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Regulatory Oversight Report
**Regulatory Oversight
Report for Research
Reactors and Class IB
Accelerators: 2016 – 2017**

Rapport de surveillance réglementaire
**Rapport de surveillance
réglementaire pour les
réacteurs de recherche
et accélérateurs de
catégorie 1B : 2016 – 2017**

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Summary

This Commission Member Document (CMD) constitutes the Regulatory Oversight Report for Research Reactors and Class IB Accelerators for the 2016 and 2017 calendar years. The Report presents information on licensees' safety performance and regulatory compliance.

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

Résumé

Ce document à l'intention des commissaires constitue le Rapport de surveillance réglementaire des réacteurs de recherche et des accélérateurs de catégorie 1B pour les années 2016 et 2017. Ce rapport présente des renseignements sur le rendement des titulaires de permis en matière de sûreté et de conformité réglementaire.

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

Signed/signé le

May 18, 2018



Haidy Tadros

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice générale de la

Direction de la réglementation du cycle et des installations nucléaires

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EXECUTIVE SUMMARY

This Regulatory Oversight Report (ROR) presents the safety performance of licensees that operate small research reactors and Class IB accelerators operating in Canada. The last report on these facilities was presented to the Commission on November 9, 2016, covering the 2015 calendar year. This ROR covers licensee performance for the 2016 and 2017 calendar years.

This ROR provides a performance assessment of the facilities licensed by the CNSC against the 14 safety and control areas (SCA), with a specific focus on radiation protection, environmental protection and conventional health and safety. These three SCAs together provide a good overall indication of the safety performance for the facilities discussed in this report. The report also presents information on CNSC compliance efforts spent toward each facility, topics of public interest, reportable events and any significant facility modifications over the reporting period. Future developments for licensees, and areas of particular regulatory focus for the CNSC, are also presented.

CNSC staff conclude that the research reactors and Class IB accelerators have performed satisfactorily, and continue to make adequate provision to protect the health, safety and security of workers, Canadians and the environment. There were no regulatory dose limits exceeded for either the public or the workers at any of these facilities, and releases to the environments remained well below authorized limits. These facilities operated in compliance with Canada's international obligations on the peaceful use of nuclear energy.

Referenced documents in this CMD are available to the public upon request.

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1 OVERVIEW

1.1 Background

This Regulatory Oversight Report presents Canadian Nuclear Safety Commission (CNSC) staff's assessment of the safety performance of licensees operating research reactors and Class IB accelerators in Canada. Specifically, the ROR covers the following facilities:

- Research Reactors
 - McMaster Nuclear Reactor
 - Royal Military College of Canada SLOWPOKE-2
 - Saskatchewan Research Council SLOWPOKE-2
 - University of Alberta SLOWPOKE-2
 - École Polytechnique de Montréal SLOWPOKE-2
- Class IB Accelerators
 - Canadian Light Source Inc.
 - TRIUMF

This ROR does not include the NRU and ZED-2 research reactors operated by the Canadian Nuclear Laboratories (CNL) at the Chalk River Laboratories (CRL). These facilities were assessed as part of the CRL licence renewal hearing of January 23-25, 2018, and will be covered by a ROR planned for 2019.

The report provides a summary on performance in all 14 SCAs, with a particular focus on radiation protection, environmental protection, and conventional health and safety. These three SCAs provide an adequate representation of the safety performance for the facilities discussed in this report.

The report also highlights the areas of CNSC staff's regulatory compliance efforts, and discusses any significant events, licence changes, major developments and matters of public interest.

The last ROR on research reactors and Class IB accelerators covered the 2015 calendar year and was presented to the Commission on November 9, 2016, in CMD 16-M43. This current ROR covers the 2016 and 2017 calendar years, and includes 5-year trends where relevant.

1.2 Regulatory Compliance Framework

The CNSC regulates the nuclear sector in Canada, including nuclear research reactors and Class IB accelerator facilities in order to:

- protect the health, safety and security of Canadians and the environment; and
- implement Canada's international commitments on the peaceful use of nuclear energy

It is also CNSC's mandate to disseminate objective scientific, technical and regulatory information to the public about the nuclear industry in Canada. This ROR is one of several methods used by the CNSC to disseminate information about its regulatory activities and the nuclear industry.

The CNSC regulates nuclear facilities based on the provisions of the *Nuclear Safety and Control Act* (NSCA), the regulations under the NSCA, the licences and licensee documentation. CNSC staff apply a risk-informed approach for compliance activities, commensurate with the risk associated with these facilities, and may apply enforcement actions as required. CNSC staff establish compliance verification plans for each facility, taking into consideration the overall risk profile of the facility, specific risk factors associated with any activity, facility performance, modifications, and operating experience. For each facility, CNSC staff conduct onsite inspections, assessments, document reviews and evaluations of licensee programs and safety performance reports. Performance of the licensee is assessed and rated against the 14 SCAs.

While all SCAs are assessed on an ongoing basis, CNSC inspectors strive to ensure that aspects of radiation protection, environmental protection, and conventional health and safety are covered specifically in every inspection. This ensures that:

- licensees' radiation protection programs remain effective and radiation doses to workers remain as low as reasonably achievable (ALARA)
- licensees' environmental protection programs are effective at all time and environmental releases remain ALARA
- licensees' conventional health and safety programs continue to protect workers from injuries/accidents

CNSC staff also verify compliance through desktop reviews of annual reports, program documents and other correspondence, supplemented with meetings and facility visits. A breakdown of the number of inspections is provided in each respective section (research reactors, Class IB accelerators) of this ROR.

1.3 Ratings and Performance

The CNSC uses the SCA framework in evaluating each licensee's safety performance. The framework includes 14 SCAs, and each SCA is sub-divided into specific areas that define its key components. The SCA framework is described in Appendix A.

CNSC staff assess licensee performance in each applicable SCA according to the following four ratings:

- FS: Fully Satisfactory
- SA: Satisfactory
- BE: Below Expectations
- UA: Unacceptable

A full definition of the four ratings is provided in Appendix B, *Rating Methodology and Definitions*.

Over the 2016 – 2017 calendar years, all research reactor facilities and Class IB accelerators were rated against all 14 SCAs. These ratings are used as an indicator of performance and potential areas requiring attention from the licensee and CNSC staff. Compliance oversight plans are developed by CNSC staff, taking into consideration a number of factors, including these ratings. Typically, a facility performing below the Satisfactory level in any of the SCAs will receive increased oversight by CNSC staff until the situation is remedied.

The ratings for each facility are presented under Section 2.3 for research reactors and Section 3.3 for Class IB accelerators.

2 RESEARCH REACTORS

2.1 Overview

This section of the ROR discusses CNSC's regulatory oversight and licensee performance of the small research reactors in Canada. These facilities are:

- McMaster Nuclear Reactor (MNR) located at McMaster University in Hamilton, ON
- Four SLOWPOKE-2 reactors located at:
 - University of Alberta (U of A) in Edmonton, AB
 - Saskatchewan Research Council (SRC) in Saskatoon, SK
 - Royal Military College of Canada (RMCC) in Kingston, ON
 - École Polytechnique de Montréal (ÉPM) in Montréal, QC

These small research reactors are designed to operate at low power, ranging from 0.02 MW for the SLOWPOKE-2 reactors to 5 MW for the McMaster Nuclear Reactor (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. The SLOWPOKE-2 reactors are sealed container-in-pool designs. The reactor core is housed in a closed container suspended in a pool of water, which acts as a neutron reflector, heat sink and shield against radiation.

The SLOWPOKE-2 reactors are cooled and moderated by light water, and fueled with either highly enriched uranium (HEU) in the case of University of Alberta and Saskatchewan Research Council, or low-enriched uranium (LEU) for Royal Military College of Canada and École Polytechnique de Montréal. Figure 2-1 shows a model of a SLOWPOKE-2 reactor core.

FIGURE 2-1: MODEL OF THE SLOWPOKE-2 REACTOR CORE



MNR is a pool-type reactor using light water to moderate and cool the LEU fuel. The live core can be observed safely from the top of the pool without any special protection. While relatively larger and more complex, MNR is one of many similar pool reactors operated around the world. They are known for their safe, robust design and flexible operating capability. The pool is divided in two sections, one for the reactor itself and the other is used to store spent fuel. The two sections can be isolated through the insertion of a gate, and the reactor core can be moved to the other section if needed.

MNR is an important producer of Iodine-125, used in cancer treatment. Figure 2-2 shows the McMaster Nuclear Reactor in operation.

FIGURE 2-2: OVERHEAD VIEW OF MCMASTER NUCLEAR REACTOR



The small nuclear research reactors 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 $\mu\text{Sv}/\text{year}$, 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 among nuclear facilities in Canada.

The small research reactors 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 2-3 shows the location of small research reactor facilities in Canada.

FIGURE 2-3: LOCATION OF RESEARCH REACTORS IN CANADA



Note: Subcritical assembly is included under the École Polytechnique SLOWPOKE-2 reactor licence, and the two facilities are in the same location on the campus of Université de Montréal.

2.2 Highlights at Research Reactor Facilities

The following subsections provide information of public and regulatory interest specific to each research reactor facility, including significant events, changes in facility program, future projects or any other development.

2.2.1 McMaster University

McMaster University operates the McMaster Nuclear Reactor (MNR) under licence NPROL-01.00/2024 [1] which was issued by the CNSC on June 26, 2014 for a period of 10 years.

MNR is a 5 MW research reactor located on the campus of McMaster University in Hamilton. This pool-type reactor uses Low-Enriched-Uranium (LEU) as fuel, and the reactor has the added safety feature of a full containment building. MNR has been in operation since 1959 and is used for research, materials testing, teaching, and isotope production. The reactor is an important producer of the isotope Iodine-125 (I-125) for medical use in Canada, the U.S. and other countries. MNR is also used for neutron radiography, which is performed on a daily basis for testing of aircraft engine components. In addition to supporting research work of McMaster University students at the Bachelor, Master and Doctoral levels in physics and engineering, MNR is also used for the irradiation of over 10,000 mineral and other samples per year for various applications such as biomedical research, material science and geological surveys. Figure 2-4 shows an outside view of MNR and its containment building.

FIGURE 2-4: MCMASTER NUCLEAR REACTOR



During 2016 – 2017, MNR’s performance was rated as Satisfactory in all SCAs, and Fully Satisfactory for Security. MNR maintains a strong security culture and provides an effective program to control access to facilities, nuclear material, and prescribed/classified information. MNR hosted an International Physical Protection Advisory Service (IPPAS) mission in 2015. IPPAS was created by the International Atomic Energy Agency (IAEA) to assist member states in strengthening their national nuclear security regime. IPPAS provides peer review and recommendations on implementing international instruments and IAEA guidance on the protection of nuclear and other radioactive material and associated facilities. Suggestions from the IPPAS mission related to access control, alarm monitoring and security culture at MNR were quickly addressed and closed. MNR continues to maintain a security program that meets the *Nuclear Security Regulations*.

In addition to annual security and nuclear materials accounting inspections, CNSC staff conducted two inspections over the review period. The facility was found in compliance with its licence, the regulations and internal documentation. Two recommendations were made in the area of training documents:

- Alignment of Training Documents with supplemental training requirements of the LCH
- Ensuring that the annual training goals and objectives identified in the Preliminary Decommissioning Plan are documented, and training activities recorded

CNSC staff also participated in McMaster University’s annual reviews of Emergency Management procedures in March 2016 and December 2017, which involves stakeholders and first responders from the Hamilton community, including Police and Fire services.

Annual Maintenance

The MNR reactor undergoes annual maintenance generally in December each year. During the 2016 and 2017 outages, McMaster University inspected primary system piping and secondary tubes of the heat exchangers, with no abnormal degradation observed. McMaster also performed the annual containment building leakage rate tests, which confirmed that the containment building continues to meet its design specifications and is fit for service. Over the review period, quarterly safety system tests were performed successfully, ensuring the continued reliability of MNR’s safety system. MNR staff inspected the reactor pool and no abnormal degradation was detected. Information on annual maintenance is provided to the CNSC in annual reports which are reviewed by CNSC staff. The information is also verified during compliance inspections.

Operations

The MNR reactor is an important producer of Iodine-125 worldwide, and has played an increasingly important role with NRU's progressive retirement and shutdown in March 2018. Other factors such as availability of other producers around the world have had an impact on demand for I-125 as well. From a normal operating regime of Monday to Friday, 8:00 to 22:00, MNR increased production to 24 hours a day, 5 days a week over some periods of time during 2017 to meet the demand for I-125. While these adjustments in resources and logistics have been temporary, CNSC staff have followed up closely with McMaster University to ensure that the increased production did not compromise the safety of the personnel, the public and the environment. The increased production rate had no measurable impact on radiological exposure or on the environment. However, it prompted some equipment upgrades, notably the gloveboxes used in the processing of I-125 which will remain beneficial for the facility. MNR has since returned to a normal operating regime but remains able to increase its operating cycle and adjust to demands as needed.

