 2020). All surface water samples met the CCME short-term uranium guideline of 33 µg/L [22] in the intermittent drainage locations. There was 1 exceedance of the CCME long-term uranium guideline of 15 µg/L [22] in the Gages Creek tributary at location SW-9 (April 2020). The risk to the environment from an exceedance of a CCME water quality guideline is expected to be minimum due to the conservative assumptions and safety factors that were used to derive the guideline.

CNSC staff will continue to oversee Cameco's monitoring at locations around the vicinity of CFM to confirm that uranium concentrations remain at safe levels in surface water.

Soil monitoring

Every 3 years, Cameco collects soil samples at the 0 to 5 cm depth each year from 23 locations surrounding the CFM facility. Soil samples were last collected in 2019 and analyzed for uranium content. The soil monitoring results are shown in table I-16 below. The 2019 average uranium concentration in soil near the CFM facility is within the Ontario natural background level of up to 2.5 µg/g. The maximum concentrations detected are attributable to historical contamination in Port Hope, which has long been recognized and continues to be the focus of environmental studies and cleanup activities. The results for all samples were below the CCME *Soil Quality Guidelines for the Protection of Environmental and Human Health* [22] of 23 µg/g. This is the most restrictive guideline; therefore, no adverse consequences to human and environmental receptors are expected. The next soil samples will be collected in 2022.

Table I-16: Soil monitoring results[15], CFM, 2009 –19

Parameter	2009	2010	2013	2016	2019	CCME guidelines
Average uranium concentration (µg/g)	5.2	4.5	3.7	2.5	2.4	**23**
Maximum uranium concentration (µg/g)	17.0	21.1	17.4	11.2	7.6	**23**

CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Gamma monitoring

For the CFM facility, a portion of radiological public dose is due to gamma radiation sources. Consequently, monitoring of gamma radiation effective dose rates at the fenceline of the CFM site is essential to ensuring that levels of potential gamma radiation exposure are maintained ALARA. The gamma radiation effective dose rates for the site are measured with environmental dosimeters supplied by a licensed dosimetry service. In 2020, the annual average of gamma measurements at location 1 (the critical receptor location) was 0.006 µSv/h. The highest average at the other monitoring locations was 0.34 µSv/h. CFM has a licensed limit for fenceline gamma dose rates of 0.35 µSv/h at location 1 and 1.18 µSv/h at all other monitoring locations. No licence limits were exceeded in 2020.

In addition to licence limits, CFM has action levels for the critical receptor and other locations. There were no exceedances of the action levels in 2020.

[15] CFM reverted to a 3-year soil monitoring program starting in 2010.

BWXT Nuclear Energy Canada Inc. Toronto & Peterborough

Atmospheric emissions

To ensure compliance with licence limits, air emissions from the BWXT NEC facilities are filtered and sampled prior to its release into the atmosphere. Table I-17 provides BWXT-NEC Toronto's annual maximum uranium emissions from 2016 to 2020. Table I-18 provides BWXT-NEC Peterborough's annual maximum uranium and beryllium emissions from 2016 to 2020. The annual emissions remained well below the licence limits for both facilities.

In 2020, BWXT-NEC established new exposure based release limits (EBRLs) for air which are concentration based release limits that take into consideration the most restrictive endpoint parameters (radiotoxicity and chemical toxicity). These are listed as licence limits in both tables. No action levels for atmospheric emissions were exceeded at any time in 2020. The results demonstrate that air emissions of uranium and beryllium were being controlled effectively.

Table I-17: Air emission monitoring results (annual maximum concentrations), BWXT-NEC Toronto, 2016–20

Parameter	Stack	2016	2017	2018	2019	2020	Licence limit
Uranium (µg/m^3)	Rotoclone	0.355	0.180	0.464	0.077	0.204	65
	6H-68	0.145	0.160	0.118	0.111	0.112	47
	4H-48	0.500	0.130	0.086	0.037	0.112	97
	Furnace #1	0.105	0.440	0.112	0.081	0.599	437
	Furnace #2/4	0.809	0.150	0.092	0.103	0.158	55
	Furnace #5/6	0.132	0.230	0.467	0.245	0.908	52

Table I-18: Air emission monitoring results (annual maximum concentrations), BWXT-NEC Peterborough, 2016–20

Parameter	Stack	2016	2017	2018	2019	2020	Licence limit
Uranium (µg/m^3)	R2 Decan	0.012	0.003	0.006	0.014	0.003	410
Beryllium (µg/m^3)	North	0.001	0.001	0.001	0.001	0.001	2.6
	South	0.001	0.001	0.001	0.001	0.001	
	Acid	0.002	0.001	0.000	0.000	0.000	

Liquid effluent

To ensure compliance with licence limits, wastewater from the BWXT-NEC Toronto and Peterborough facilities is collected, filtered and sampled prior to its release into sanitary sewers. Table I-19 provides BWXT-NEC's annual maximum concentrations of uranium and beryllium released to the sanitary sewers from 2016 to 2020. In 2020, the releases continued to be well below the licence limits.

In 2020, BWXT-NEC established new EBRLs for water which are concentration based release limits that take into consideration the most restrictive endpoint parameters (radiotoxicity, chemical toxicity, and protection of aquatic life). These are listed as licence limits in both tables. No action levels for liquid effluent were exceeded at any time in 2020. The results demonstrate that liquid effluent releases were being controlled effectively.

Table I-19: Liquid effluent monitoring results (annual maximum concentrations), mg/L, BWXT-NEC, 2016–20

Facility	Parameter	2016	2017	2018	2019	2020	Licence limit
BWXT-NEC Toronto	Uranium	2.80	2.56	2.95	2.58	2.79	1000
BWXT-NEC Peterborough	Uranium	0.48	0.09	0.03	0.07	0.37	2500
	Beryllium	0.0025	0.0054	0.0025	0.0018	0.0091	26

Uranium in ambient air

BWXT-NEC Toronto operates 5 high-volume air samplers to measure the airborne concentrations of uranium at points of impingement of stack plumes. The results from these samplers show that the annual average concentration of uranium (among the sampling stations) in ambient air measured around the facility in 2020 was below the minimum detection limit and therefore is reported as zero. This demonstrates that the results are well below MECP's Ambient Air Quality Criteria (AAQC) for uranium of 0.03 µg/m^3 [20]. Table I-20 provides air monitoring results for BWXT-NEC Toronto.

BWXT-NEC Peterborough does not monitor uranium in ambient air because the atmospheric emissions discharged from the facility already meet the MECP standard of 0.03 µg/m^3 at the point of release, thus eliminating the need for additional ambient monitoring.

Table I-20: Uranium in boundary air monitoring results, BWXT-NEC Toronto, 2016–20[16]

Parameter	2016	2017	2018	2019	2020
Average concentration (µg/m^3)	0.001	0.000	0.000	0.000	0.000

µg = microgram

Groundwater and surface water monitoring

There is no groundwater or surface water monitoring programs at the BWXT-NEC facilities. Liquid effluent from the BWXT-NEC facilities are sampled and analyzed as part of the Effluent Monitoring Programs before being discharged to the sanitary sewers. There are no direct discharges to surface water bodies.

The GE Hitachi complex in Peterborough currently monitors surface water and groundwater for PCBs and trichloroethylene (historical contaminants not associated with BWXT-NEC operations).

Given the low concentrations of beryllium and uranium in stormwater runoff and the absence of any significant soil or groundwater contamination on site, pathways associated with groundwater are also not considered pathways of concern at BWXT-NEC Toronto and Peterborough, as stated in the ERA.

Soil monitoring

BWXT-NEC conducts soil sampling for uranium at its Toronto facility as part of its environmental program. In 2020, soil samples were taken from 49 locations and analyzed for uranium content. The samples were collected on the BWXT-NEC Toronto site, on commercial lands located along the south border of the site and in the nearby residential neighbourhood. In 2020, the measured soil concentrations of uranium ranged from <1.0 µg/g at a residential location to 17.6 µg/g on commercial lands. Regardless of sampling location (i.e., on site, commercial residential), all samples were below the most stringent soil guideline (i.e. CCME *Soil Quality Guidelines for the Protection of Environmental and Human Health* [22] for uranium for industrial, commercial and residential/parkland land use).

BWXT-NEC conducted soil sampling for beryllium in 2020 around the Peterborough facility as committed in the CNSC licence renewal hearing. In 2020, soil samples were taken from 21 locations that were selected for consistency with the CNSC's IEMP.
Of the 21 samples, 19 samples submitted were non-detect with results below the laboratory reported detection limit (<0.5 µg/g). The 2 samples that were detected ranged from 0.5 µg/g to 0.52 µg/g.

[16] Ontario standard for uranium in ambient air is 0.03 µg/m^3.

All samples fell well below Ontario's background concentrations of up to 2.5 µg/g and well below the applicable CCME Soil Quality Guidelines for the Protection of Environmental health (4 mg/kg) and Human Health (75 mg/kg) [22].

Tables I-21, I-22, I-23, and I-24 provide soil sampling results. The data demonstrates that the current BWXT-NEC operations at Toronto and Peterborough do not contribute to the accumulation of uranium or beryllium in surrounding soil, and that no adverse consequences to relevant human and environmental receptors are expected.

Table I-21: Uranium in soil monitoring results, BWXT-NEC Toronto property, 2016–20

Parameter	2016	2017	2018	2019	2020
Number of samples	1	1	1	1	1
Average uranium concentration (µg/g)	1.2	1.7	1.3	1.2	1.3
CCME guideline (µg/g)	**300**				

CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Table I-22: Uranium in soil monitoring results, commercial lands, BWXT-NEC Toronto, 2016–20

Parameter	2016	2017	2018	2019	2020
Number of samples	34	34	34	34	34
Average uranium concentration (µg/g)	2.7	3.0	2.3	1.5	2.9
Maximum uranium concentration (µg/g)	13.6	20.6	11.9	2.8	17.6
CCME guideline (µg/g)	**33**				

CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Table I-23: Uranium in soil monitoring results, residential locations, BWXT-NEC Toronto, 2016–20

Parameter	2016	2017	2018	2019	2020
Number of samples	14	14	14	14	14
Average uranium concentration (µg/g)	0.5	1.0	< 1.0	1.1	1.0
Maximum uranium concentration (µg/g)	0.7	1.6	< 1.0	1.7	1.0
CCME guidelines (µg/g)*	**23**				

CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Table I-24: Beryllium in soil monitoring results, institutional or park lands, BWXT-NEC Peterborough 2020

Parameter	2020
Number of samples	21
Average beryllium concentration (µg/g)	0.50
Maximum beryllium concentration (µg/g)	0.52
CCME guidelines (µg/g)*	**4.0**

CCME = *Canadian Council of Ministers of the Environment*; µg/g = microgram per gram

Gamma monitoring

A portion of radiological public dose from both the BWXT-NEC Toronto and Peterborough facilities is due to gamma radiation sources. Consequently, it is necessary to monitor gamma radiation effective dose rates at the fenceline of the Toronto site and at the Peterborough facility boundary to ensure that levels of potential gamma radiation exposure are maintained ALARA.