Events

McMaster University reported two events during 2016 – 2017:

- The first event occurred on July 7, 2016 and involved a fire at a McMaster University service building in the vicinity of the reactor building. The reactor was not affected by the fire. As a precautionary measure, MNR staff shut down the reactor through the duration of the event. The event was reported under the LCH clause: *“Any situation or event that has the potential to generate media or public concerns or inquiries.”* McMaster University was able to resume normal operations within the following week.
- The second event took place on July 4, 2017 when MNR was started up with the Fission Products Monitor (FPM) offline for approximately 10 minutes. The FPM allows for early detection of fission products from the reactor core should there be a fuel failure. Upon detection of fission products in the water, the FPM shuts down the reactor automatically. There were no consequences associated with this event; however, it was a contravention to the MNR Operating Limits and Conditions, which state that the FPM must be available and functional when MNR is operating.

A root cause analysis was performed for this event, which identified issues with the use of checklists, communications, training and assignment of responsibilities.

Corrective actions were implemented, which included revision to checklists, verification and confirmation steps, revision to staff training and assignment of responsibilities.

These two events were reportable to the CNSC under the MNR licence; however, they were not presented to the Commission as *Event Initial Reports* (EIR) given that there was no significant risk to the public, the workers, to security or to the environment. CNSC staff verified that the events were investigated for root causes and corrective actions were identified. CNSC staff verified that the corrective actions were implemented satisfactorily during an inspection in December 2017.

Projects

Design and preliminary construction work have progressed toward the installation of the new McMaster Intense Positron Beam Facility (MIPBF) and the Small Angle Neutron Scattering (SANS) facilities, for which grants were awarded from the Canadian Foundation for Innovation (CFI). These facilities are installed inside the reactor building and consist of highly specialized equipment that use the existing beam ports located around the core. McMaster University will complete the commissioning of these new experimental facilities between 2018 and 2019. These facilities are authorized by the Commission under the current licensing basis. CNSC staff are monitoring the progress and reviewing the safety documents associated with these new facilities as they become available.

2.2.2 Royal Military College of Canada

The Royal Military College of Canada (RMCC) operates the SLOWPOKE-2 facility under licence NPROL-20.00/2023 [2], which was issued by the CNSC in 2013 for a period of 10 years.

This facility is located within the RMCC complex in Kingston, Ontario. Figure 2-5 shows an aerial view of the RMCC complex. The facility comprises the reactor room, with the reactor located in a steel-lined concrete well, a control room on the first floor and laboratories on the first and second floors of the Sawyer Science and Engineering Building, Module 5.

FIGURE 2-5: ROYAL MILITARY COLLEGE SLOWPOKE-2 FACILITY



The RMCC SLOWPOKE-2 facility is used for neutron activation analysis, analysis of fissile materials, neutron radiography, and education in radiation protection and programs at the postgraduate level. The reactor has been in operation since 1985. The core is fueled with Low-Enriched Uranium (LEU).

During 2016 – 2017, RMCC did not report any operational challenges. CNSC staff conducted two inspections and there were no non-compliances identified. CNSC staff's review of records showed that the facility performed scheduled routine inspections and maintenance activities to ensure that the structures, systems and components (SSC) remain effective over time and continue to effectively fulfill their intended purpose.

Depending on the use of the reactor, the fuel in a SLOWPOKE-2 reactor can last over 30 years. In November 2017, after 32 years of operation, the Royal Military College of Canada announced their intention to refuel the SLOWPOKE-2 reactor, with a target completion date of December 2021. Although refueling is covered under the operating licence, the complexity of project will increase the demand for compliance verification by CNSC staff. The project involves the removal of the fuel core into a specially designed container certified by the CNSC, shipment of the spent fuel to a licensed waste management facility, installation of the new core and adjustment of the reactivity through the insertion of beryllium shims. These operations are performed by highly skilled personnel certified by the CNSC, which includes the Reactor Operator, the Reactor Engineer and the Reactor Technician.

2.2.3 University of Alberta

The University of Alberta SLOWPOKE-2 reactor was located on the campus of the University of Alberta in Edmonton, Alberta, and was in operation between 1977 and 2017. The SLOWPOKE-2 facility was used for neutron activation analysis, isotope production and teaching and research programs of the University's departments and affiliated teaching hospitals. The core was fueled with Highly Enriched Uranium (HEU). Figure 2-6 shows an aerial view of the Dentistry/Pharmacy Building where the SLOWPOKE-2 reactor was located.

FIGURE 2-6: UNIVERSITY OF ALBERTA SLOWPOKE-2 FACILITY

During 2016 – 2017, University of Alberta operated the facility safely and did not report any operational challenges.

In December 2016, University of Alberta made a decision to cease operation of the SLOWPOKE-2 reactor and applied for a licence amendment to authorize the decommissioning and dismantling of the facility. CNSC staff reviewed the detailed decommissioning plan and recommended to the Commission to issue the amendment, in accordance with regulatory requirements. The amendment was granted in a decision of the Commission on September 22, 2017 and licence NPROL-18.01/2023 [3] was issued for the period ending on June 23, 2013.

During 2017, the reactor was defueled and the HEU core was repatriated to the United States in accordance with the April 2010 agreement between Canadian Prime Minister Harper and United States President Obama to return spent HEU fuel to the U.S. This is part of a broader international effort to consolidate HEU inventories in fewer locations around the world. This commitment promotes non-proliferation by removing existing weapons-grade material from Canada and eliminates a nuclear liability for future generations of Canadians. Once these inventories are returned to the U.S., they are to be reprocessed and used in American nuclear power plants to produce energy.

CNSC conducted an inspection of the facility in October 2017 and verified completion of the decommissioning activities, including the radiological surveys performed by the licensee. No surface contamination was found and radiological conditions were consistent with normal background levels detectable by the instrument. The reactor well was then backfilled with concrete. The rooms housing the facility can be repurposed for any non-nuclear activities without any restrictions.

University of Alberta submitted an end-state report to the CNSC and requested a licence to abandon the facility. This decision is pending a Commission hearing scheduled for May 2018.

2.2.4 Saskatchewan Research Council

Saskatchewan Research Council (SRC) operates the SLOWPOKE-2 facility under licence NPROL-19.00/2023 [4], which was issued by the CNSC in 2013 for a period of 10 years.

The Saskatchewan Research Council (SRC) SLOWPOKE-2 facility is located within SRC's Environmental Analytical Laboratories in Saskatoon, Saskatchewan, as shown in figure 2-7. The facility consists of a reactor room, a laboratory and a waste storage room. The facility is used for neutron activation analysis, delayed neutron analysis and teaching in conjunction with the University of Saskatchewan. The reactor has been in operation since 1981. The core is fueled with Highly Enriched Uranium (HEU).

FIGURE 2-7: SASKATCHEWAN RESEARCH COUNCIL SLOWPOKE-2 FACILITY



During 2016 – 2017, SRC operated the facility safely and did not report any operational challenges. CNSC conducted two inspections and did not identify any non-compliances or compliance actions.

In December 2017, SRC announced their intention to the CNSC to cease operation of the SLOWPOKE-2 reactor and decommission the facility. SRC plans to repatriate the HEU core to the United States following the same international agreement that University of Alberta used to repatriate their reactor core.

SRC indicated that they will apply for a licence amendment in 2018 or 2019 to authorize decommissioning of the facility. Subject to Commission approval, and after the decommissioning process is completed, the operating licence would then be revoked. A licence to abandon a nuclear facility would be issued once the facility has achieved the end state as described in the decommissioning plan and once it is confirmed that no radiological hazards remain in the facility. CNSC staff will continue to implement regulatory oversight activities during decommissioning, ensuring the safety of the public, the workers and the environment are maintained during this project.

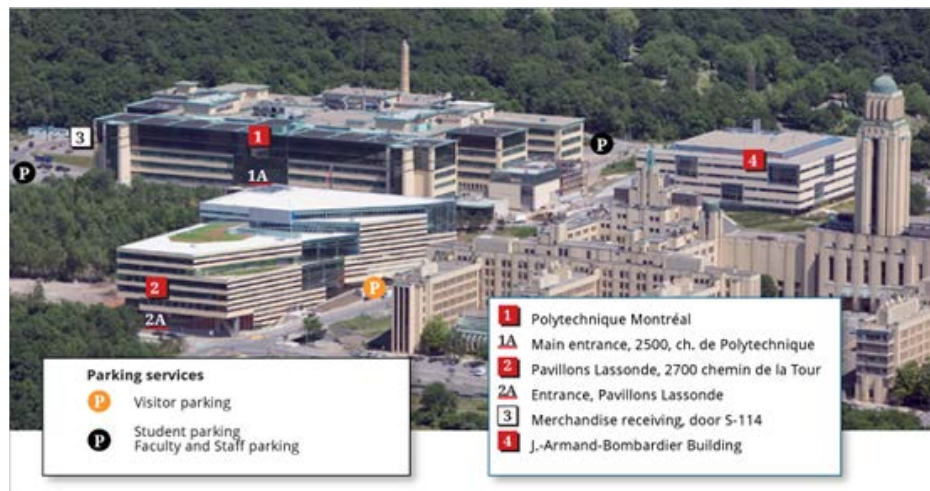
2.2.5 École Polytechnique de Montreal

La version française est incluse à l'annexe G.

École Polytechnique (ÉPM) operates the SLOWPOKE-2 facility under licence PERFP-9A.01/2023 [5], which was issued by the CNSC in 2016 for a period of 7 years.

The École Polytechnique (ÉPM) SLOWPOKE-2 facility is located on the campus of the Université de Montréal, in Montréal, Quebec, as shown on figure 2-8. The reactor is used for research, teaching, neutron analysis and isotope production and has been in operation since 1976. The reactor core is fueled with LEU.

FIGURE 2-8: ÉCOLE POLYTECHNIQUE DE MONTRÉAL



During 2016 – 2017, the ÉPM SLOWPOKE-2 reactor was operated safely and reliably, and no operational issues were reported.

In December 2017, CNSC staff conducted a compliance inspection covering 10 SCAs as well as other general requirements under the operating licence, such as the public information and disclosure program. Four action notices related to the management system and public information program were raised and are being followed up until completion. Specifically:

- ÉPM must complete the web page in support of the public information program
- ÉPM must conduct audits at yearly intervals, in accordance with its management system
- ÉPM must complete its revision of procedures, as stated in correspondence with CNSC staff
- ÉPM must update its list of sealed sources to include three sources from the subcritical assembly

École Polytechnique also operates a Subcritical Assembly, located in a room next to the SLOWPOKE-2 reactor. The assembly consists of natural uranium bars and neutron sources that are manually inserted into graphite blocks. The Subcritical Assembly is used only for teaching and research purposes. When the assembly is inactive, the uranium bars are returned to a locked shielded storage box, and the neutron sources are stored and locked in shielded containers.

The Subcritical Assembly had been covered under a separate licence; however, in an effort to improve regulatory efficiency and to consolidate licences, ÉPM requested the amendment of their non-power reactor operating licence PERFP-9A.00/2023 to include the operation of the Subcritical Assembly. This request was approved by the Commission on June 30, 2016 and the operation of the Subcritical Assembly is now covered under the consolidated SLOWPOKE-2 operating licence PERFP-9A.01/2023 [5]. The Subcritical Assembly is seldom used, the last operation going back to 2012. ÉPM has not formally indicated any future projects or changes for the facility.

2.3 Performance Ratings

The following Table 2-1 provides the performance ratings for the research reactors for all SCAs during 2016 – 2017. SCA ratings in the RORs are approved by the regulatory program Director and by the Director of the specialist division primarily responsible for the respective safety and control area. These ratings are reviewed on an annual basis and are used to identify areas of challenge and high performance. Rating results are used in the planning of compliance oversight. These ratings have not changed between 2016 and 2017, or for the last five-year trending period of 2013 – 2017.

TABLE 2-1: SCA PERFORMANCE RATINGS FOR RESEARCH REACTORS FOR 2016 – 2017

Safety and control area	MNR	U of A	SRC	RMCC	ÉPM
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	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

The definition for the four ratings (UA, BE, SA, FS) is provided in Appendix B, *Rating Methodology and Definitions*.

2.4 Regulatory Compliance Efforts for Research Reactors

CNSC staff use a risk-informed approach in planning compliance activities for each licensee. This takes into consideration the overall risk of the facility, operational performance and compliance history of the licensee, as well as changes in the regulatory framework. Regulatory compliance is assessed through inspections, review of licensee documents and annual reports, and through regular interaction between CNSC staff and the licensee.

Table 2-2 below presents the licensing and compliance effort from CNSC staff for the research reactor facilities for 2016 – 2017.

TABLE 2-2: CNSC REGULATORY OVERSIGHT LICENSING AND COMPLIANCE ACTIVITIES FOR RESEARCH REACTORS IN 2016 – 2017

Facility	2016			2017		
	Inspections	Licensing (person-days)	Compliance (person-days)	Inspections	Licensing (person-days)	Compliance (person-days)
McMaster Nuclear Reactor	1	57	118	1	56	110
University of Alberta	1	32	49	1	73	16
Saskatchewan Research Council	1	13	78	1	7	24
Royal Military College of Canada	1	42	60	1	10	23
École Polytechnique de Montréal	0	19	19	1	16	14

Compliance and licensing efforts vary between facilities and years depending on the risk profile, specific projects undertaken by the licensees, licensee performance, safety-significant events, changes in the regulatory framework, etc.

Licensing and compliance efforts were comparable between 2016 and 2017 for MNR and ÉPM due to consistent performance and a stable licensing basis.

CNSC efforts shifted to increased licensing efforts for University of Alberta in 2017 with the amendment of the licence and decommissioning of the facility.

SRC and RMCC received less licensing and compliance efforts in 2017 due to consistent performance and stable licensing basis, as well as efficiencies gained with CNSC's risk-informed approach.

2.5 Radiation Protection

As shown in Table 2-1, the 2016 – 2017 ratings for the radiation protection (RP) SCA for all small nuclear research reactor facilities were Satisfactory. Based on compliance inspections and review of licensee documents performed over the review period, this rating remains unchanged from the previous five years for all research reactor facilities.

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

This SCA encompasses the following specific areas:

- Application of ALARA
- Worker Dose Control
- Radiation Protection Program Performance
- Radiological Hazard Control
- Estimated Dose to the Public

Application of ALARA

During 2016 – 2017, all research reactor facilities continued to implement RP measures to keep radiation exposures and doses to persons ALARA. Examples of ALARA measures included: appropriate use of shielding and personal protective equipment, minimization of time in radiological areas, and maximizing of distances from radioactive sources. The application of this principle has resulted in doses to persons being well below CNSC regulatory dose limits.

Worker Dose Control

All research reactor facilities continued to comply with the regulatory requirements to ascertain and record doses received by all persons present at their licensed facilities, including workers, contractors and visitors. No worker or member of the public received a radiation dose in excess of the regulatory dose limits or licensee-specific action levels established in the RP programs.

Radiological hazards vary between facilities due to the complex and different work environments. Therefore, direct comparison of doses to workers among the facilities does not provide an appropriate measure of respective licensee RP program effectiveness.

The design of RP programs, including the dosimetry methods and the determination of workers who are identified as Nuclear Energy Workers (NEW), varies depending on the radiological hazards present in the facility and the expected magnitude of doses received by workers.

At the research reactor facilities, employees and contractors conducting work activities that present a reasonable probability of receiving an occupational dose greater than 1 mSv/year are identified as NEWs. These workers are subjected to a regulatory dose limit of 50 mSv/year.

Certain facilities (SRC, ÉPM) do not require a NEW designation for their workers, given the very low dose these workers receive and therefore, the maximum regulatory dose to a member of the public of 1 mSv/year applies. RMCC has a combination of both NEWs and non-NEWs. In any of the cases, no regulatory dose limit was exceeded at any of the research reactors between 2016 and 2017.

The maximum and average effective doses to workers at the research reactor facilities are provided in Table 2-3. For each facility, the highest average dose and the highest maximum doses recorded between 2016 and 2017 are shown. This demonstrates that the highest doses recorded were well below regulatory dose limits for all workers, facilities and reporting years combined.

TABLE 2-3: EFFECTIVE DOSE TO WORKERS 2016 – 2017

Dose Statistics	Non-NEWs			NEWs		
	SRC	ÉPM	RMCC	MNR	U of A	RMCC
Average effective dose (mSv)	<0.1	<0.1	<0.1	0.34	<0.1	<0.1
Maximum individual effective dose (mSv)	0.28	0.23	<0.1	3.91	<0.1	0.37
Total persons monitored (typical)*	17	7	8	111	2	19
Regulatory dose limit	1 mSv			50 mSv		

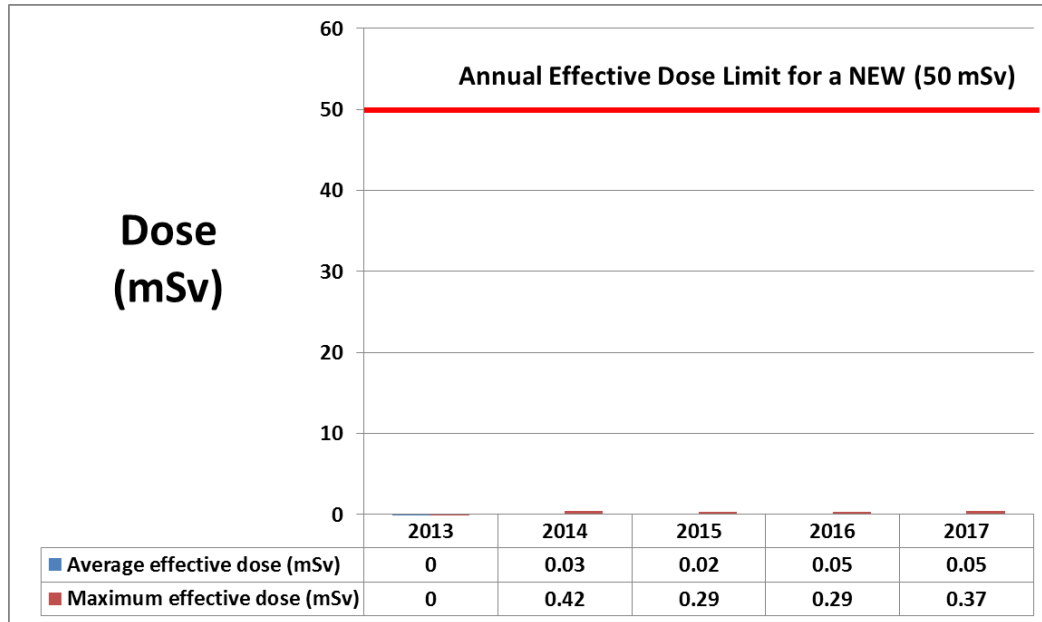
* The number of staff monitored in each facility may vary slightly between years.

Five-Year Trends

Radiological data are represented as five-year trends to illustrate the progression over time, in the following figures. Certain parameters, such as extremity exposure, are not relevant to all reactors and for this reason, it is only provided for MNR where the radiological work conducted by its workers warrants it.

Figure 2-9 shows the maximum values for effective doses and averages at any of the four SLOWPOKE reactors over five years. This demonstrates that the highest dose at any of the SLOWPOKE reactors over five years was 0.42 mSv (RMCC, 2014), which is well below the annual limit of 50 mSv for a NEW, and below the regulatory limit of 1 mSv/year for a non-NEW.

FIGURE 2-9: SLOWPOKE REACTORS EFFECTIVE DOSE TO WORKERS – FIVE YEAR TREND



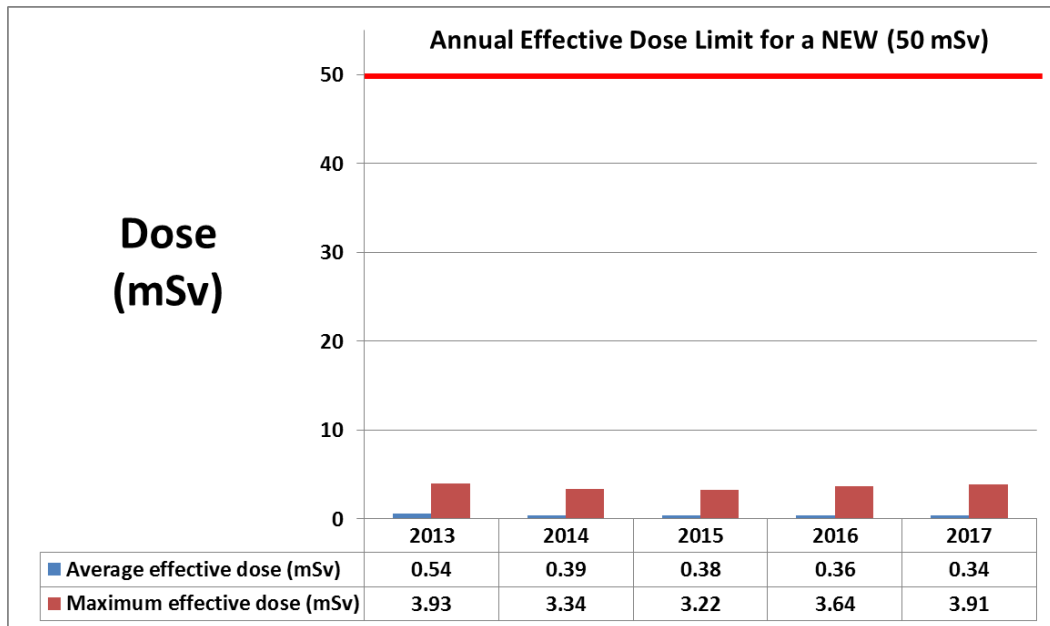
In 2013, the maximum and average dose at any of the four SLOWPOKE-2 reactors were below 0.1 mSv/year (shown as 0 on graph). RMCC was not operating during that year while some building renovations were taking place. Maximum doses at the three other SLOWPOKE-2 reactors were less than 0.1 mSv during 2013.

McMaster Nuclear Reactor workers conduct a broad range of activities and radiological work, including isotope production, fuel handling, neutron radiography and maintenance.

McMaster University ascertains external doses using whole body and extremity dosimeters. In addition, Electronic Personnel Dosimeters (EPDs) are used to monitor doses on a daily basis. Internal exposure is assessed at MNR through routine thyroid screening for the workers working with volatile I-125. Internal dose to workers exposed to other radionuclides is assessed through the review of results from contamination monitoring of surfaces, airborne contamination monitoring, and personnel contamination monitoring. In 2016-2017, CNSC staff confirmed that no internal doses were recorded from extensive facility air and surface contamination monitoring, personnel contamination monitoring or thyroid screening.

Figure 2-10 shows the average effective doses and the maximum effective doses to an individual at MNR from 2013 to 2017. The maximum effective dose of 3.93 mSv was received in 2013 by a NEW, which is well below the regulatory limit of 50 mSv/year.

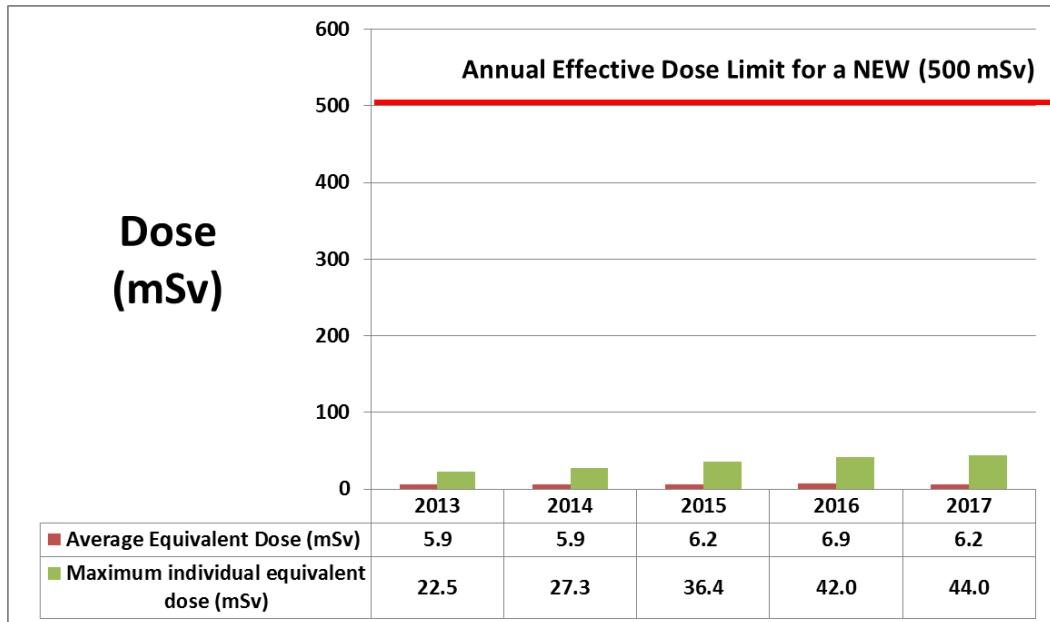
FIGURE 2-10: MNR EFFECTIVE DOSE TO WORKERS – FIVE-YEAR TREND



Extremity exposure is a relevant indicator at MNR, given the broad range of radiological work taking place in the facility, including the Iodine-125 production.