Since 2014, BWXT-NEC has used environmental dosimeters to measure the effective dose rates for gamma radiation for the Toronto site. In 2020, the radiation dose from direct gamma radiation was 5.7 µSv.

Since 2016, the gamma radiation effective dose rate for the BWXT-NEC Peterborough facility has also been measured with environmental dosimeters. In 2020, the radiation dose from direct gamma radiation was 0.0 µSv.

These estimates indicate that gamma dose from both BWXT-NEC facilities are controlled, ALARA and that the public is protected.

SRB Technologies (Canada) Inc.

Atmospheric emissions

SRBT monitors tritium releases from the facility stacks and reports them on an annual basis. The monitoring data for 2016 through 2020, provided in table iodine-25, demonstrates that atmospheric emissions from the facility remained below their regulatory limits.

Table I-25: Atmospheric emissions monitoring results, SRBT, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit (GBq/year)
Tritium as tritium oxide (HTO) (GBq/year)	6,293	7,198	10,741	11,858	9,755	**67,200**
Total tritium as HTO + HT (GBq/year)	28,945	24,822	33,180	31,769	25,186	**448,000**

GBq = gigabecquerel; HTO = hydrogenated tritium oxide; HT = tritium gas

Liquid effluent

SRBT continues to control and monitor tritium released as liquid effluent from the facility to the sewer. The monitoring data for 2016 through 2020, provided in table iodine-26, demonstrates that liquid effluent from the facility remained below their regulatory limits.

Table I-26: Liquid effluent monitoring results for release to sewer, SRBT, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit (GBq/year)
Tritium-water soluble (GBq/year)	5.18	6.85	10.02	13.67	5.56	**200**

GBq = gigabecquerel

Tritium in ambient air

SRBT has 40 passive air samplers located within a 2-kilometre radius of the facility. These samplers represent tritium exposure pathways for inhalation and skin absorption, and are used in the calculations to determine public dose. In 2020, SRBT converted to analyzing the passive air samples in-house with approved procedures. This change was implemented due to the former third party service provider becoming unavailable during the COVID-19 pandemic. The 2020 air monitoring results from these samplers demonstrated that tritium levels in ambient air near SRBT remain low.

Groundwater monitoring

Sampling wells are used to establish tritium concentrations in the groundwater each month at various depths and in differing geologic strata. From the 2020 sampling results, the highest average tritium concentration was reported for monitoring well MW06-10 (29,513 Bq/L, with a minimum monthly total of 17,231 Bq/L in June, and a maximum of 43,247 Bq/L in February) which is approximately 15% lower than the average measured in 2019

(34,592 Bq/L). This well is located directly beneath the area where the active ventilation stacks are located. This well is a dedicated, engineered groundwater monitoring well very near to the facility within a secured area, and is not available to be used as a source of water consumption. Throughout 2020, no other wells exceeded the Ontario Drinking Water Standard for tritium of 7,000 Bq/L. The annual average tritium concentrations in groundwater are provided in Figure I-1.

Figure I-1: Annual average tritium concentrations in groundwater and the Muskrat River, SRBT, 2020

Tritium concentrations decrease significantly at locations farther away from SRBT. In 2020, tritium concentrations in the sampled business wells were 938 Bq/L or less, and those in the sampled residential wells were 49 Bq/L, far below Ontario's drinking quality standard of 7,000 Bq/L. All of residential wells are over 1 km away from SRBT and are not in the groundwater flow pathway.

In 2020, SRBT converted to analyzing Muskrat River samples in-house with approved procedures. This change was implemented due to the former third party service provider becoming unavailable during the COVID-19 pandemic. Tritium concentrations in Muskrat River (the receiving surface water environment about 420 meters from the SRBT property) in 2020 fell below the minimum detectable activity (MDA), as they were in 2019.

Overall, CNSC staff concluded that the tritium inventory in the groundwater system around the facility has been trending downward since 2006. This trend is due to SRBT's initiative to reduce emissions, including the commissioning of improved tritium trap valves and remote display units, the real-time monitoring of gaseous effluent, and a reduction in the amount of failed leak tests of manufactured light sources. Along with the reduced emissions, the concentration of tritium in the groundwater is decreasing due to the natural decay of tritium and the flushing of historical tritium emissions through the groundwater system. Since 2016, SRBT has been in compliance with CSA N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [20].

Other monitoring

SRBT also samples and analyzes runoff water from its facility, and engages a qualified third party to perform monitoring and analysis of precipitation, surface water, produce, milk and wine. The 2020 monitoring data for these items remain low. This monitoring complements the principal monitoring activities, which focus on air and groundwater.

Nordion (Canada) Inc.

Atmospheric emissions

Nordion continues to control and monitor the releases of radioactive materials from its facility to prevent unnecessary releases of radioisotopes to the atmosphere. Table I-27 below shows Nordion's radioactive air emissions monitoring results from 2016 to 2020.

The monitoring data demonstrates that the radioactive air emissions from the facility in 2020 remained below the regulatory limits In November 2016, Nordion ceased the production of molybdenum-99, iodine-125, iodine-131 and xenon-133, which resulted in zero releases of radioiodine and noble gases from Nordion in 2020. In addition, there was no detectable air releases for cobalt-60 in 2020.

Table I-27: Air emissions monitoring results, Nordion, 2016–20

Parameter	2016	2017	2018	2019	2020	Licence limit (DRL) (GBq/year)
Cobalt-60	0.006	0.0034	0.002	0.00002	0	250
Iodine-125	0.21	0.0012	0	0	0	952
Iodine-131	0.35	0.0008	0.006	0	0	686
Xenon-133	7,277	0	0	0	0	677,000,000
Xenon-135	4,299	0	0	0	0	102,000,000
Xenon-135m	5,421	0	0	0	0	69,000,000

DRL = derived release limit; GBq = gigabecquerel

Liquid effluent

Nordion continues to collect, sample and analyze all liquid effluent releases before discharge into the municipal sewer system. Table I-28 of below shows Nordion's monitoring results for radioactive liquid emissions from 2016 to 2020.

The monitoring data demonstrates that the authorized radioactive liquid effluent releases from the facility in 2020 remained below the regulatory limits.

In 2020, Nordion reported 1 environmental reportable limit exceedance involving non-radiological releases to the sanitary sewer which resulted in by-law limit exceedance of suspended solids. This was identified by Nordion during routine sampling and self-reported to the City of Ottawa. CNSC staff conclude that this singular reportable exceedance did not pose undue risk to the environment or human health.

Table I-28: Liquid effluent monitoring results for release to sewer, Nordion, 2016-20

Parameter	2016	2017	2018	2019	2020	Licence limit (DRL) (GBq/year)
β < 1 MeV	0.222	0.212	0.243	0.162	0.226	763
β > 1 MeV	0.051	0.048	0.055	0.038	0.057	35,000
Iodine-125	0.144	0.145	0.146	0.063	0	1,190
Iodine-131	0.006	0.006	0.007	0.004	0	389
Molybdenum-99	0.052	0.049	0.055	0.036	0	10,200
Cobalt-60	0.026	0.022	0.027	0.020	0.031	35.4
Niobium-95	0.0010	0.0010	0.0010	0.002	0.0015	3,250
Zirconium-95	0.0015	0.0020	0.0017	0.0019	0.0013	2,060
Cesium-137	0.0007	0.0007	0.0007	0.0007	0.00076	24.8

β < 1 MeV = beta particles less than 1 megaelectronvolt; DRL = derived release limit; GBq = gigabecquerel

Groundwater monitoring

There are currently 9 groundwater monitoring wells on the Nordion site. Since 2005, Nordion has been monitoring groundwater at least once a year for non-radioactive contaminants in 4 monitoring wells. The monitoring results from 2014 to 2020 demonstrate that there were no significant changes in the groundwater in 2020 compared to previous years.

Since 2014, Nordion has been monitoring groundwater at least once a year for radioactive contaminants in 5 monitoring wells. The results since then have detected only naturally occurring radionuclides that are not processed at the Nordion facility.
These results, which are either below detection limits or at natural background levels, indicate that releases of radioactive and hazardous substances from Nordion's facility have had no measurable impact on groundwater quality.

Nordion has completed a gap analysis against the requirements of CSA N288.7-15 [20] and is continuing to update internal procedures and programs to meet these requirements and fill gaps identified.

Soil sampling

Nordion performed soil sampling in 2020, and no radionuclides attributable to licensed activities were detected in the soil samples.

Environmental thermoluminescent dosimeters program

Nordion monitors environmental gamma radiation with the use of thermoluminescent dosimeters. The dosimeters are deployed at locations to cover the points of a compass and preferentially to the east of the facility, which receives the prevailing west winds. Dosimeters are also placed in residences of Nordion employees located near the facility. The annual monitoring results for 2020 showed that the levels of gamma radiation at offsite monitoring locations are in the range of natural background levels. These results indicate that Nordion's operations is not contributing to the public's exposure to gamma radiation at, and beyond, the perimeter of the facility.

Best Theratronics Ltd.

Effluent and emissions control (releases)

BTL has determined that there are no radiological releases (liquid or airborne) at the BTL facility that require controls or monitoring. BTL's operation uses radioactive sealed sources that do not produce any radioactive releases.

BTL safely manages hazardous liquid effluents from routine operations. They are collected, temporarily stored on-site, and then removed for disposal by a certified third party contractor. Lubricating oil for on-site boring and milling machines are recovered and recirculated. Therefore, there would be no hazardous waterborne releases into the environment requiring controls or effluent monitoring.

Hazardous airborne emissions from BTL are related to the exhausting of the lead pouring, paint booth, fire torching and sand blasting areas. Engineering controls, such as filters and ventilation, are in place to reduce or eliminate emissions generated during operations.

As a result, BTL does not have an effluent monitoring program or an environmental monitoring program.

Assessment and monitoring

BTL does not conduct environmental monitoring around its facility as there are no radiological releases that require controls or monitoring. Hazardous airborne emissions pertain to exhausting associated with the lead pouring area. BTL submits a report on lead, and its compounds, to the National Pollutant Release Inventory, maintaining annual compliance with the *Toxics Reduction Act*. There have not been any abnormal releases within the licensing period.