Figure 2-11 provides the average and maximum equivalent (extremity) doses at MNR from 2013 to 2017. The maximum equivalent (extremity) dose of 44 mSv occurred in 2017, which is well below the regulatory limit of 500 mSv/year.

FIGURE 2-11: MNR EXTREMITY DOSE TO WORKERS – FIVE YEAR TREND



Radiation Protection Program Performance

CNSC staff provided regulatory oversight of the Radiation Protection programs at all research reactor facilities during 2016 – 2017. This regulatory oversight consisted of document reviews and onsite inspections that included components of the RP programs. Through these oversight activities, CNSC staff confirmed that all research reactor facilities have effectively implemented their RP programs to control occupational exposures to workers.

Action levels for radiological exposures are established as part of the research reactor facilities' RP programs. Licensees are responsible for identifying action levels that serve the following objectives:

- a) Prevent dose limits from being reached; and
- b) Indicating when there may be a loss of control of the RP program and trigger specific action to be taken

If an action level is reached, the licensee must conduct an investigation to establish the cause, notify the CNSC and identify and take action to restore the effectiveness of the RP program. There were no action level exceedances reported by research reactor facilities during 2016 – 2017.

Radiological Hazard Control

All research reactor facilities continued to implement adequate measures to monitor and control radiological hazards in their facilities according to regulatory requirements. These measures include zoning for contamination control purposes for all research reactor facilities, fixed area alarming radiation monitors and air monitoring systems (at MNR). These items were part of compliance inspections conducted at all facilities over the review period. Workplace monitoring programs to protect workers were effectively implemented and have demonstrated that levels of radioactive contamination and dose rates were adequately controlled within the facilities.

Estimated Dose to the Public

The ALARA principle also applies to the environmental releases, ensuring that the dose to the public is kept to a minimum. Safety analyses for the SLOWPOKE reactors and annual radiation safety program assessments for MNR conservatively estimate the public dose to less than 1 μ Sv/year for all research reactor facilities, which is less than a thousandth of the regulatory dose limit of 1 mSv for a member of the public. Information related to public exposure is presented in Section 2.6.

The research reactor facilities implemented effective RP programs during 2016 – 2017, in compliance with *Radiation Protection Regulations*, and ensuring the health and safety of the public and persons working in these facilities.

2.6 Environmental Protection

The Environmental Protection 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 the result of licensed activities. The CNSC requires licensees to develop and implement policies, programs and procedures to comply with applicable federal and provincial regulatory requirements to control the release of nuclear and hazardous substances into the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs.

This SCA encompasses the following specific areas for the small nuclear research reactor facilities:

- Effluent and Emissions Control (releases)
- Assessment and Monitoring

CNSC staff assessed the environmental protection SCA as Satisfactory for all research reactor facilities in 2016 – 2017. Based on the compliance inspections and review of licensee documents performed over the review period, this rating remains unchanged from the previous five years for all research reactor facilities.

The environmental releases from the small research reactors in Canada are extremely small and present negligible risk, as discussed in the following paragraphs. The environmental protection programs will differ slightly at each facility, depending on the nature of the operation.

McMaster Nuclear Reactor

For 2016 – 2017, CNSC staff continued to rate the environmental protection SCA at MNR as Satisfactory.

Radiological releases from MNR to the environment are effectively controlled and monitored and comply with the conditions of the operating licence and regulatory requirements. All the releases to the environment were very low, well below regulatory limits during 2016 – 2017, as explained in the following paragraphs.

Effluent and Emissions Control (releases)

MNR's Effluent and Emission Monitoring program consists of monitoring exhaust ventilation for I-125 and Argon-41 (Ar-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.

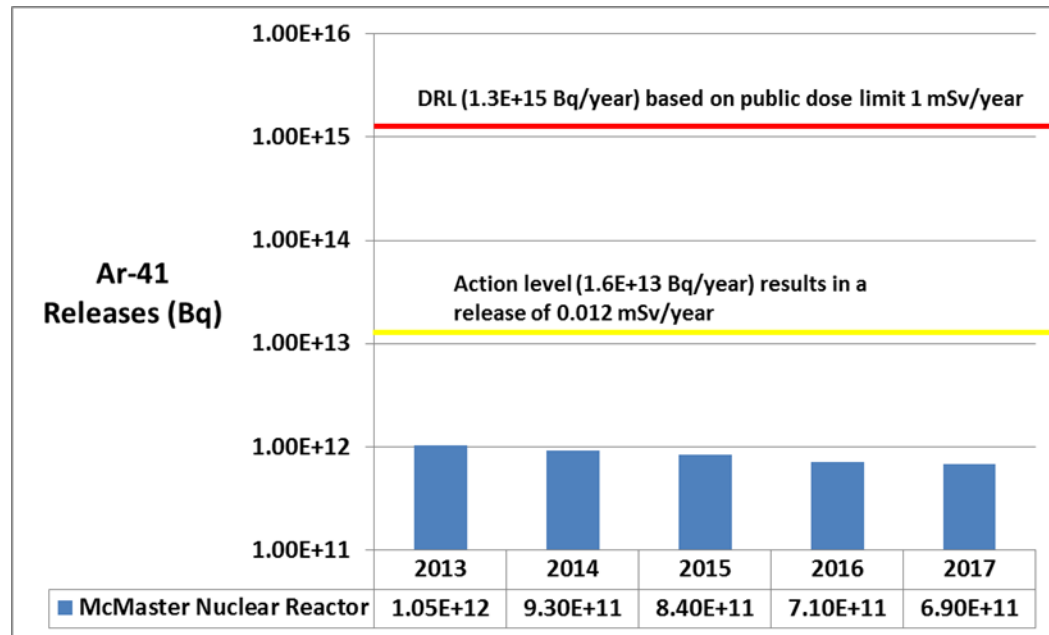
Controls are in place to ensure that airborne releases of nuclear substances to the environment are minimized. These include the use of activated charcoal filters to minimize the release of radioiodines, and the use of filters to ensure releases of radioactive particulates are controlled.

Annual airborne releases at MNR are shown in Figures 2-12 and 2-13 for Ar-41 and I-125 respectively. Ar-41 is produced mostly by the irradiation of air present in the sample irradiation system (also called “rabbit” system), where samples are moved in and out of the neutron flux of the core by pneumatic action. The I-125 releases are related to the I-125 production program, where trace amounts can escape from containment or pass through filters.

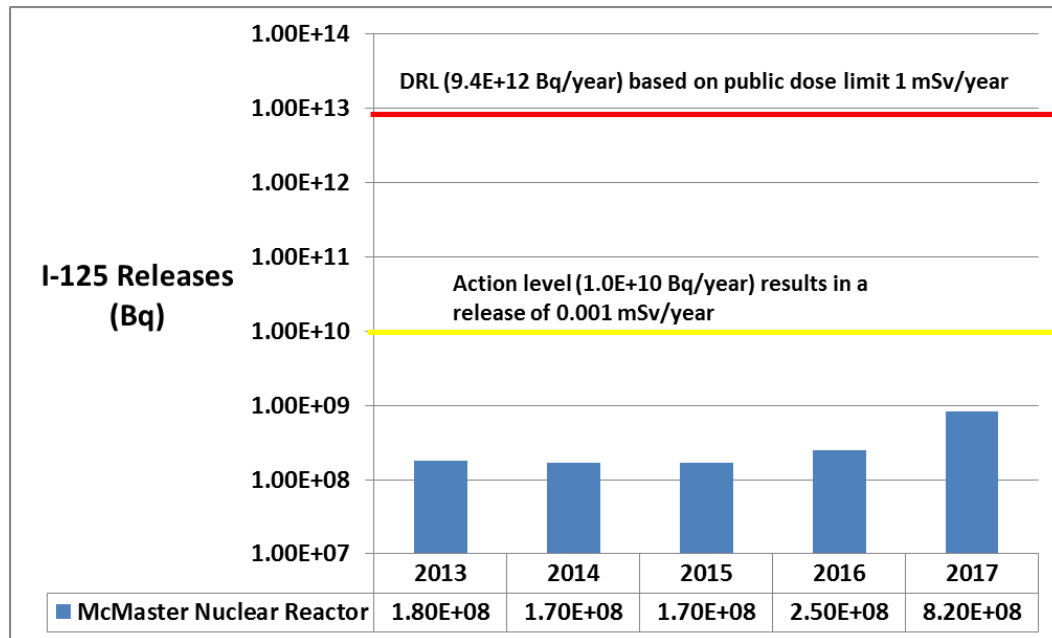
Derived Release Limits (DRL) have been established for airborne releases of Ar-41 and I-125 at MNR, based on the regulatory public dose limit of 1 mSv/year. The maximum effective dose to the public is equal to the sum of the doses associated with I-125 and Ar-41. This dose was conservatively assessed as less than 1 μ Sv in 2016 and 2017 at MNR, which is less than one thousandth of the regulatory public dose limit of 1 mSv/year.

MNR also maintains environmental action levels corresponding to a small fraction of the DRL. Exceedance of an action level triggers a notification to the CNSC and an investigation which may result in corrective actions or preventative measures being put in place. There were no exceedances of any environmental action level or regulatory limit at MNR in 2016 – 2017 or over the past five years.

FIGURE 2-12: ARGON-41 RELEASES AT MNR



Note: This graph uses a logarithmic scale

FIGURE 2-13: IODINE-125 RELEASES AT MNR

Note: This graph uses a logarithmic scale

Refer to Appendix E for the total releases to air from MNR.

Assessment and Monitoring

MNR's Environmental Monitoring program includes three monitoring stations located around the facility. Samples are collected weekly and analyzed for gross beta activity. Charcoal cartridges are collected and sampled monthly for I-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.

Other Waste

Liquid waste from the facility is captured and processed or evaporated in the facility. There were no releases of contaminated liquid to the municipal sewer system in 2016 – 2017.

Low-level active solid waste from MNR is transported to licensed waste management facilities. Spent fuel is sent approximately once every seven to ten years to a facility in the United States.

SLOWPOKE-2 Facilities

The SLOWPOKE-2 facilities release negligible quantities of radioactive noble gases, mainly Xenon-133 and Xenon-135, resulting from the weekly purges of reactor head space, and Ar-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.

CNSC staff completed a sector specific environmental risk assessment to determine the environmental protection requirements for SLOWPOKE-2 facilities [6]. As the estimated maximum dose to members of the public (0.08 μ Sv/year) 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, formal release limits and a receiving environment monitoring program are not required for SLOWPOKE-2 facilities.

Solid waste at the SLOWPOKE reactors consists for the most part of irradiated samples for neutron activation analysis. These samples are stored until they decay to background levels and disposed of as non-radioactive material. Any irradiated samples with long-lived radionuclides are either returned to the client or transported to a licensed waste management facility.

The research reactor facilities do not release liquid effluents from reactor operations.

CNSC staff confirm that the research reactor facilities implemented effective environmental programs during 2016 – 2017, protecting the health and safety of the public and of persons working in these facilities.

2.7 Conventional Health and Safety

The Conventional Health and Safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

This SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness

Conventional health and safety was rated as Satisfactory for all research reactor facilities in 2016 – 2017. Based on the compliance inspections and review of licensee documents performed over the review period, this rating remains unchanged from the previous five years for all research reactor facilities.

At the federal level, conventional health and safety at the research reactor facilities is regulated by both the Employment and Social Development Canada (ESDC) and the CNSC. Licensees submit hazardous occurrence investigation reports to both ESDC and the CNSC, in accordance with their respective reporting requirements. If a concern is identified, CNSC staff may consult with ESDC staff so that appropriate action is taken. The facilities are also subject to provincial legislation, as applicable with each licensee's provincial jurisdiction.

Licensees are required to report unsafe occurrences to the CNSC as directed by Section 29 of the *General Nuclear Safety and Control Regulations*. These reports include serious illness or injury incurred or possibly incurred as a result of licensed activity. No unsafe occurrences were reported by any of the research reactor facilities between 2016 and 2017.

Performance

A key performance indicator for conventional health and safety SCA is the number of Lost Time Injuries (LTI) that occur per year. An LTI is an injury or illness resulting in lost days beyond the date of injury as a direct result of an occupational injury or illness incident.

There were no lost-time injuries at any of the small nuclear research reactor facilities during 2016 – 2017.

The small nuclear research reactor facilities have been implementing their conventional health and safety programs satisfactorily and their programs are effective in protecting the health and safety of persons working in their facilities.

Practices

The research reactor facilities implement Health and Safety Programs that comply with the requirements of *Canada Labour Code* and *Canada Occupational Health and Safety Regulations*.