McMaster Nuclear Reactor

Atmospheric emissions

MNR routinely monitors the exhaust ventilation from the Reactor Building for iodine-125 and argon-41 which are the only nuclear substances routinely released to the environment in measurable quantities (i.e., above detection limits). Radioactive particulates are also monitored for gross beta to ensure that no unexpected radionuclides are present in the air stream. Samples are collected weekly and analyzed by windowless proportional counting for gross beta and by gamma spectrometry for iodine-125. During operation of the reactor, daily measurements of argon-41 concentrations in the exhaust are made using a gas counting chamber.

Controls are in place to ensure that airborne releases of nuclear substances to the environment are minimized. These include the use of activated charcoal filters to minimize the release of iodine-125, and the use of filters to ensure releases of radioactive particulates are controlled. The annual total airborne releases are shown in Appendix G.

DRLs have been established for airborne releases of argon-41 and iodine-125 at MNR, based on the regulatory public dose limit of 1 mSv/year.

Liquid effluent

At MNR, the 2 potential pathways for liquid releases are deliberate pump out from the building sumps to the municipal sewer and breakthrough of primary water to the secondary side of the heat exchanger. There were no releases of contaminated liquids to the municipal sewer system in the 2018-2020 period. Any liquid effluent generated by MNR continues to be captured and then it is processed or evaporated in the facility.

Assessment and monitoring

MNR's environmental monitoring program consists of several locations surrounding the Reactor Building to sample for particulates and iodine-125 in air. Samples are collected weekly and analyzed for gross beta activity using a windowless proportional counter. Charcoal cartridges are collected and sampled monthly for iodine-125 via gamma spectrometry. The gaseous effluent monitors and environmental monitoring results at MNR did not indicate any radiological releases that could compromise the health and safety of persons and the environment.

No supplementary environmental monitoring programs (e.g., groundwater monitoring, surface water monitoring, soil monitoring, etc.) are required at MNR based on the licensees operations.

École Polytechnique de Montréal, Royal Military College of Canada and Saskatchewan Research Council SLOWPOKE-2 Reactors

Atmospheric emissions

The SLOWPOKE-2 RRs release negligible quantities of radioactive noble gases, mainly xenon-133 and xenon-135, resulting from the weekly purges of reactor head space, and argon-41, due to irradiation activities. The releases take place through filters and a dedicated facility stack, after sampling and analysis of the head space cover gas. Once released to the stack, these quantities are below the threshold of detection capability.

Due to the negligible quantities that are released and the minimal impact to the environment and to people, CNSC staff determined that no formal release limits are necessary for the SLOWPOKE-2 RRs.

During the SRC SLOWPOKE-2 decommissioning, SRC used an alpha/beta Integrated Continuous Air Monitoring to monitor for any potential radioactive. Throughout the entire decommissioning process, there were no detectable concentrations of airborne radioactivity above normal background.

Liquid effluent

The RR facilities do not generate any liquid effluent during normal operations.

The SRC SLOWPOKE-2 RR did generate some liquid effluent during its decommissioning in the form of the reactor pool water. The water was treated through an ion exchange column to reduce radioactivity. CNSC staff reviewed SRC's analyses of radionuclides in the their liquid effluent and compared them against the clearance levels in Appendix R of CNSC REGDOC-1.6.1, *Regulatory Quantities for Typical Radionuclides, Sewer* [26], as well as the exposure-based release limit derived using the methodology in CSA N288.1-14, , *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities* [18]. These conditional clearance levels are based on a member of the public receiving a dose of 0.01 mSv/yr. CNSC staff also reviewed the results of the hazardous substances and compared them against the limits in schedule "B" of the City of Saskatoon's sewer use bylaw. CNSC staff confirmed that all of the results were below their respective conditional clearance level or release limit. Thus, CNSC staff concluded that the pool water could be discharged to the city sewer without any impacts to workers, human health, and the environment.

Assessment and monitoring

Environment monitoring programs are not required for SLOWPOKE-2 RRs because the estimated dose to public is several orders of magnitude below the regulatory public dose limit, and the dose rates to non-human ecological receptors are orders of magnitude lower than conservative benchmarks.

The operations of the SLOWPOKE-2 RRs also do not result in any releases of hazardous substances to the environment. Thus, there is no requirement to monitor hazardous substances.

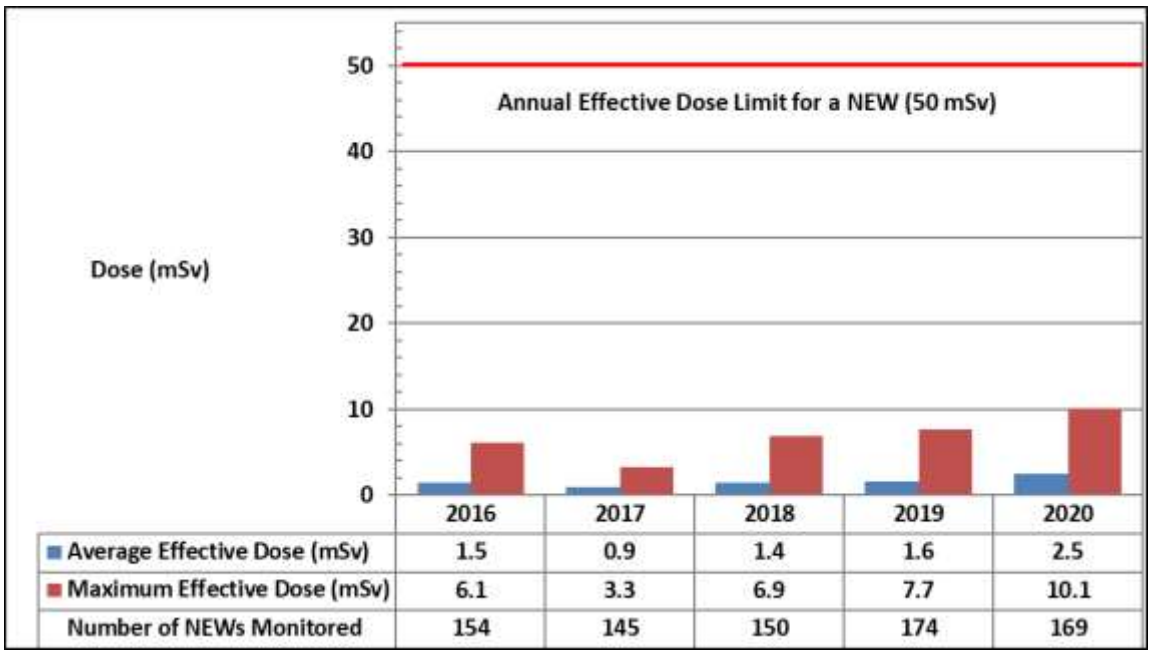
J. Worker Dose Data

This appendix presents information on doses to NEWs and non-NEWs at UNSPF and RRs.

Blind River Refinery

Figure J-1 provides the average and maximum effective doses for NEWs at BRR between 2016 and 2020. The maximum effective dose received by a NEW in 2020 was 10.1 mSv, which is approximately 20% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period. Average and maximum effective doses over this 5-year period are reflective of the work activities at BRR, and influenced by factors such as production levels and number of operating days. The average and maximum effective doses are trending higher in 2020, attributable to production rates. The NEW having the maximum effective dose also worked primarily in processing areas having the highest gamma and beta dose rates at BRR, contributing to the majority of their effective dose during the year.

Figure J-1: Effective dose statistics for NEWs, BRR, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	1.5	0.9	1.4	1.6	2.5
Maximum Effective Dose (mSv)	6.1	3.3	6.9	7.7	10.1
Number of NEWs Monitored	154	145	150	174	169

For the 5-year dosimetry period, which began January 1, 2016, and concluded on December 31, 2020, the maximum cumulative effective dose received by a NEW at BRR was 31.7 mSv. This effective dose result represents approximately 32% of the CNSC regulatory dose limit of 100 mSv in a 5-year dosimetry period.

Average and maximum equivalent dose results for the skin and extremities of NEWs, from 2016 to 2020, are provided in Tables J-1 and J-2. In 2020, the maximum individual skin dose received by a NEW at BRR was 39.1 mSv, which is approximately 8% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. The maximum individual extremity dose received by a NEW at BRR was 14.5 mSv, which is approximately 3% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. The average and maximum equivalent doses have been relatively steady over this 5-year period.

There was an increase in the maximum skin dose for a NEW in 2020. This NEW worked primarily in processing areas having the highest gamma and beta dose rates at BRR, and was also the same NEW with the maximum individual effective dose in 2020.

Table J-1: Equivalent (skin) dose statistics for NEWs, BRR, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average skin dose (mSv)	3.3	3.1	4.1	4.8	5.1	**N/A**
Maximum individual skin dose (mSv)	26.0	16.2	28.4	29.2	39.1	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Table J-2: Equivalent (extremity) dose statistics for NEWs, BRR, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average extremity dose (mSv)	1.2	1.0	3.5	3.9	3.4	**N/A**
Maximum individual extremity dose (mSv)	10.6	13.6	14.5	11.9	14.5	**500 mSv/year**

mSv = millisievert; N/A = not applicable

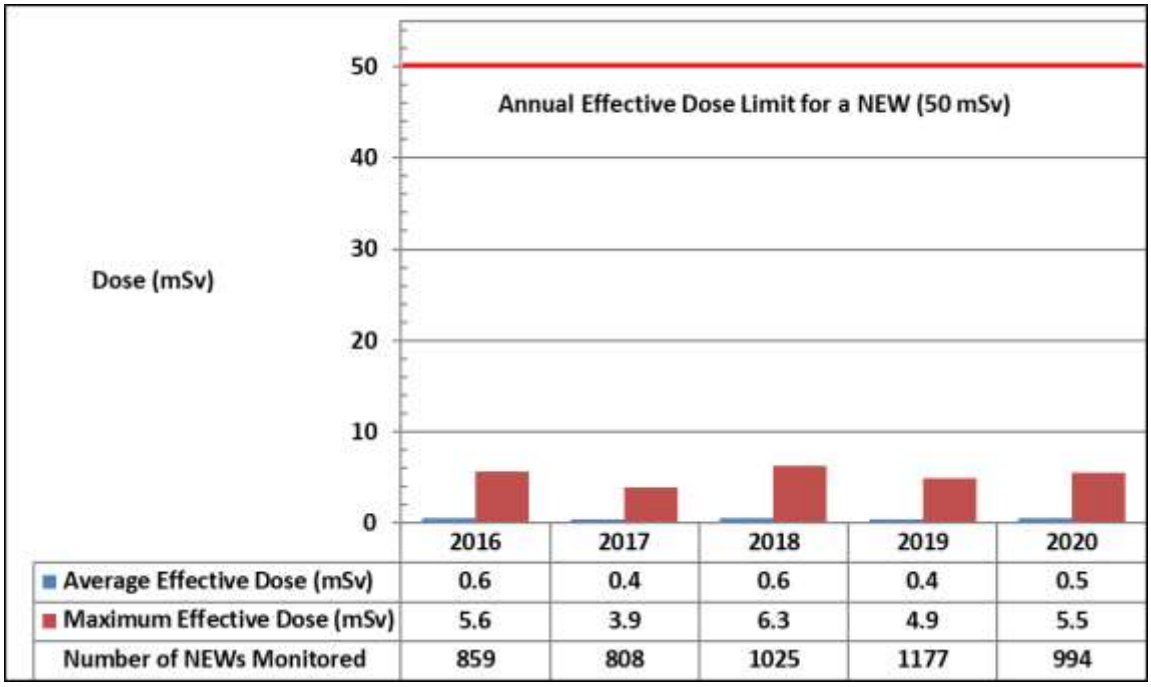
Non-NEWs at BRR

Site visitors and contractors that are not considered NEWs are issued external dosimetry to monitor their radiological exposures while at BRR. In 2020, the maximum individual effective dose received by a site visitor or contactor that was not a NEW was 0.15 mSv, which is well below the CNSC's regulatory effective dose limit of 1 mSv per calendar year for a person who is not a NEW.

Port Hope Conversion Facility

Figure J-2 provides the average and maximum effective doses for NEWs at PHCF between 2016 and 2020. The maximum individual effective dose received by a NEW in 2020 was 5.5 mSv, which is approximately 11% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period. The average and maximum total effective doses over this 5-year period have remained steady, and are reflective of the work activities and production levels at PHCF.

Figure J-2: Effective dose statistics for NEWs, PHCF, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0.6	0.4	0.6	0.4	0.5
Maximum Effective Dose (mSv)	5.6	3.9	6.3	4.9	5.5
Number of NEWs Monitored	859	808	1025	1177	994

For the 5-year dosimetry period, which began January 1, 2016, and concluded on December 31, 2020, the maximum cumulative effective dose received by a NEW at PHCF was 20.6 mSv. This effective dose result represents approximately 21% of the CNSC regulatory dose limit of 100 mSv in a 5-year dosimetry period.

Average and maximum equivalent dose results for the skin of NEWs, from 2016 to 2020, are provided in Table J-3. In 2020, the maximum individual skin dose received by a NEW at PHCF was 17 mSv, which is approximately 3% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. The average and maximum skin doses over this 5-year period have been relatively steady.

Table J-3: Equivalent (skin) dose statistics for NEWs, PHCF, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average skin dose (mSv)	0.8	0.6	0.7	0.5	0.5	**N/A**
Maximum individual skin dose (mSv)	16.9	13.7	14.9	20.1	17.0	**500 mSv/year**

mSv = millisievert; N/A = not applicable

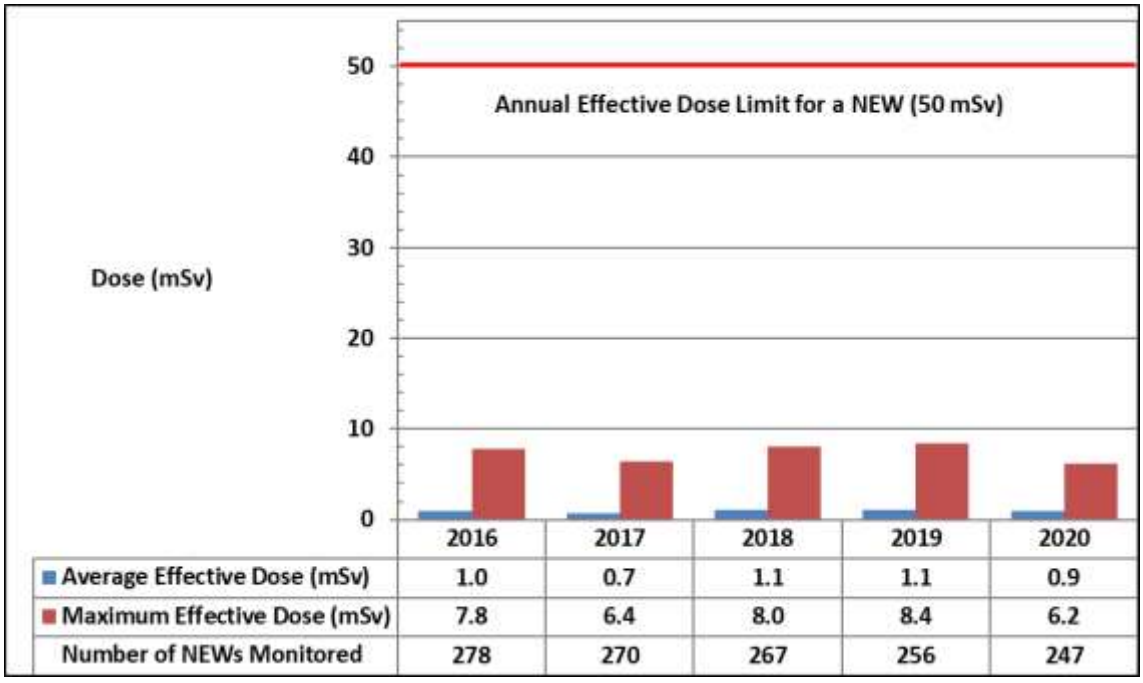
Non-NEWs at PHCF

Cameco employees, site visitors and contractors whose work activities do not require NEW status may be issued whole-body dosimeters and may participate in the internal dosimetry program to monitor their radiological exposures while at PHCF. In 2020, the maximum individual effective dose received by a person who is not a NEW was 0.04 mSv, which is well below the CNSC's regulatory effective dose limit of 1 mSv per calendar year for a person who is not a NEW.

Cameco Fuel Manufacturing Inc.

Figure J-3 provides the average and maximum effective doses for NEWs at CFM between 2016 and 2020. The maximum individual effective dose received by a NEW in 2020 was 6.2 mSv, which is approximately 12% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period The average and maximum total effective doses over this 5-year period have remained steady, and are reflective of the work activities and production levels at CFM.

Figure J-3: Effective dose statistics for NEWs, CFM, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	1.0	0.7	1.1	1.1	0.9
Maximum Effective Dose (mSv)	7.8	6.4	8.0	8.4	6.2
Number of NEWs Monitored	278	270	267	256	247

For the 5-year dosimetry period, which began January 1, 2016, and concluded on December 31, 2020, the maximum cumulative effective dose received by a NEW at CFM was 30.6 mSv. This effective dose result represents approximately 31% of the CNSC regulatory dose limit of 100 mSv in a 5-year dosimetry period.

Average and maximum equivalent dose results for the skin and extremities of NEWs, from 2016 to 2020, are provided in Tables J-4 and J-5. In 2020, the maximum skin dose received by a NEW at CFM was 55.3 mSv, which is approximately 11% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. The maximum extremity dose received by a NEW at CFM was 65.6 mSv, which is approximately 13% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. The average and maximum equivalent doses to the skin have been decreasing over this 5-year period. CFM attributes this trend, in part, to improvements made to work practices and work areas.

Table J-4: Equivalent (skin) dose statistics for NEWs, CFM, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average skin dose (mSv)	6.6	5.5	3.4	3.1	3.1	**N/A**
Maximum individual skin dose (mSv)	95.7	88.1	59.0	56.9	55.3	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Table J-5: Equivalent (extremity) dose statistics for NEWs, CFM, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average extremity dose (mSv)	13.2	10.6	15.8	18.4	17.9	**N/A**
Maximum individual extremity dose (mSv)	98.4	59.0	57.1	90.8	65.6	**500 mSv/year**

mSv = millisievert; N/A = not applicable

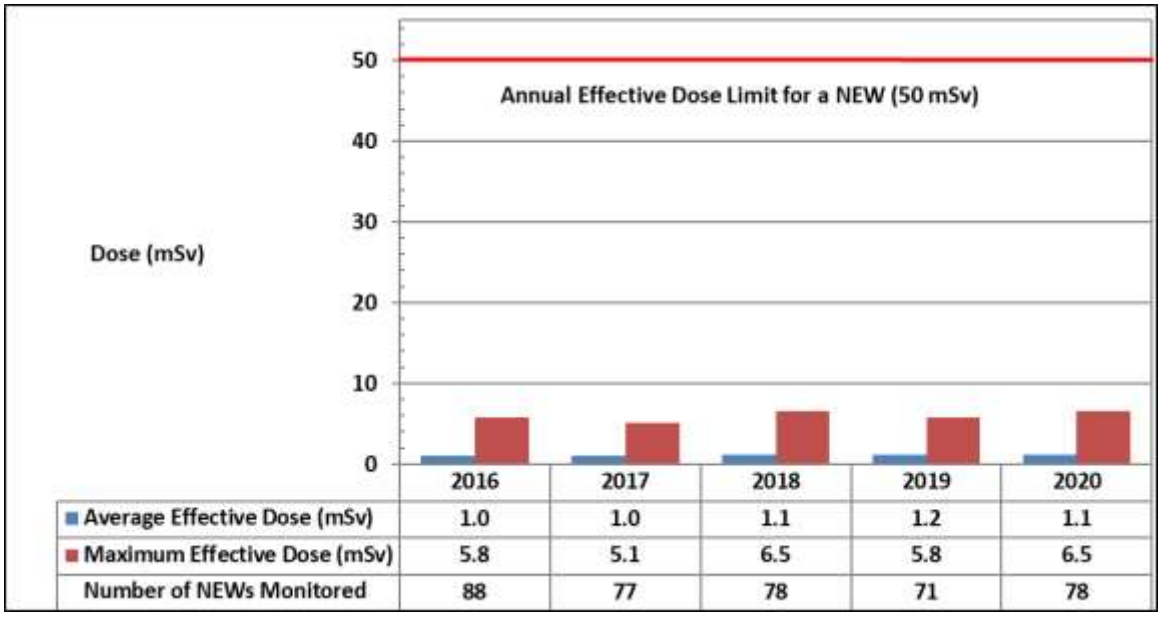
Non-NEWs at CFM

Visitors and contractors that are not considered as NEWs are issued dosimeters to monitor their radiological exposures while at CFM. In 2020, there were no measurable doses recorded on dosimeters issued to persons who are not NEWs.

BWXT Nuclear Energy Canada Inc. Toronto and Peterborough

Figure J-4 provides the average and maximum effective doses for NEWs at BWXT-NEC's Peterborough facility between 2016 and 2020. The maximum effective dose received by a NEW in 2020 at the Peterborough facility was 6.5 millisievert (mSv), or approximately 13% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period.