In general for research reactors that are part of a broader organization such as a university, a central committee monitors activities and programs for the entire campus. A local committee, comprising workers and managers, is formed to promote and provide a safe work environment in the research reactor facility. The health and safety committees at each facility are charged with reviewing incidents, conducting safety inspections, evaluating safety programs, and recommending health and safety improvements. Compliance with fire code requirements are also verified as part of this program.

Awareness

Workers at research reactor facilities are made aware of the conventional health and safety program as well as workplace hazards through training and ongoing internal communications with the broader organization. CNSC staff continue to monitor the effectiveness of this program through regular onsite inspections.

CNSC staff have reviewed all research reactor facilities conventional health and safety programs during inspections in 2016 and 2017 and conclude that the programs meet the compliance requirements.

2.8 Public Information and Disclosure

Small research reactors are required to maintain and implement public information and disclosure programs as per RD/GD-99.3¹: *Public Information and Disclosure*. These programs are supported by disclosure protocols, which outline the type of information on the facility and its activities that will be shared with the public (e.g., incidents, major changes to operations, periodic environmental performance reports and information of public interest) and how that information will be shared. The objective is to ensure that timely information about the health, safety and security of persons and the environment and other issues associated with the lifecycle of nuclear facilities are effectively communicated.

During 2016 – 2017, all research reactor licensees actively provided information on the operations of their nuclear research reactor on their websites. Examples of other communications activities undertaken include open houses, outreach events, facility tours and participation in community events.

CNSC staff verified during inspections that public information and disclosure programs were being implemented satisfactorily during 2016 – 2017, ensuring that the programs remain effective at communicating useful information about the health, safety and security of persons and the environment and other matters of public interest associated with these facilities.

2.9 Financial Guarantees

The CNSC requires licensees to maintain preliminary decommissioning plans (PDP) and revise them every five years, at a minimum. CNSC staff review the plans against regulatory requirements and to ensure that they contain credible cost estimates. These cost estimates form the basis for the financial guarantee that assures sufficient funding is available to cover the cost of the decommissioning work at the end of the lifetime of the facility. Financial guarantees are presented to the Commission for acceptance, and maintained as part of a licence condition. Table 2-4 lists the four research reactor facilities along with the current value of their respective Nuclear Reactor Reserve Fund (NRRR), which constitutes part or all of their financial guarantee. Licensees may contribute annual payments to the NRRR until the financial guarantee is funded to the full value of the decommissioning cost, and they may include other financial instruments as part of their financial guarantee agreement.

¹ RD/GD-99.3 was superseded by REGDOC-3.2.1 *Public Information and Disclosure* in May 2018

TABLE 2-4: FINANCIAL GUARANTEES THE RESEARCH REACTORS

Facility	NRRR value Canadian dollar amount	Other instruments
McMaster University	\$12,539,090	N/A
University of Alberta	N/A (Decom. completed)	N/A
Saskatchewan Research Council	\$5,100,000	N/A
Royal Military College of Canada	N/A ¹	N/A
École Polytechnique de Montréal	498,160 ²	Letter of credit for 800,000 ²

1. The SLOWPOKE-2 facility is owned by National Defence and is therefore the property of the Crown. The costs associated with the future decommissioning of this facility are the responsibility of National Defence.
2. Under review.

Financial guarantees are reviewed periodically (at a minimum every five years) to ensure they continue to be sufficient, as the predicted costs of decommissioning evolve with time. École Polytechnique is currently reviewing its financial guarantee. Once deemed acceptable, CNSC staff will request the Commission's approval of the proposed financial guarantee.

2.10 Regulatory Developments

There were no fundamental changes in the regulatory environment for the research reactors between 2016 and 2017. The ÉPM licence was amended in 2016 to consolidate the operation of the SLOWPOKE-2 reactor and the Subcritical Assembly. The University of Alberta SLOWPOKE-2 reactor licence was amended in 2017 to allow decommissioning. University of Alberta submitted an end-state report to the CNSC and requested a licence to abandon the facility. This decision is pending a Commission hearing scheduled for May 2018.

There were no changes to the MNR, SRC or RMCC licences.

The CNSC continues to modernize the regulatory framework with the REGDOC series of regulatory and guidance documents. Table 2-5 lists the updates to the CNSC regulatory documents that were made in 2016 – 2017, which apply to the research reactor licensees, with status of implementation.

TABLE 2-5: UPDATES TO REGULATORY DOCUMENTS APPLICABLE TO RESEARCH REACTORS

Regulatory document	Publication	Status
REGDOC-2.2.2, <i>Personnel Training, Version 2</i>	2016	Implementation plans
REGDOC-2.14.1: <i>Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulation, 2015</i>	2016	Implemented
REGDOC-2.9.1: <i>Environmental Protection: Environmental Principles, Assessments and Protection Measure, version 1.1</i>	2017	Implemented
REGDOC-2.10.1: <i>Nuclear Emergency Preparedness and Response, version 2</i>	2017	Implemented
REGDOC-2.13.1: <i>Safeguards and Nuclear Material Accountancy</i>	2018	Implementation plans
REGDOC-3.1.2, <i>Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills</i>	2018	Implementation plans
REGDOC-3.2.1, <i>Public Information and Disclosure</i>	2018	Implementation plans

Table 2-6 lists the updates to the industry standards that were made in 2016 – 2017, which potentially apply the research reactor licensees.

TABLE 2-6: UPDATES TO INDUSTRY STANDARDS APPLICABLE TO RESEARCH REACTORS

Standard	Publication	Status
N286-12 (R2017) <i>Management system requirements for nuclear facilities</i>	2012	Implementation plans
N292.1-16 <i>Wet storage of irradiated fuel and other radioactive materials</i>	2016	Implemented at MNR. Not applicable to SLOWPOKES

The LCHs for each small research reactor facility are being updated to reflect these regulatory documents and standards as part of the periodic revision cycle, taking into consideration licensees' implementation plans. CNSC staff verify the implementation as part of ongoing compliance verification activities.

2.11 Conclusion for the Research Reactors

During 2016 – 2017, CNSC staff continued to provide regulatory oversight of the research reactor facilities in Canada through inspections, review of licensee documents and an effective implementation of CNSC's regulatory framework. There were no radiological dose limit exceedances to the public or the workers, and there were no unauthorized environmental releases. The research reactor facilities were rated Satisfactory or Fully Satisfactory in all 14 SCAs.

The research reactors licensees continue to operate these facilities safely while protecting the health and safety of the public and the workers, the environment and security, and in compliance with Canada's international obligations on the peaceful use of nuclear energy.

3 CLASS IB ACCELERATORS

3.1 Overview

This section of the ROR presents the regulatory oversight information on the Class IB accelerator facilities in Canada. These facilities are:

- Tri University Meson Facility Accelerators (TRIUMF)
- Canadian Light Source Inc. (CLSI)

For 2013 and 2014, the Class IB accelerator facilities regulatory oversight report was presented with the DNSR Industry Report, CMD 15-M27. For 2015, the information was presented as part of the Regulatory Oversight Report for Nuclear Processing, Small Research Reactor and Class IB Accelerator Facilities in 2016, CMD 16-M43.

The performance of the Class IB accelerator facilities is presented together with the research reactors as they are similar in terms of risk, impact to the environment and compliance programs.

Figure 3-1 shows the location of Class IB accelerator facilities in Canada.

FIGURE 3-1 LOCATION OF CLASS IB ACCELERATOR FACILITIES IN CANADA



3.2 Highlights at Class IB Accelerator Facilities

3.2.1 TRIUMF

TRIUMF operates one 520 megaelectronvolt (MeV) cyclotron accelerator facility, four smaller cyclotrons facilities, and three linear accelerator facilities under operating licence PA10L-00/2022 [7] which was issued by the Commission in 2012 for a 10-year period.

TRIUMF is located on the University of British Columbia campus in Vancouver and is Canada's national laboratory for nuclear and particle physics research and related sciences. An aerial view of the TRIUMF site is shown in Figure 3-2. TRIUMF is also a major producer of radioisotopes used for medical diagnostic procedures. It is owned and operated as a joint venture by a consortium of 18 Canadian universities. The 520 MeV cyclotron accelerator, shown in Figure 3-3, has been in operation for over 40 years. There are approximately 560 persons working at TRIUMF.

FIGURE 3-2: AERIAL VIEW OF THE TRIUMF SITE



During 2016 – 2017, CNSC staff continued to rate TRIUMF’s performance as Satisfactory in all SCAs, with the Safeguards SCA rated as Fully Satisfactory. The rating for Waste Management SCA was downgraded to Below Expectations following an inspection in 2016 which found deficiencies related to inventory and labelling of radioactive waste, as well as the absence of secondary containment of some hazardous waste. CNSC staff performed a follow-up inspection in October 2017 to verify TRIUMF corrective actions. CNSC staff were satisfied with the corrective actions and brought back the rating to Satisfactory. In 2016, CNSC staff also conducted an inspection focused on Radiation Protection SCA and found minor deficiencies, which brought down the rating from Fully Satisfactory to Satisfactory.

FIGURE 3-3: INSIDE LOOK OF THE 520 MEV CYCLOTRON



In 2016 – 2017, there were no licence amendments or changes to the TRIUMF licence, and there were no changes in operations, organization or operating policies and there were only minor changes to the LCH. This is reflected in the low regulatory effort for this activity in Section 3.4 below.

In 2016 – 2017, TRIUMF focused on initiatives in safety, management system and environmental protection. TRIUMF completed the review of their environmental protection program to align it with CSA N288 standards. CNSC staff reviewed and approved the revision to the environmental protection program for the Derived Release Limits. TRIUMF reported the releases under the revised program in 2017.

Events

In 2016 – 2017, TRIUMF reported 2 events to the CNSC.

- On June 10, 2017, the 350 μA current licence limit for irradiating cadmium targets was exceeded for the TR30-2 isotope production cyclotron when it was run at 375 μA for a period of about one-half hour. TRIUMF conducted a root cause analysis and determined that the interlock to limit the beam current to values below the licence limit was not used at the time of the incident and there is no procedure or checklist explicitly mandating the verification of target type and operating current. TRIUMF corrective action was to implement an engineered control that will enforce beam current limits strictly less than licence limit. There were no consequences to this event. However, it was a contravention to TRIUMF licence operating limits for this type of target.
- On August 25 and September 1, 2017, there were two unintentional releases of C-11 from Life Sciences Radiochemistry Annex, both in the range 35-40 GBq. Both releases amount to 0.1% of the full site releases for the year and in a worst case would contribute to 0.3 μSv to an individual of the most highly expose group.

CNSC staff verified that corrective actions developed to prevent recurrence of both events have been implemented.

3.2.2 Canadian Light Source Inc.

Canadian Light Source Inc. (CLSI) operates a synchrotron facility, on the University of Saskatchewan campus in Saskatoon, Saskatchewan, under licence PA10L-02.01/2022 [8] which was issued in 2012 for a 10-year period.

Figure 3-4 shows an aerial view of the CLSI facility.

The facility consists of three major accelerator systems: a 300 MeV linear accelerator, a booster ring that accelerates electrons up to 2.9 Giga-electron volts (GeV) and a storage ring that keeps electrons circulating at this energy for several hours.

FIGURE 3-4: AERIAL VIEW OF CANADIAN LIGHT SOURCE INC.

The facility produces synchrotron radiation that is used as a light source for experiments in diverse fields such as biology, materials research, atomic and molecular science, earth sciences, pharmaceuticals, biomedical research and electronics. Synchrotron radiation is electromagnetic radiation produced by magnetic bending of high-energy electrons in a storage ring. The light ranges from infrared through the visible spectrum to ultraviolet and X-rays. The experiments take place in optical beam lines tangential to the storage ring. The facility has been in operation since 2005.

Figure 3-5 shows an inside look of the CLSI facility. There were approximately 1200 workers (staff and facility users) at CLSI in 2016 and 1300 in 2017.

FIGURE 3-5: INSIDE LOOK OF THE CANADIAN LIGHT SOURCE RESEARCH FACILITY



During 2016 – 2017, there were three amendments to the LCH, which are reflected in the regulatory oversight effort discussed in Section 3.4.

In 2016, following an inspection focused on Management System in which CLSI received below expectation rating, CLSI initiated a review of programs to meet N286-12 standard and continued with the implementation of the changes in 2017. The Management System SCA was rated as Satisfactory in 2017. In October of 2016, Public Safety Canada completed both a Critical Infrastructure Resiliency Review and Cybersecurity Resiliency Review. The final report for the Critical Infrastructure Resilience Review was received in December. Many strengths in the CLS security program were noted, and some opportunities for improvement were suggested. The report is currently under review by CLSI. The Cybersecurity Resiliency Review was completed in conjunction with the University of Saskatchewan Information Technology group, and a report is expected early in 2017.

Annual Testing

During 2016 – 2017, CLSI conducted a planned annual testing of safety systems according to the schedule.