Figure J-4: Effective dose statistics for NEWs, BWXT-NEC Peterborough, 2016 –20

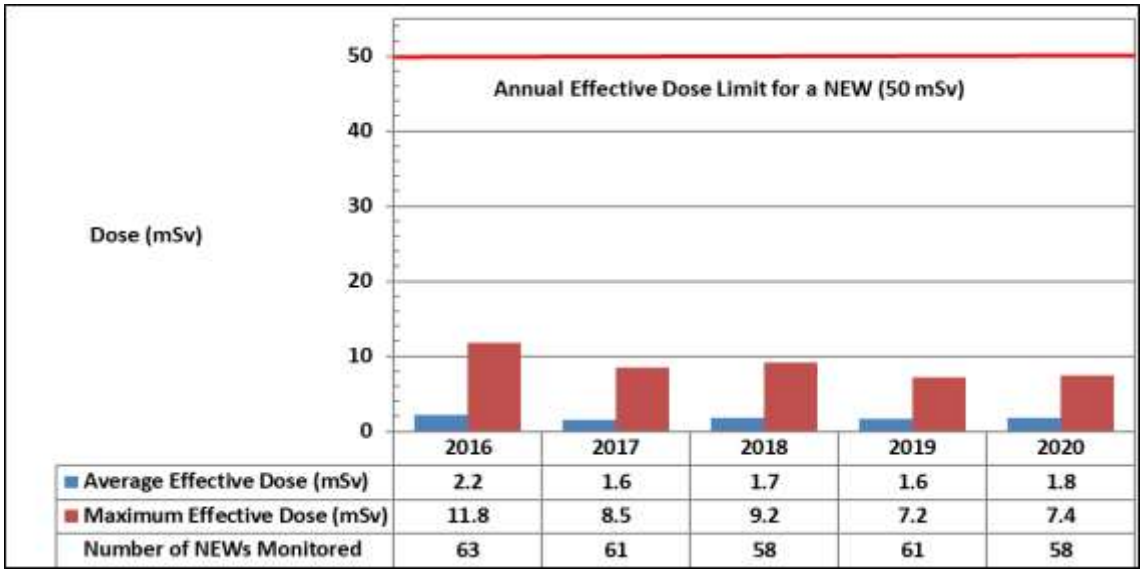


	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	1.0	1.0	1.1	1.2	1.1
Maximum Effective Dose (mSv)	5.8	5.1	6.5	5.8	6.5
Number of NEWs Monitored	88	77	78	71	78

The maximum individual effective dose for a NEW at the Peterborough facility for the 5-year dosimetry period (January 1, 2016-December 31, 2020) was 23.3 mSv, or approximately 23% of the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period. This is considerably lower than the previous maximum dose at the Peterborough site for the 2011-2015 5-year dosimetry period of 35.6 mSv.

Figure J-5 provides the average and maximum effective doses for NEWs at BWXT-NEC's Toronto facility between 2016 and 2020. The maximum effective dose received by a NEW in 2020 at the Toronto facility was 7.4 mSv, or approximately 15% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period.

Figure J-5: Effective dose statistics for NEWs, BWXT Toronto, 2016 –20



The maximum individual effective dose for a NEW at the Toronto facility for the 5-year dosimetry period (2016-2020) was 36.6 mSv, or approximately 37% of the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period. This is comparable and slightly lower than the previous maximum dose at the Toronto site for the 2011-2015 5-year dosimetry period of 39.1 mSv.

Annual average and maximum equivalent dose results for NEWs from 2016 to 2020 are also provided J-6 and J-7. In 2020, the maximum individual equivalent skin dose at the Peterborough facility was 19.01 mSv, while in Toronto, it was 39.10 mSv.

Table J-6: Equivalent (skin) dose statistics for NEWs, BWXT-NEC Peterborough Facility, 2016 –20

Dose Data	2016	2017	2018	2019	2020	Regulatory Limit
Average skin dose (mSv)	2.66	2.77	2.87	3.00	2.81	**N/A**
Maximum individual skin dose (mSv)	21.15	25.14	17.87	17.44	19.01	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Table J-7: Equivalent (skin) dose statistics for NEWs, BWXT-NEC Toronto, 2016 –20

Dose Data	2016	2017	2018	2019	2020	Regulatory Limit
Average skin Dose (mSv)	10.23	7.85	8.92	8.07	8.88	**N/A**
Maximum individual skin dose (mSv)	74.26	54.27	58.36	39.76	39.10	**500 mSv/year**

mSv = millisievert; N/A = not applicable

In 2020, the maximum individual equivalent extremity dose at the Peterborough facility was 43.17 mSv, while in Toronto, it was 115.52 mSv, which is approximately 9% and 21% respectively, of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period, as provided in tables J-8 and J-9 below.

Table J-8: Equivalent (extremity) dose statistics for NEWs, BWXT-NEC Peterborough, 2016 –20

Dose Data	2016	2017	2018	2019	2020	Regulatory Limit
Average extremity dose (mSv)	9.78	13.62	14.34	11.30	18.77	**N/A**
Maximum individual extremity dose (mSv)	32.84	43.18	46.06	29.41	43.17	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Table J-9: Equivalent (extremity) dose statistics for NEWs, BWXT-NEC Toronto, 2016 –20

Dose Data	2016	2017	2018	2019	2020	Regulatory Limit
Average extremity dose (mSv)	29.58	27.36	24.56	20.67	25.37	**N/A**
Maximum individual extremity dose (mSv)	119.47	115.07	83.33	79.67	115.52	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Across the 2 facilities, the maximum individual equivalent doses to the skin and the extremities were received by NEWs at the Toronto facility, and are approximately 8% and 23% (respectively) of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period. Over the past 5 years, average equivalent extremity and skin doses have been relatively stable at both facilities. The reason for the consistently lower skin and extremity doses at the Peterborough facility is the low likelihood of direct pellet handling by workers, as opposed to the Toronto facility, where this practice is routine. At the Peterborough facility, except in the end cap welding station, all pellets are shielded in zirconium tubes, bundles or boxes.

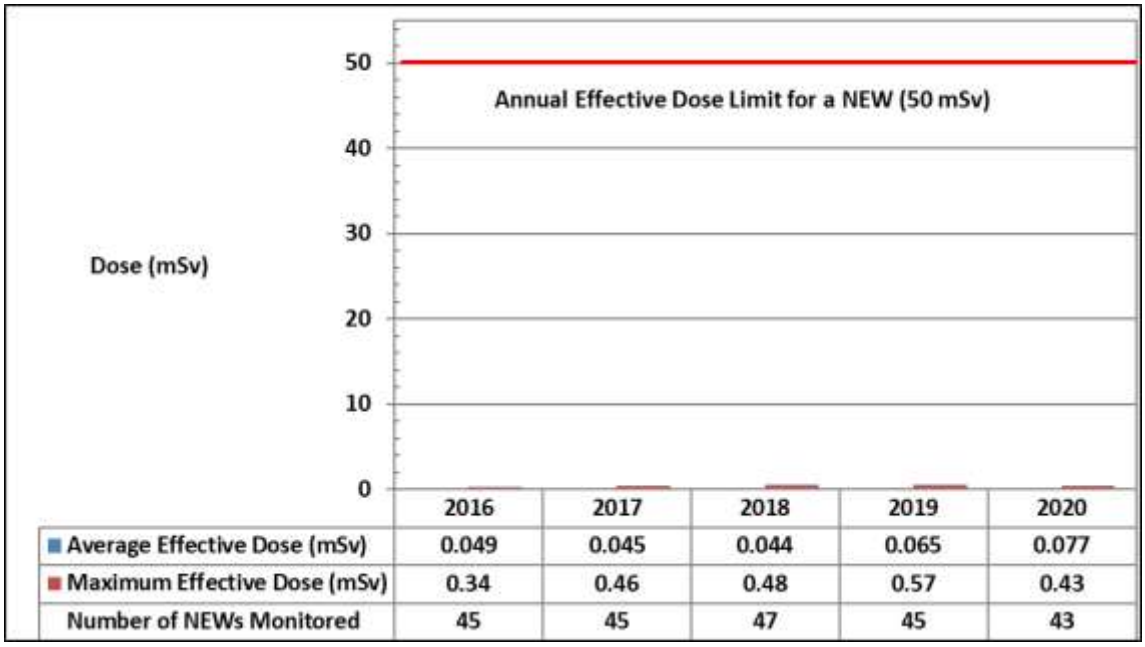
Non-NEWs at BWXT-NEC

For both the Peterborough and Toronto facilities, non-NEWs and contractors (which are all considered non-NEWs) are not directly monitored. Doses are estimated based on in-plant radiological conditions and occupancy factors, to ensure that radiation doses are controlled well below the CNSC's regulatory effective dose limit of 1 mSv per calendar year for a person who is not a NEW.

SRB Technologies (Canada) Inc.

Figure J-6 provides the average and maximum effective doses for NEWs at SRBT from 2016 to 2020. The maximum effective dose received by a NEW in 2020 was 0.43 mSv, approximately 1% of the CNSC regulatory effective dose limit of 50 mSv in a 1-year dosimetry period. There was an increase in average effective dose this year. This is attributed to an increase in expired exit sign processing that started in 2019 and continued into the first quarter of 2020. Noting the increase in the exposures, the licensee undertook a review and found that certain work practices were leading to an increased number of light source breakages. Corrective actions were implemented to enhance how light sources are handled in order to reduce worker exposures. These enhancements contributed to the lower maximum worker dose received in 2020.

Figure J-6: Effective dose statistics for NEWs, SRBT, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0.049	0.045	0.044	0.065	0.077
Maximum Effective Dose (mSv)	0.34	0.46	0.48	0.57	0.43
Number of NEWs Monitored	45	45	47	45	43

The maximum individual effective dose for a NEW at SRBT for the 5-year dosimetry period (2016-2020) was 2.20 mSv, or approximately 2.2 % of the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period.

Due to the uniform distribution of tritium in body tissues, equivalent skin doses are essentially the same as the effective whole-body dose and are therefore not reported separately. For this same reason, extremity doses are not separately monitored for workers at SRBT.

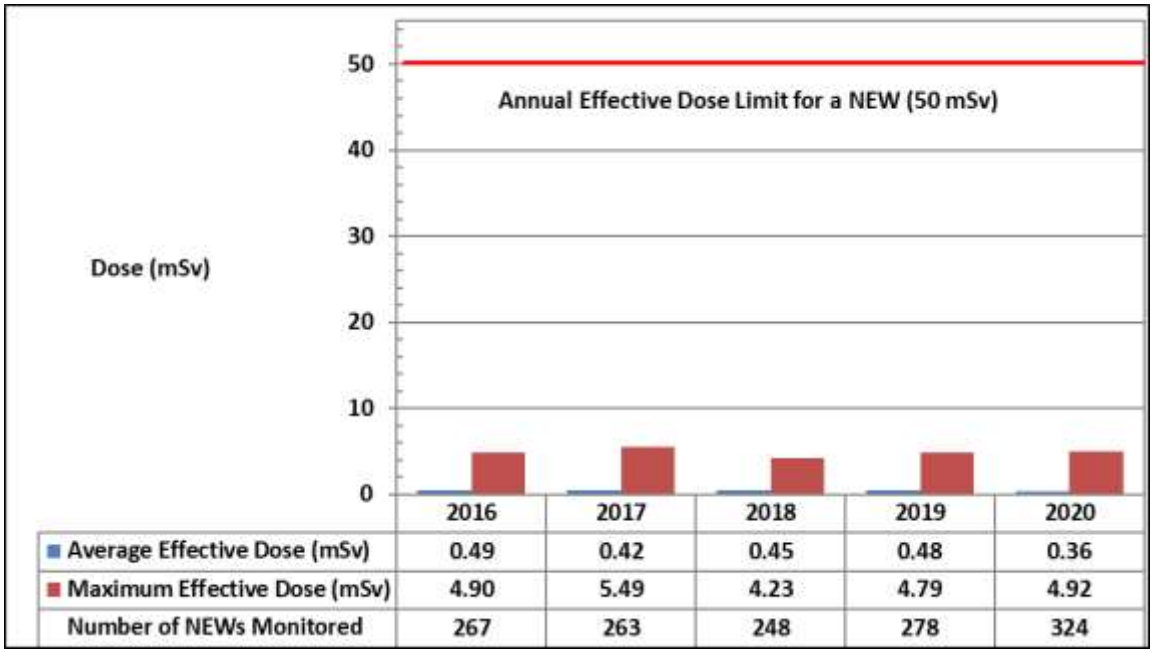
Non-NEWs at SRBT

While contractors are not generally identified as NEWs, since they do not perform radiological work, their radiological exposures are monitored while they are at the SRBT facility to ensure that their doses remain ALARA and below the CNSC regulatory dose limit of 1 mSv/year for a person who is not a NEW. In 2020, no contractors received a recordable dose that resulted from work activities performed at the facility.

Nordion (Canada) Inc.

Figure J-7 provides the average and maximum effective doses to NEWs at Nordion from 2016 to 2020. Nordion reported that the maximum effective dose received by a NEW in 2020 was 4.92 mSv, approximately 10% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period. Average and maximum effective doses have been relatively stable over these years.

Figure J-7: Effective dose statistics NEWs, Nordion, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0.49	0.42	0.45	0.48	0.36
Maximum Effective Dose (mSv)	4.90	5.49	4.23	4.79	4.92
Number of NEWs Monitored	267	263	248	278	324

The maximum individual effective dose for a NEW at Nordion for the 5-year dosimetry period (2016-2020) was 22.85 mSv, or approximately 23 % of the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period.

Tables J-10 and J-11 shows annual average and maximum equivalent (skin) and equivalent (extremity) dose results from 2016 to 2020. Nordion reported that the maximum equivalent skin dose for all NEWs monitored at Nordion in 2020 was 4.93 mSv, and that the maximum equivalent extremity dose for a worker in the active area was 16.48 mSv. These doses represent approximately 1% and 3% respectively of the CNSC's regulatory equivalent dose limits of 500 mSv in a 1-year dosimetry period.

Table J-10: Equivalent (skin) dose statistics for NEWs, Nordion, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average skin dose (mSv)	0.59	0.42	0.45	0.49	0.37	**N/A**
Maximum individual skin dose (mSv)	5.20	5.52	4.26	4.78	4.93	**500 mSv/year**

Table J-11: Equivalent (extremity) dose statistics for NEWs, Nordion, 2016 –20 [17]

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Average extremity dose (mSv)	0.79	0.53	0.96	1.14	0.93	**N/A**
Maximum individual extremity dose (mSv)	8.3	16.4	9.08	20.93	16.48	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Non-NEWs at Nordion

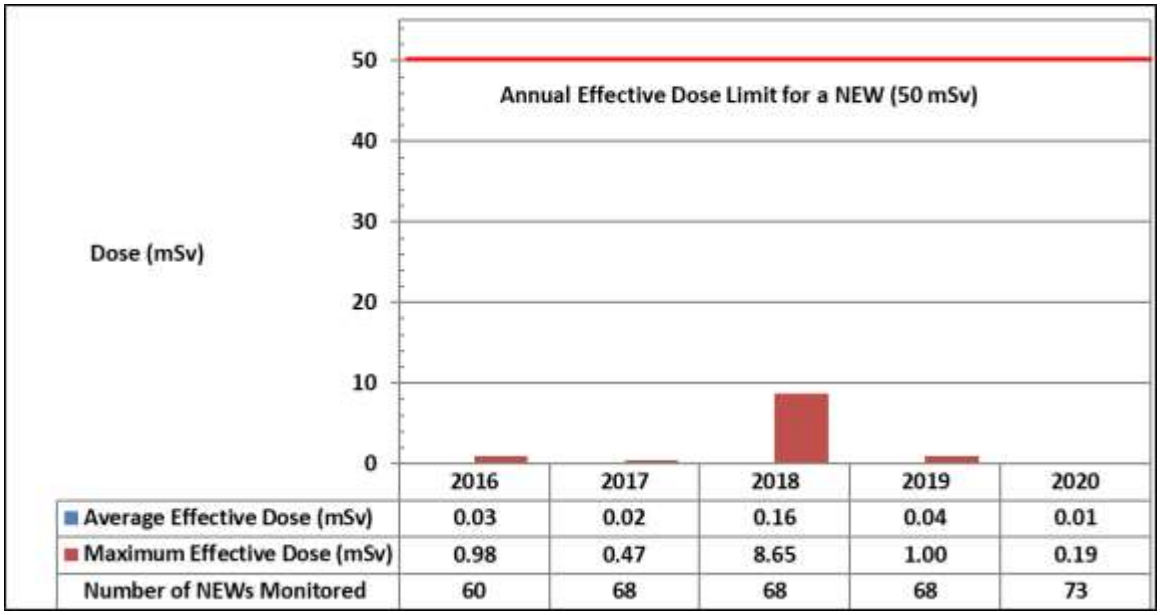
At Nordion, there may be occasions in which workers who are classified as non-NEWs enter the active area but do not perform any radiological work. Nordion monitors non-NEWs as required and provides relevant training to ensure that their doses are kept ALARA. In 2020, Nordion monitored 381 non-NEWs, which is an increase from previous years. The large increase of non-NEWs monitored is due to construction activities in the Medical Isotopes Facility. Nordion reported that the maximum effective dose received by a non-NEW was 0.29 mSv, which is well below the CNSC's regulatory effective dose limit of 1 mSv in a calendar year for a person who is not a NEW. The average effective dose for non-NEWs in 2020 was 0.01 mSv.

[17] Only the workers who routinely work in the active area are monitored for extremity dose.

Best Theratronics Ltd.

At BTL, employees are classified as NEWs if they are expected to have a reasonable probability of receiving an annual occupational dose greater than 1 millisievert (mSv). Figure J-8 provides the average and maximum effective doses for NEWs at BTL between 2016 and 2020. In 2020, the maximum effective dose received by a NEW at BTL was 0.19 mSv, or approximately 0.4% of the CNSC's regulatory effective dose limit of 50 mSv in a 1-year dosimetry period. Over the past 5 years, annual effective doses at BTL have remained stable and very low with slight variations due to production volumes.

Figure J-8: Effective dose statistics for NEWs, BTL, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0.03	0.02	0.16	0.04	0.01
Maximum Effective Dose (mSv)	0.98	0.47	8.65	1.00	0.19
Number of NEWs Monitored	60	68	68	68	73

The maximum individual effective dose for a NEW at BTL for the 5-year dosimetry period (2016-2020) was 8.65 mSv, or approximately 8.7% of the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period, all of which was accrued during the 2018 event mentioned above.

The higher than normal maximum effective and equivalent extremity doses in 2018 were due to an unplanned upset condition that resulted in an action level exceedance. Annual average and maximum equivalent extremity dose results from 2016 to 2020 are provided in Table J-12. The maximum equivalent extremity dose for 2020 was 2.4 mSv, which is approximately 0.5% of the CNSC's regulatory equivalent dose limit of 500 mSv. Over the past 5 years, average extremity equivalent doses have remained very low, between approximately 0 mSv and 2 mSv.

Table J-12: Equivalent (extremity) dose statistics for NEWs, BTL, 2016 –20

Dose Data	2016	2017	2018	2019	2020	Regulatory Limit
Average extremity dose (mSv)	0.09	0.07	1.41	0.22	0.15	**N/A**
Maximum individual extremity dose (mSv)	29.9	11.2	13.51	2.51	2.4	**500 mSv/year**

mSv = millisievert; N/A = not applicable

Although equivalent skin doses are ascertained; due to the nature of exposure, they are essentially equal to the effective dose and are not included in this report.

Non-NEWs at BTL

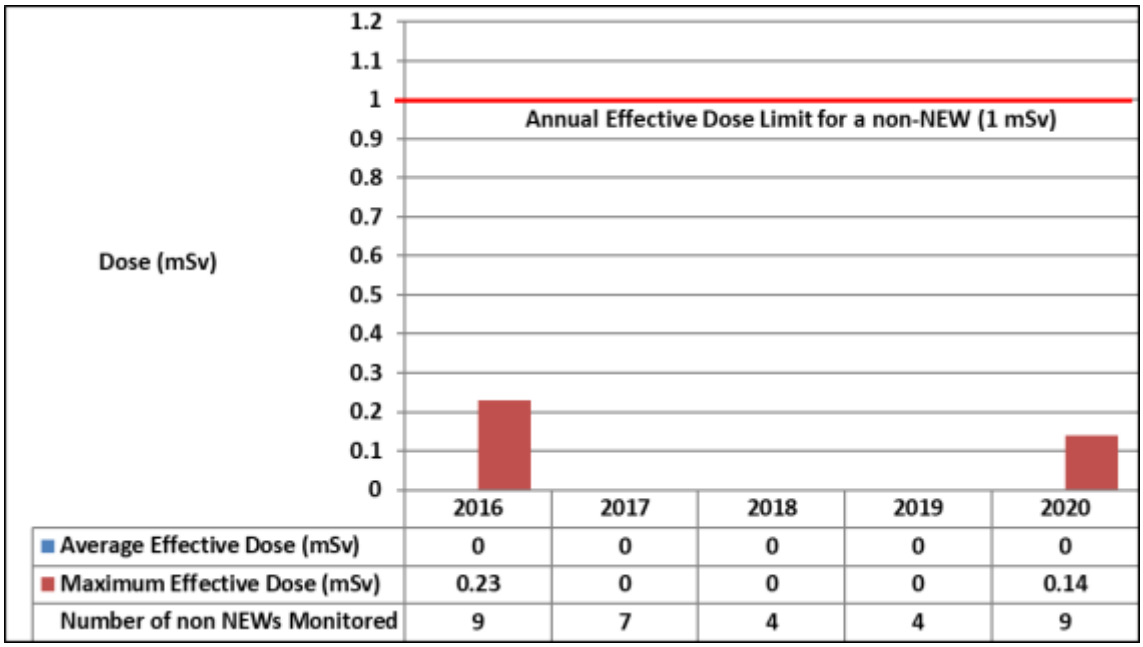
BTL workers identified as non-NEWs, such as administrative staff, are not permitted in controlled areas, and are therefore not occupationally exposed to radiation.