Projects

In May 2017, CLSI applied to modify its licensing basis to add a new mode of operation, top-up mode. The mode differs from the current mode which can be described as decay mode, where electrons are injected into the storage ring every 8 to 12 hours with the beamlines shutters closed. Top-up consists of refilling the storage ring with a small amount of electrons approximately every few minutes. It is performed with the beamlines safety shutters opened. This change in the licensing basis was approved in a decision of the Commission in February 2018.

Events

CLSI reported two events in 2016 and one event in 2017.

- On July 14, 2016, City of Saskatchewan emergency dispatch received a threat from an anonymous caller identifying himself as a member of ISIS. Police and CLSI staff responded, secured and searched the building. The incident was determined to be hoax.
- On October 12, 2016, CLSI reported a near miss accident after it discovered that an electrical disconnect switch had not been properly locked in the ‘off’ position prior to working on 600V power supply. A worker had properly completed the Lockout Tagout (LOTO) process. The worker had worked periodically for 2 days cleaning inside the power supply cabinet without contacting the electrical connections prior to the issue being discovered. Upon discovery, the area was promptly secured and the LOTO corrected. CLSI conducted an investigation which resulted in several recommendations to reduce the risk of a recurrence. CNSC staff followed up with an inspection in January 2017, the response and the implementation of recommendations by CLSI was considered acceptable.
- On February 24, 2017, CLSI reported that during annual Access Control Interlock System (ACIS) validation and verification (V&V) testing, a wiring error was found in the Linac ACIS hardware system. CLSI reviewed all accelerator ACIS design and installation. The error was corrected and the Linac ACIS V&V was repeated. The review also identified other issues which were promptly corrected:
 - PLC programming issue in the Booster Ring Radiofrequency interlock was identified. Repair will be completed in fall 2017 shutdown, during which time the PLC programming issue will be repaired.
 - An opportunity for improvement was identified in the HW circuit for the storage ring RF interlock logic. A relay failure would result in the bypass of both the All-Clear interval and an EOS pressed for zones 8 and 9.
 - It was found that the BR1/SR1/Beamlines ACIS RF and injection permissive signals are summed into a single relay, K1. The contacts of K1 fan out to the various LINAC radiation sources. A correction has been identified which separates the SR1/BR1/Beamlines ACIS RF and injection permissive logic of the PLC from the HW chain and presents parallel outputs from these chains to interlock the LINAC radiation sources.

3.3 Performance Ratings

The following table provides the performance ratings for the Class IB accelerator facilities for all SCAs during 2016 – 2017.

TABLE 3-1: OVERALL SCA PERFORMANCE RATINGS FOR CLASS IB ACCELERATORS FOR 2016 – 2017

Safety and control area	CLSI		TRIUMF	
	2016	2017	2016	2017
Management system	BE	SA	SA	SA
Human performance management	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA
Safety analysis	FS	FS	SA	SA
Physical design	FS	FS	SA	SA
Fitness for service	FS	FS	SA	SA
Radiation protection	FS	FS	SA	SA
Conventional health and safety	SA	FS	SA	SA
Environmental protection	FS	FS	SA	SA
Emergency management and fire protection	SA	SA	SA	SA
Waste management	FS	FS	BE	SA
Security	FS	FS	SA	SA
Safeguards and non-proliferation	N/A*	N/A*	FS	FS
Packaging and transport	FS	FS	SA	SA

* N/A: There are no safeguards verification activities associated with CLSI

For 2016 – 2017, CNSC staff ratings for all individual SCAs were either Satisfactory or Fully Satisfactory for Class IB particle accelerator facilities, with the exception of a Below Expectation rating for CLSI in the Management System SCA and Waste Management SCA for TRIUMF. Appendices C and D contain the SCA ratings for the past 5 years for TRIUMF and CLSI respectively.

TRIUMF

For 2016 – 2017, CNSC staff rated TRIUMF's performance as Satisfactory or better in all SCAs except for Waste Management SCA in 2016. TRIUMF's below expectation rating for waste management was based on inspection findings. During an inspection in October 2016, CNSC staff found that TRIUMF did not maintain a complete inventory of radioactive waste and hazardous waste. It was also found that TRIUMF did not control the access to some radioactive waste storage areas and hazardous waste, and some radioactive waste containers were not labelled. CNSC staff also found deficiencies in secondary containment for the waste. TRIUMF developed and implemented corrective actions in the first half of 2017. CNSC staff verified the corrective actions during a follow-up inspection in October 2017. CNSC staff noted a major improvement in waste management, enough to bring this SCA back to Satisfactory.

CLSI

For 2016 – 2017, CNSC staff rated CLSI's performance as Satisfactory or better in all SCAs except Management System in 2016. The below expectation rating in Management System SCA at CLSI was based on the inspection findings focused on Management System. CNSC staff found that CLSI had not implemented the changes required to meet the CNSC compliance verification criteria on Management System that are described in the LCH. CNSC staff found outdated documents at CLSI which were not adhered to by CLSI staff. CLSI agreed with CNSC staff findings and created an action plan to meet the Management System requirements. In 2017, CLSI made progress on the requirements without completing the implementation of all the phases of their plan. The licensee is on track in implementing the changes to align with the revised N286 requirements. The rating for this SCA in 2017 has improved to Satisfactory. CNSC staff will follow up in the incoming years on the implementation status of the Management System and with its compliance with CSA N286-12. CNSC staff will verify the implementation through an onsite inspection and will inform the Commission of the results in the next edition of this report.

3.4 Regulatory Compliance Efforts for Class IB Accelerators

The Class IB accelerators are overall low-risk facilities, with the main hazard being radiological exposure and industrial hazards. There is no hazard associated with fuel or criticality, and the environmental releases are very small. While all SCAs are assessed over the duration of the licence, the regulatory compliance efforts typically focus on radiation protection, environmental protection and conventional health and safety.

CNSC staff conducted consistent and risk-informed regulatory oversight at the Class IB particle accelerator facilities. Table 3-2 below presents the licensing and compliance effort from CNSC staff for the Class IB accelerator facilities for 2016 – 2017.

TABLE 3-2: CNSC REGULATORY OVERSIGHT LICENSING AND COMPLIANCE ACTIVITIES FOR CLASS IB ACCELERATORS IN 2016 – 2017

Facility	2016			2017		
	Inspections	Licensing (person-days)	Compliance (person-days)	Inspections	Licensing (person-days)	Compliance (person-days)
TRIUMF	3	8	156	2	4	144
CLSI	1	6	54	2	21	96

During the review period, CNSC staff conducted eight targeted onsite inspections at the Class IB particle accelerator facilities. Findings from these inspections were provided to the licensees in detailed inspection reports and were tracked by CNSC staff until adequately addressed by the licensee.

The Class IB particle accelerator facilities are required, as part of their operating licences, to submit an annual compliance report by March 31 each year.

There were no significant changes in the efforts expended on TRIUMF between 2016 and 2017.

For CLSI, the regulatory efforts increased in 2017 to assess the top-up mode of operation. CLSI has received a small increase in oversight due to the near miss electrical incident. Following the near miss incident in 2016, CNSC staff conducted a follow up inspection in January 2017 to verify the effectiveness of the implementation of the corrective actions.

3.5 Radiation Protection

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

This SCA encompasses the following specific areas:

- Application of ALARA
- Worker Dose Control
- Radiation Protection Program Performance
- Radiological Hazard Control
- Estimated Dose to the Public

The rating for the Radiation Protection SCA for all Class IB accelerator facilities was Satisfactory or better, which is unchanged from previous five years.

Application of ALARA

During 2016 – 2017, CNSC staff determined that all Class IB accelerator facilities implemented effective measures to keep radiation exposures and doses to persons ALARA. This has consistently resulted in doses to persons being well below CNSC regulatory dose limits.

Worker Dose Control

All Class IB accelerator facilities continued to comply with the regulatory requirements to measure and record doses received by workers. No worker or member of the public received a radiation dose in excess of the regulatory dose limits or facility-specific action levels established in the radiation protection programs.

The design of RP programs, including the dosimetry methods and the determination of workers who are identified as NEW, varies depending on the radiological hazards present and the expected magnitude of doses received by workers.

At Class IB accelerator facilities, employees and contractors conducting work activities that present a reasonable probability of receiving an occupational dose greater than 1 mSv/year are identified as NEWs.

During 2016 – 2017, all Class IB accelerator facilities monitored and controlled the radiation exposures and doses received by all persons present at their licensed facilities, including workers, contractors and visitors.

TRIUMF

Application of ALARA

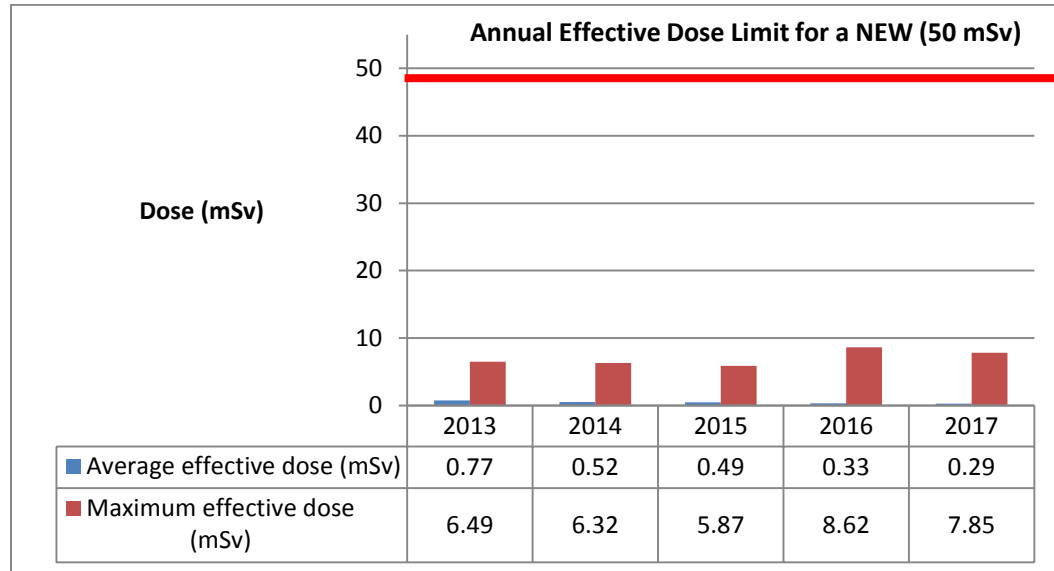
As required by the *Radiation Protection Regulations*, TRIUMF continued to implement RP measures in 2016 – 2017 to keep radiation exposures and doses to persons ALARA, taking into account social and economic factors.

Worker Dose Control

TRIUMF's workers are primarily exposed externally to a wide variety of radionuclides generated by the use of the cyclotron. External whole body and equivalent doses are ascertained using dosimeters. For internal exposures, TRIUMF has specific internal monitoring protocols depending on the type of research project a worker may be involved with. There were no internal doses recorded in 2016 and 2017.

Figure 3-6 provides the average and maximum effective doses of NEWs over the years 2013 to 2017 at TRIUMF. The maximum individual effective dose received by a NEW at TRIUMF was 8.62 mSv or approximately 17.2 percent of the regulatory effective dose limit of 50 mSv in a one-year dosimetry period.

FIGURE 3-6: TRIUMF EFFECTIVE DOSE TO NEWS – 2013 - 2017



Effective doses were monitored for 976 non-NEWs in 2016 and 960 in 2017, with a maximum effective dose of 0.15 mSv.

Radiation Protection Program Performance

Action levels for radiological exposures are established as part of the TRIUMF RP program as per regulatory requirements. An action level, if reached, triggers TRIUMF staff to investigate and establish the cause for reaching the action level, notify the CNSC, and restore the effectiveness of the RP program.

In 2016 – 2017, there were no occurrences of the action level exceedance at TRIUMF.

Radiological Hazard Control

A thorough radiation dose area monitoring program has been established at TRIUMF. CNSC staff routinely verify the results and compare them to previous years' results. No unusual results were detected in 2016 with the exception of one anomalous (but within acceptable limits) neutron dose of 0.5 mSv in the Proton Therapy control. TRIUMF investigated it and corrected the deficiency in shielding blocks. There were no unusual results detected in 2017.

Estimated Dose to the Public

The 2016 to 2017 maximum effective doses to a member of the public are shown in Table 3-3. The main component for the variation of these values is the 520 MeV cyclotron annual delivered beam charge. During the last five years, the public dose to a member of the public was well below the CNSC regulatory dose limit for a member of the public of 1 mSv/year.