École Polytechnique de Montréal SLOWPOKE-2

ÉPM workers are exposed externally to sources of radiation. Due to the low potential for exposures, ÉPM workers are classified as non-NEWs and therefore the 5-year dosimetry period does not apply.

Figure J-9 provides the average and maximum effective doses received for non-NEWs at ÉPM between 2016-2020. From 2018-2020, the maximum annual effective dose received by a non-NEW at ÉPM was 0.14 mSv, or approximately 14% of the CNSC's regulatory annual effective dose limit of 1 mSv.

Figure J-9: Effective dose statistics for non-NEWs, ÉPM, 2016 –20

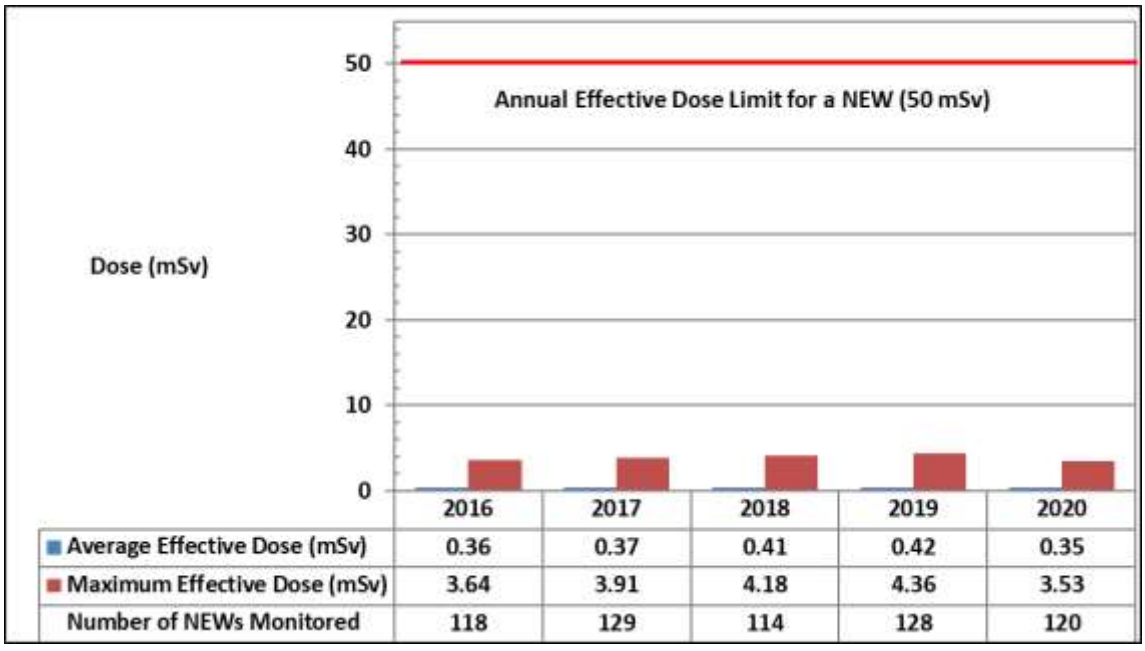


From 2018 to 2020, there were no action level exceedances at ÉPM. Over the past 5 years, annual effective doses at ÉPM have remained stable and very low.

McMaster Nuclear Reactor

Figure J-10 provides the average and maximum effective doses for NEWs at MNR between 2016 and 2020. From 2018-2020, MNR reported that no internal doses were recorded. Average and maximum effective doses over this 5-year period are reflective of the work activities at MNR, and are influenced by factors such as production levels and the scope of radiological work activities. The maximum effective dose, in each of the years from 2016 to 2020, was received by a NEW working as part of the NRay neutron radiography staff. All of the contribution to doses to NEWs working for NRay are from external sources.

Figure J-10: Effective dose statistics for NEWs, McMaster Nuclear Reactor, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0.36	0.37	0.41	0.42	0.35
Maximum Effective Dose (mSv)	3.64	3.91	4.18	4.36	3.53
Number of NEWs Monitored	118	129	114	128	120

For the 5-year dosimetry period, which began January 1, 2016, and concluded on December 31, 2020, the maximum cumulative effective dose received by a NEW at the MNR was 15.94 mSv, which is well below the CNSC's regulatory effective dose limit of 100 mSv in a 5-year dosimetry period.

Average and maximum equivalent dose results for the skin and extremities of NEWs, from 2016 to 2020, are provided in Tables J-13 and J-14. Between 2016 and 2020, the maximum individual skin dose received by a NEW at MNR was 11.75 mSv, which is approximately 2% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period.

The maximum individual extremity dose received by a NEW at MNR was 47.24 mSv, which is approximately 9% of the CNSC's regulatory equivalent dose limit of 500 mSv in a 1-year dosimetry period.

Table J-13: Equivalent (skin) dose statistics for NEWs, MNR, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory dose limit
Average extremity dose (mSv)	0.45	0.50	0.55	0.59	0.59	--
Maximum individual skin dose (mSv)	4.28	4.23	6.25	11.75	11.09	**500 mSv/year**

Table J-14: Equivalent (extremities) dose statistics for NEWs, MNR, 2016 –20

Dose data	2016	2017	2018	2019	2020	Regulatory dose limit
Average extremity dose (mSv)	6.90	6.21	5.84	6.86	4.78	--
Maximum individual extremity dose (mSv)	42.00	43.96	38.09	47.24	29.24	**500 mSv/year**

Non-NEWs at MNR

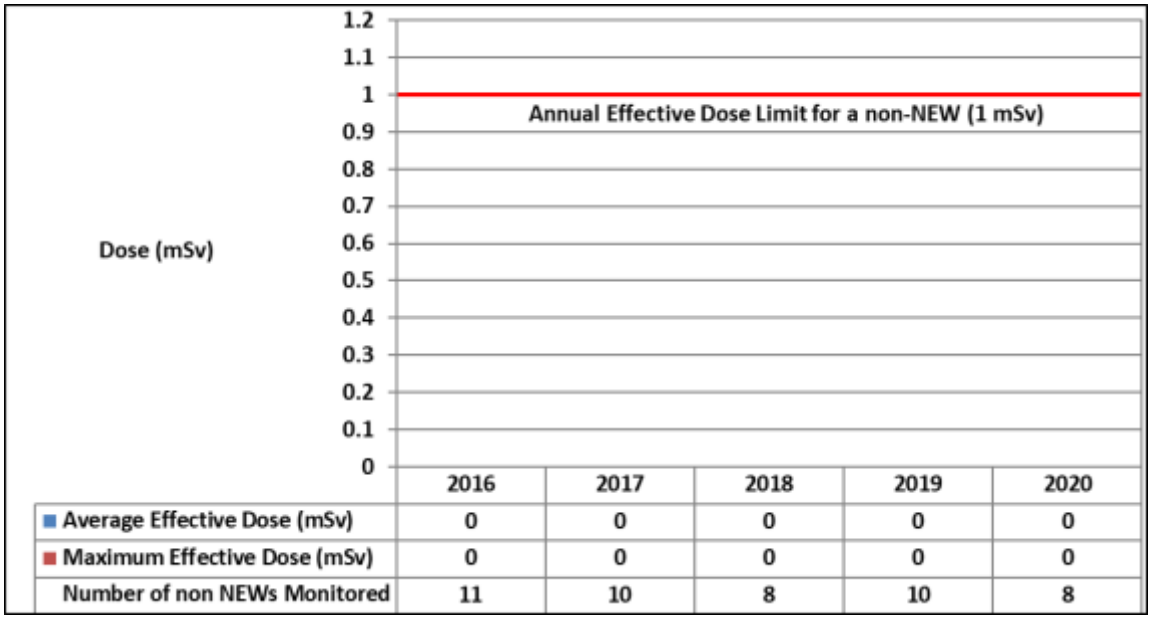
Site visitors and contractors that are not considered NEWs are issued electronic personal dosimeters to monitor their radiological exposures while at MNR. Between 2016 and 2020, the maximum individual effective dose received by a site visitor or contactor that was not a NEW was 0.017 mSv, which is well below the CNSC's regulatory effective dose limit of 1 mSv per calendar year for a person who is not a NEW.

Royal Military College of Canada SLOWPOKE-2

RMC workers are exposed externally to sources of radiation. No doses have been recorded for any NEW over the last 5 years, and therefore over the 5-year dosimetry period. Due to the low potential for exposures, doses to RMC workers are expected to be below 1 mSv and are therefore compared to the annual effective dose limit for a non-NEW (1 mSv). External whole body and equivalent doses are ascertained using licensed dosimeters.

No worker received a dose above the minimum reporting threshold for the dosimeter (i.e. less than 0.1 mSv). Figure J.11 provides the average and maximum effective doses received for NEWs at RMC between 2016-2020. From 2018-2020, the maximum annual effective dose received by a NEW at RMC was 0 mSv.

Figure J.11: Effective dose statistics for NEWs, RMC, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0	0	0	0	0
Maximum Effective Dose (mSv)	0	0	0	0	0
Number of non NEWs Monitored	11	10	8	10	8

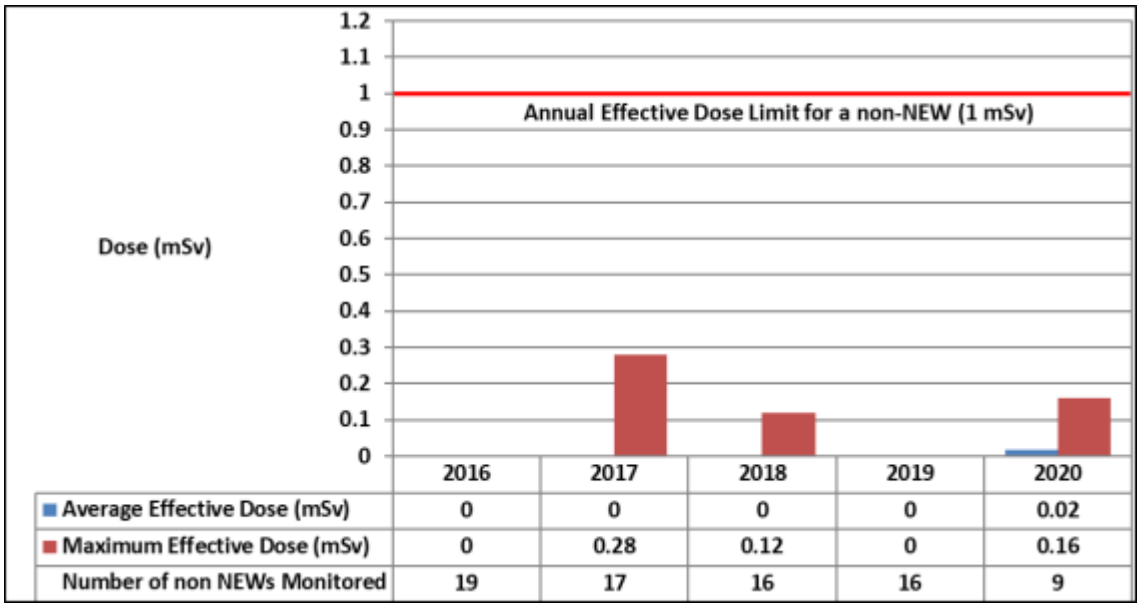
From 2018 to 2020, there were no action level exceedances at RMC. Over the past 5 years, annual effective doses at RMC have remained stable and very low.

Saskatchewan Research Council SLOWPOKE-2

Due to the low potential for exposures, SRC workers are classified as non-NEWs and therefore the 5-year dosimetry period does not apply. During the entire life of the facility, only on rare occasions have workers exceeded the reporting threshold of 0.1 mSv for the licensed dosimeters used at SRC.

Figure J-12 provides the average and maximum effective doses for non-NEWs at SRC between 2016 and 2020. From 2018 to 2020, the maximum annual effective dose received by a non-NEW at SRC was 0.16 mSv, or approximately 16% of the CNSC's regulatory annual effective dose limit of 1 mSv. This dose was received during decommissioning activities in 2020.

Figure J-12: Effective dose statistics for non-NEWs, SRC, 2016 –20



	2016	2017	2018	2019	2020
Average Effective Dose (mSv)	0	0	0	0	0.02
Maximum Effective Dose (mSv)	0	0.28	0.12	0	0.16
Number of non NEWs Monitored	19	17	16	16	9

From 2018 to 2020, there were no action level exceedances at SRC. Over the past 5 years, annual effective doses at SRC have remained stable and very low.

K. Health and Safety Data

Table K-1: Lost-time injury statistics, UNSPF and research reactors, 2016 –20

Facility	Statistic	2016	2017	2018	2019	2020
BRR	LTI[18]	0	0	0	0	0
	Severity Rate[19]	0	0	0	0	0
	Frequency Rate[20]	0	0	0	0	0
PHCF	LTI	4	1	2	0	0
	Severity Rate	2.40	1.67	7.58	0	0
	Frequency Rate	0.80	0.28	0.49	0	0
CFM	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0
BWXT-NEC	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0
SRBT	LTI	0	3	0	0	0
	Severity Rate	0	17.7	0	0	0
	Frequency Rate	0	7.6	0	0	0
Nordion	LTI	3	1	0	2	0
	Severity Rate	70.04	5.61	0	4.15	0
	Frequency Rate	2.32	0.93	0	0.69	0
BTL	LTI	3	1	2	2	0
	Severity Rate	37.61	15.00	8.21	5.47	0

[18] An LTI is an injury that takes place at work and results in the worker being unable to return to work for a period of time

[19] The accident severity rate measures the total number of days lost to injury for every 200,000 person-hours worked at the site. Severity = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[20] The accident frequency rate measuring the number of LTIs for every 200,000 person-hours worked at the site. Frequency = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

Facility	Statistic	2016	2017	2018	2019	2020
	Frequency Rate	2.05	0.68	1.37	1.37	0
ÉPM	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0
MNR	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0
RMC	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0
SRC	LTI	0	0	0	0	0
	Severity Rate	0	0	0	0	0
	Frequency Rate	0	0	0	0	0

L. Reportable Events

FACILITY	NUMBER OF EVENTS
BRR	3
PHCF	8
CFM	1
BWXT-NEC Toronto	0
BWXT-NEC Peterborough	1
SRBT	0
Nordion	10
BTL	1
ÉPM	1
MNR	1
RMC	0
SRC	0
TOTAL	**26**

M. List of identified Indigenous groups with an interest in uranium and nuclear substance processing facilities

Blind River area (BRR)

- Mississauga First Nation;
- Sagamok Anishnawbek Nation;
- Serpent River First Nation;
- Thessalon First Nation; and
- Métis Nation of Ontario (Region 4).

Facilities in Port Hope, Toronto and Peterborough areas (PHCF, CFM, and BWXT-NEC facilities in Toronto and Peterborough)

- Williams Treaties First Nations, which include Alderville First Nation, Curve Lake First Nation, Hiawatha First Nation, the Mississaugas of Scugog Island First Nation, the Chippewas of Beausoleil First Nation, the Chippewas of Georgina Island First Nation and the Chippewas of Rama First Nation;
- Mississaugas of the Credit First Nation;
- Métis Nation of Ontario (Region 6 and 8); and
- Mohawks of the Bay of Quinte.

Ottawa Valley facilities (SRBT, Nordion, and BTL)

- Algonquins of Ontario;
- Algonquins of Pikwàkanagàn First Nation;
- Kitigan Zibi Anishinabeg;
- Algonquin Anishinabeg Nation Tribal Council;
- Kebaowek First Nation;
- Métis Nation of Ontario (Regions 5 and 6); and
- Mohawks of the Bay of Quinte.

N. Participant funding recipients for the 2020 UNSPF and research reactors regulatory oversight report

Recipient
Curve Lake First Nation
Algonquins of Ontario

Further information on the CNSC's participant funding program can be found on the CNSC's website at:

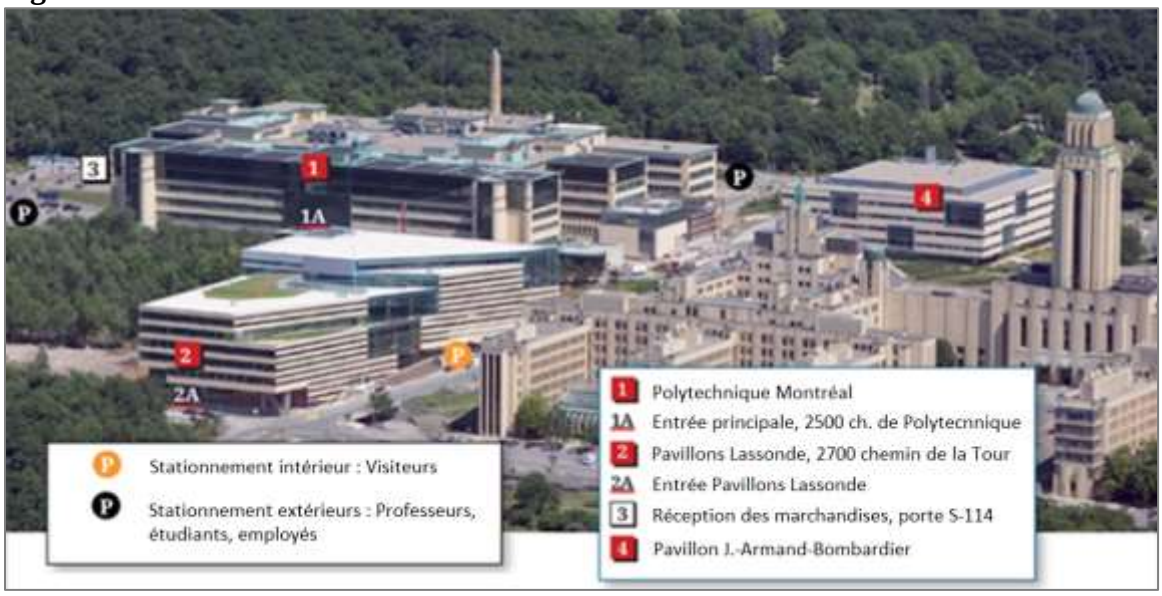
http://www.nuclearsafety.gc.ca/eng/the-commission/participant-funding-program/index.cfm

O. Réacteur SLOWPOKE-2 de l'École Polytechnique de Montréal

L'École Polytechnique de Montréal (EPM) exploite un réacteur SLOWPOKE-2 à Montréal (Québec) aux termes d'un permis délivré en 2016 par la CCSN pour une période de sept ans. Le réacteur a été mis en service en 1976 et son combustible a été remplacé en 1997 par du combustible à l'uranium faiblement enrichi. L'EPM s'attend à exploiter le réacteur jusqu'en 2032. Le réacteur est utilisé pour des travaux de recherche, l'analyse des neutrons, l'enseignement et la production d'isotopes. Le campus de l'EPM est présenté à la figure 4-2.

L'installation SLOWPOKE-2 de l'EPM comprend un assemblage sous-critique situé dans une salle à côté du réacteur. L'assemblage se compose de barres d'uranium naturel et de sources de neutrons qui sont insérées manuellement dans des blocs de graphite. L'assemblage sous-critique a été utilisé dans le passé à des fins d'enseignement et de recherche. Cependant, il n'est plus utilisé depuis 2012.

Figure O-1: Vue aérienne de l'EPM



Le personnel de la CCSN a réalisé 2 inspections à l'EPM de 2018 à 2020 qui ont porté sur dix DSR. Le tableau B-8 de l'annexe B énumère ces inspections, et les 4 ANC qui en ont résulté sont présentés à la section 6 du présent CMD.

Le personnel de la CCSN estime que l'EPM a exploité son réacteur de recherche de manière sûre au cours de la période de 2018 à 2020 et conformément à son fondement d'autorisation. Aucun problème ou événement opérationnel n'a été signalé au cours de la période de 2018 à 2020.

Le personnel de la CCSN sera prêt à recevoir la demande de l'EPM pour un permis d'exploitation du réacteur SLOWPOKE-2 en 2022, car le permis doit être renouvelé en juillet 2023.