TABLE 3-3: TRIUMF ACCELERATORS INC. MAXIMUM EFFECTIVE DOSE TO A MEMBER OF THE PUBLIC, 2013-2017

Dose Data	2013	2014	2015	2016	2017	Regulatory Limit
Maximum effective dose (mSv)	0.012	0.016	0.011	0.010	0.007	1 mSv/year

CLSI

Application of ALARA

As required by the *Radiation Protection Regulations*, CLSI continued to implement RP measures in 2016 – 2017 to keep radiation exposures and doses to persons ALARA, taking into account social and economic factors. ALARA initiatives continued to be implemented in 2016 and 2017, with the addition of local shielding to reduce gamma and neutron exposures.

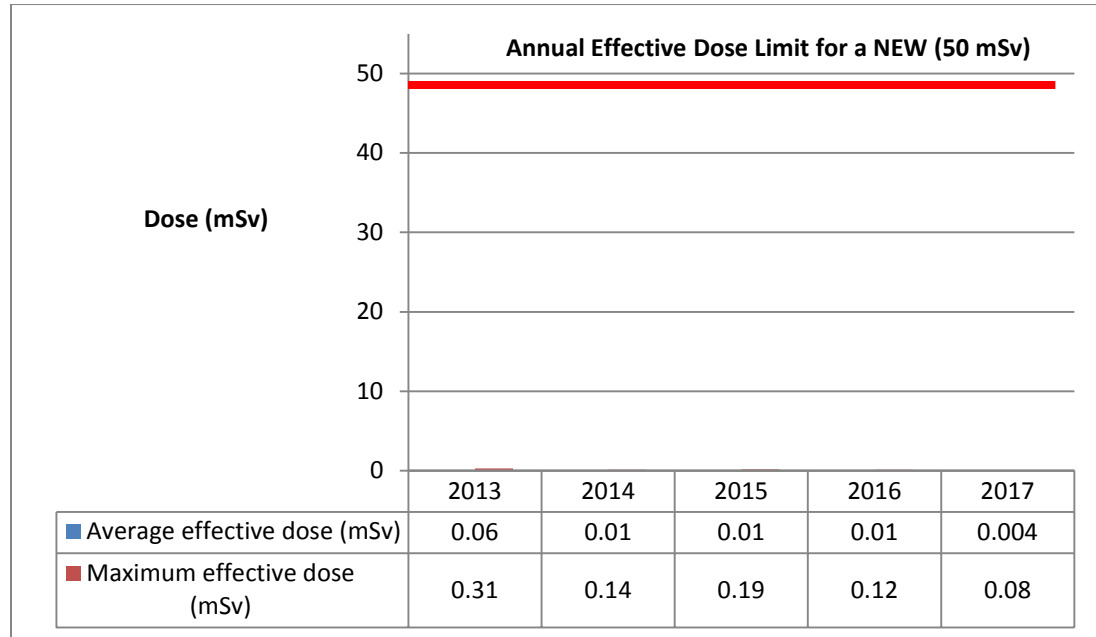
Worker Dose Control

CLSI workers are exposed externally to activation products associated with the use of the beam line. External whole body doses are ascertained using dosimeters. At CLSI, employees are identified as either NEWs or non-NEWs.

The maximum effective dose received by a NEW worker in 2016 – 2017 was 0.12 mSv, or approximately 0.24 percent of the regulatory effective dose limit of 50 mSv in a one-year dosimetry period.

Figure 3-7 provides the average and maximum effective doses of NEWs over the years 2013 to 2017 at CLSI. The maximum individual effective dose received by a NEW at CLSI was 0.31 mSv.

FIGURE 3-7: CLSI EFFECTIVE DOSE TO NEWS – 2013 – 2017



Effective doses were also monitored for 995 non-NEW employees, users of the facility and contractors in 2016, with a maximum effective dose of 0.05 mSv. In 2017, CLSI monitored 1023 non-NEW employees, users and contractors with a maximum effective dose of 0.11 mSv.

Radiation Protection Program Performance

Action levels for radiological exposures are established as part of the CLSI RP program. An action level, if reached, triggers CLSI staff to investigate and establish the cause for reaching the action level, notify the CNSC, and, if applicable, restore the effectiveness of the RP program.

In 2016 – 2017, there were no occurrences of the action level exceedance at CLSI.

Radiological Hazard Control

A thorough radiation dose area monitoring program has been established at CLSI. Results are verified routinely and compared to previous years' results. No unusual results were detected in 2016 – 2017. In addition, routine surface contamination measurements are performed at various locations.

In 2016 – 2017, there was no contamination found.

Estimated Dose to the Public

There are no airborne or liquid effluent releases of radioactive materials or hazardous substances from CLSI, and CLSI monitors environmental radiation levels outside of main CLSI building which are at ambient background radiation levels. Therefore, the estimated dose to the public is at natural radiation background levels.

The public dose to a member of the public from the Class IB facilities has been consistently well below the CNSC regulatory dose limit for a member of the public of 1 mSv/year.

CNSC staff conclude that the Class IB accelerator facilities effectively implemented and maintained their RP programs during 2016 – 2017 to ensure the health and safety of persons present in their facilities.

3.6 Environmental Protection

The Environmental Protection 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 the result of licensed activities. Licensees are required to develop and implement policies, programs and procedures to comply with applicable federal and provincial regulatory requirements to control the release of nuclear and hazardous substances into the environment. Licensees are also expected to have suitably trained and qualified staff to effectively develop, implement and maintain their environmental protection programs.

This SCA encompasses the following specific areas:

- Effluent and Emissions Control (releases)
- Environmental Management System (EMS)
- Assessment and Monitoring
- Protection of the Public
- Environmental Risk Assessment

The rating for the environmental protection SCA was Satisfactory for TRIUMF and Fully Satisfactory for CLSI. This is unchanged from the previous five years.

The Class IB accelerator facilities satisfactorily implemented their environmental programs satisfactorily during 2016 – 2017, and their programs are effective in protecting the health and safety of persons working in their facilities.

TRIUMF

For 2016 – 2017, CNSC staff continued to rate the environmental protection SCA at TRIUMF as Satisfactory. CNSC staff performed an environmental protection inspection at TRIUMF in 2017 and confirmed that TRIUMF has an effective environmental protection program.

Radiological releases from the TRIUMF facility to the environment continue to be effectively controlled and monitored, to comply with the conditions of the operating licence and regulatory requirements. All the releases to the environment were well below regulatory limits during 2016 – 2017. There were no releases of hazardous substances (non-radiological) to the environment in 2016 – 2017. Environmental monitoring of water, vegetation, and gamma/beta measurements at the site boundary indicates that the public and the environment continue to be protected from facility releases.

Effluent and Emissions Control (Releases)

Releases are presented in this section as percentage of the DRL with total annual releases to air and water provided in Appendix E.

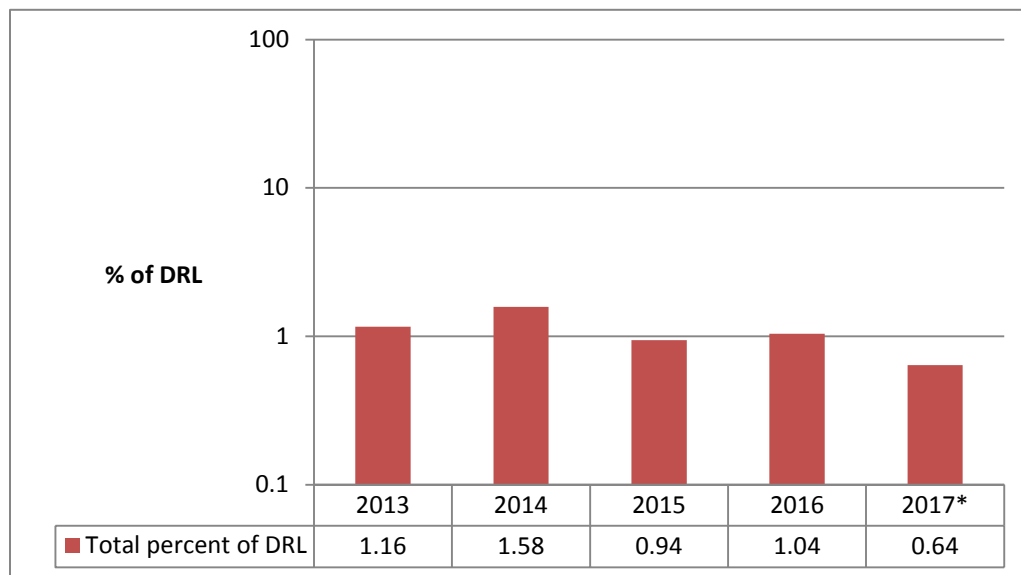
Atmospheric Emissions

TRIUMF monitors airborne radiological releases of beta plus (β^+) emitters², argon-41, noble gases, and volatile & particulate from the TRIUMF facility.

In 2017, TRIUMF submitted an updated DRL document for their airborne and liquid releases, which was reviewed and approved by CNSC staff.

Figure 3-8 shows the trend in airborne releases, expressed in percentage of the DRL, which is associated to a 1 mSv regulatory annual dose limit to a member of the public.

FIGURE 3-8: TRIUMF AIRBORNE RELEASES – FIVE YEAR TREND



Note: This graph uses a logarithmic scale
 *updated DRL calculations to align with CSA N288.1-14

² Beta plus emitters are short-lived positron emitting radionuclides (carbon-11, nitrogen-13 and oxygen-15).

In 2016, the total releases of airborne effluents represent a combined total of 1.04 percent of the DRL. The action levels are set at 5 percent of the DRL and none were exceeded at any time in 2016 – 2017. The annual airborne emissions remained well below the DRLs for the TRIUMF facility. The results demonstrate that the air emissions are being controlled effectively at the TRIUMF facility.

Liquid Effluent

TRIUMF has no liquids releases to surface waters. There are approved radiological liquid effluent releases to the sanitary sewer which are monitored via the various holding tanks and sumps from the facility. Liquid effluent releases for the most recent five year period (2013-2017) are provided in Table 3-4. Over the last five years, releases have been extremely low and orders of magnitude below the DRLs. Specifically, 2016 releases were of 0.000000576 percent of the DRL with 2017 releases reporting at 0.00000460 percent of the DRL.

**TABLE 3-4: TRIUMF-LIQUID EFFLUENT RELEASE TO SANITARY SEWER
(2013 – 2017)**

Parameter	2013 (% DRL) ^a	2014 (% DRL)	2015 (% DRL)	2016 (% DRL)	2017 ^b (% DRL)
Total of various isotopes	0.00000379	0.00000121	0.000000381	0.000000576	0.00000461

a: 100% of the Derived Release Limit equals a 1 mSv annual dose (regulatory limit for member of the public
b: Updated DRL calculations to align with CSA N288.1-14

The results demonstrate that the liquid effluent releases are being controlled effectively at the TRIUMF facility. No action levels were exceeded at any time in 2016 – 2017.

Environmental Management System (EMS)

TRIUMF has developed and is maintaining an EMS which provides a framework for integrated activities with respect to the protection of the environment at the TRIUMF facility. TRIUMF's EMS is described in its Environmental Management System document and includes activities such as establishing annual environmental objectives and targets, conducting internal audits and an annual management review.

Assessment and Monitoring

TRIUMF's environmental monitoring program serves to demonstrate that the site emissions of nuclear materials are properly controlled. The principal monitoring activities, as described in the following paragraphs, are focused on monitoring of storm sewer water, radio-assays of building drains and vegetation samples, as well as gamma/beta measurements at the site boundary. Due to the low levels of emissions from the TRIUMF facility, very little is detected in the environmental monitoring program.

Water Monitoring

TRIUMF conducts periodic sampling of building drains and storm sewer water. Radio-assays of building drains were completed in July. Only natural background radioactive isotopes were detected. Storm sewer water was sampled in March and November at two locations, one upstream and one downstream of the TRIUMF site; only natural background radioactive isotopes were detected.

Vegetation Monitoring

TRIUMF conducts vegetation sampling at 11 locations twice per year. The only radionuclide detected that may be attributed to TRIUMF operation continues to be Beryllium-7 (Be-7), though this radionuclide is also naturally present in the environment as a result of cosmic ray activation. The measured Be-7 activity levels are similar to background levels indicating little to no measurable contribution from TRIUMF. Reported activity levels in 2016 and 2017 are similar to previous years.

Gamma/beta Monitoring

TRIUMF conducts gamma/beta dose monitoring at nine locations along TRIUMF's security fence. The gamma/beta radiation effective dose rates are measured using Landauer environmental dosimeters. As part of their approved radiation protection program TRIUMF has established a maximum acceptable dose rate of 0.15 $\mu\text{Sv/h}$ above background for the site fence boundary. In 2016 – 2017, the highest six month average gamma/beta measurements at the TRIUMF site was recorded on the east side of the site at 0.09 $\mu\text{Sv/h}$ above background. Thus dose rates at the fenceline are below the levels established within their approved radiation protection program.

CNSC Independent Environmental Monitoring Program (IEMP)

To complement ongoing compliance activities, the CNSC implements an Independent Environmental Monitoring Program (IEMP) to independently verify that the public and the environment around licensed nuclear facilities are protected. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological (nuclear) and non-radiological (hazardous) substances in those samples. CNSC staff conducted independent environmental monitoring around the TRIUMF facility in 2016. The results are available on the CNSC's IEMP webpage. The IEMP results indicate that the public and the environment in the vicinity of the TRIUMF facility are protected, and there are no expected health impacts as a result of the operation of TRIUMF's particle accelerator.

Protection of the Public

The licensee must demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the facility.

Releases of nuclear substances were well within licence limits with doses being an extremely small fraction of the regulatory public dose limit. There were also no releases of hazardous substances (non-radiological) to the environment in 2016 – 2017 from TRIUMF that would pose a risk to the public or environment.

Based on CNSC staff reviews of the programs at the TRIUMF, CNSC staff conclude that the public continues to be protected from facility emissions.

Environmental Risk Assessment (ERA)

Following a 2015 compliance onsite inspection, CNSC staff requested TRIUMF to conduct a screening level environmental risk assessment in accordance with the CSA standard N288.6-12 *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. ERAs provide the basis for the scope and complexity of monitoring program covered by CSA standard N288.4-10 *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* and CSA standard N288.5-11 *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*. This was requested to ensure that TRIUMF's existing programs adequately account for the recently (2012, 2015 and 2016) updated requirements contained in these standards. TRIUMF submitted its screening level environmental risk assessment in November 2017. CNSC staff reviewed the document and found that it adequately addressed the compliance requirements of the CSA standards.

CLSI

CLSI does not release radiological contaminants to the environment. CLSI operates an accelerator that does not produce any emissions. An inspection was performed in July 2017 and confirmed the fact that there is no release to the environment. As there are no releases to the environment, there are no data to present in this section.

3.7 Conventional Health and Safety

The Conventional Health and Safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

This SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness

The rating for the conventional health and safety SCA was Satisfactory for all Class IB accelerator facilities in 2016 – 2017, which is unchanged from previous years for TRIUMF. Following the inspection in July 2017, the rating for CLSI increased from Satisfactory to Fully Satisfactory.

Licenses are required to report unsafe occurrences to the CNSC as directed by section 29 of the *General Nuclear Safety and Control Regulations*. These reports include serious illness or injury incurred or possibly incurred as a result of licensed activity. No unsafe occurrences were reported by any of the Class IB accelerator facilities between 2016 and 2017.

Table 3-5 summarizes the number of recordable LTIs reported by Class IB accelerator facilities during 2016 – 2017. An LTI is an injury or illness resulting in lost days beyond the date of injury as a direct result of an occupational injury or illness incident.

TABLE 3-5: CLASS IB ACCELERATOR FACILITIES LOST-TIME INJURIES, 2013 – 2017

Facility	2013	2014	2015	2016	2017
TRIUMF	3	0	4	0	3
CLSI	2	0	1	0	1

The numbers of reportable LTIs reported by the Class IB accelerator facilities have remained low during 2016 – 2017. There is a total of 4 LTIs reported for this period. The Class IB accelerator facilities have implemented conventional health and safety programs satisfactorily during 2016 – 2017 and their programs are effective in protecting the health and safety of persons working in their facilities.

TRIUMF

Performance

A key performance indicator for conventional health and safety SCA is the number of Lost Time Injuries (LTI) that occur per year.

As indicated in Table 3-5, TRIUMF reported three LTIs in 2017. Details of the LTIs are provided in Appendix F.

Practices

TRIUMF's activities and operations must comply with not only the NSCA and its associated regulations, but also Part II of the *Canada Labour Code* and *British Columbia's Occupational Health and Safety Regulation (OHSR)*.

In 2017, TRIUMF completed the redesign of industrial safety signage consistent with ANSI Z535.2. The changes in signage will be implemented in 2018. TRIUMF further revised the *TRIUMF Safety Note 1.3 Lockout Policy and Procedures Document-539* to include the role of supervisory locks for continuation of lockout. Training will be completed in early 2018. TRIUMF also revised the management walkthroughs and implemented the new process in November 2017.

Awareness

TRIUMF continues to develop and maintain a comprehensive occupational health and safety management program in 2016 – 2017. As part of raising awareness about safety in the workplace, TRIUMF participated in May 2017 in North American Occupational Safety Week. In September 2017, TRIUMF hosted the 13th International Technical Safety Forum with an objective to share expertise and lessons learned on technical safety and operational aspects of safety programs. Representatives from fifteen laboratories and institutions from nine countries participated in this forum.

CNSC staff will continue to monitor the effectiveness of the improvements initiatives through regular onsite inspection.

CLSI

Performance

As indicated in Table 3-5, CLSI reported one LTI in 2017. Details of the LTI are provided in Appendix F.

In 2017 CNSC staff conducted inspection focused on Conventional Health and Safety and found no deficiency in the program. CLSI received a Fully Satisfactory rating for this SCA.

Practices

The regulation of conventional health and safety at CLSI involves both Employment and Social Development Canada (ESDC) and the CNSC. CNSC staff monitor compliance with CNSC regulatory reporting requirements. On occasion, when a concern is identified, ESDC staff are consulted and asked to take appropriate action. The licensees submit hazardous occurrence investigation reports to both ESDC and the CNSC, in accordance with their respective reporting requirements. The facilities are also subject to provincial legislation, as applicable with each licensee's provincial jurisdiction.

In addition to the NSCA and its associate regulations, CLSI's activities and operations must comply with Part II of the *Canada Labour Code*.

CLSI Occupational Health and Safety Committee (OHSC) inspects the facility as required by the *Canada Occupational Health and Safety Regulations*. The inspections identify hazards and controls to mitigate the hazard. The findings of these inspections are discussed and tracked by management

Awareness

CLSI continues to develop and maintain a comprehensive occupational health and safety management program. An example is that CLSI sends weekly safety tip emails to engage all staff and visitors on hazards encountered at the facility. CNSC staff will continue to monitor the effectiveness of the improvement initiatives through regular onsite inspections.

3.8 Public Information and Disclosure

Class IB accelerator facilities have a responsibility to inform the public about their nuclear facilities and activities. CNSC staff recognize that Class IB accelerators are low-risk facilities and that a full-scale public information program, as undertaken by larger nuclear facilities, is not warranted. However, the CNSC requires these licensees to provide open and transparent information to the public and transition to the requirements of regulatory document RD/GD-99.3³, Public Information and Disclosure. The objective is to ensure that timely information about the health, safety and security of persons and the environment and other issues associated with the nuclear facility are effectively communicated.

CNSC staff verified through annual compliance reporting that public information and disclosure programs were being implemented satisfactorily during 2016 – 2017, ensuring that the programs remain effective at communicating useful information about the health, safety and security of persons and the environment and other matters of public interest associated with these facilities.

During 2016 – 2017, all Class IB accelerator facilities actively provided information on the operations of their accelerators. TRIUMF continued to generate public's interest through information program and outreach activities through facility tours, providing public lecture series and their Artist in Residence program. TRIUMF uses various pathways and platforms to share information and communicate with broader public. In 2017, TRIUMF recruited a Public Programs Manager and a communications Associate committed to TRIUMF 50th anniversary programming. CLSI continued to increase traditional and social media reach and participated in community outreach events. As part of the program CLSI produced Research Reports for 2015 and 2016. In 2017 CLSI started to work on new promotional literature for several programs and initiatives.

The Class IB accelerator facilities continued to provide public information during 2016 – 2017, and their programs are effective at communicating information about the health, safety and security of persons and the environment and other issues associated with their facilities.

³ RD/GD-99.3 was superseded by REGDOC-3.2.1 *Public Information and Disclosure* in May 2018

3.9 Financial Guarantees

The CNSC requires licensees to maintain preliminary decommissioning plans (PDP) and revise them every five years, at a minimum. CNSC staff review the plans against regulatory requirements and to ensure that they contain credible cost estimates. These cost estimates form the basis for the financial guarantee that assures sufficient funding is available to cover the cost of the decommissioning work at the end of the lifetime of the facility. Table 3-6 lists the accelerator facilities along with the current value of their respective Nuclear Reactor Reserve Fund (NRRR), which constitutes part or all of their Financial Guarantee. Licensees may contribute annual payments to the NRRR until the financial guarantee is funded to the full value of the decommissioning cost, and they may include other financial instruments as part of their financial guarantee agreement.

TABLE 3-6: FINANCIAL GUARANTEES THE CLASS IB ACCELERATORS

Facility	Canadian dollar amount
CLSI	10,241,800
TRIUMF	10,800,000

3.10 Regulatory Developments

There were no changes to any of the licences for the Class IB facilities in 2016 and 2017.

Table 3-7 lists the updates to the CNSC regulatory documents that were made in 2016 – 2017, which affect the Class IB accelerator licensees.

TABLE 3-7: UPDATES TO REGULATORY DOCUMENTS APPLICABLE TO CLASS IB ACCELERATORS

Regulatory document	Publication	TRIUMF Status	CLSI Status
REGDOC-2.2.2, <i>Personnel Training, Version 2</i>	2016	Implemented	Implemented
REGDOC-2.9.1: <i>Environmental Protection: Environmental Principles, Assessments and Protection Measures</i>	2017	Implemented	Implemented
REGDOC-2.13.1: <i>Safeguards and Nuclear Material Accountancy</i>	2018	Implementation plan	N/A
REGDOC-3.1.2, <i>Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills</i>	2018	Implementation plan	Implementation plan
REGDOC-3.2.1, <i>Public Information and Disclosure</i>	2018	Implementation plan	Implementation plan

Table 3-8 lists the updates to the regulatory documents that were made in 2016 – 2017, which potentially affect the Class IB accelerator licensees.

TABLE 3-8: UPDATES TO INDUSTRY STANDARDS APPLICABLE TO CLASS IB ACCELERATORS

Standard	Publication	TRIUMF Status	CLSI Status
N286-12 <i>Management system requirements for nuclear facilities</i>	2012	Implementation plan Planned inspection Q4 2018	Implemented Planned completion in 2018

CNSC staff will continue to verify the implementation of the most recent updates of these regulatory documents and industry standards by licensees.

3.11 Conclusion for the Class IB Accelerators

During 2016 – 2017, CNSC staff continued to provide regulatory oversight of the Class IB accelerator facilities in Canada through inspections, review of licensee documents and an effective implementation of CNSC’s regulatory framework. There were no radiological dose limit exceedances to the public or the workers. Although there were two small unintentional releases to the environment from TRIUMF in 2017, both releases did not pose any risk to the health and safety of the public and the environment. While most of the SCA were rated in 2016 as Satisfactory or above, CLSI received a Below Expectation rating in Management Systems and TRIUMF in Waste Management. Both licensees have implemented or are in the process of implementing corrective actions approved by CNSC staff and in 2017 Class IB accelerator facilities were rated Satisfactory or Fully Satisfactory all 14 SCAs.

CNSC staff confirm that the Class IB accelerator licensees continue to operate these facilities while protecting the health and safety of the public and the workers, the environment and security, and in compliance with Canada’s international obligations on the peaceful use of nuclear energy.

4 OVERALL CONCLUSIONS

This report summarizes CNSC staff's assessment on the performance of small nuclear research reactor and Class IB particle accelerator facilities in 2016 and 2017. CNSC staff conclude that these facilities operated safely during this review period. This conclusion is based on assessment of licensee activities, which included site inspections, review of reports submitted by licensees, event and incident reviews with follow-up and general communication and exchange of information with the licensees.

For the 2016 – 2017 calendar years, the performance in all 14 SCAs for the facilities being assessed are as follows:

- Research reactor facilities were rated as Satisfactory or better.
- Class IB particle accelerator facilities were rated as Satisfactory or better, with the exception of Canadian Light Source Inc., which was rated Below Expectations in management system in 2016, and TRIUMF, which was rated Below Expectations in waste management in 2016. Both licensees remedied these areas and were rated Satisfactory or better in 2017.

CNSC staff's compliance activities confirmed that:

- Radiation protection programs at all facilities were adequate in controlling radiation exposures and keeping doses as low as reasonably achievable. There were no radiological dose limits exceeded for either the public or the workers.
- Environmental protection programs at all facilities were effective in protecting the environment.
- Conventional health and safety programs at all facilities continue to protect workers.

CNSC staff will continue to provide regulatory compliance oversight to all licensed facilities to ensure that the facilities continue to make adequate provision to protect the health, safety and security of workers, Canadians and the environment, as well as the implementation of Canada's international obligations on the peaceful use of nuclear energy.

REFERENCES

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2. Non-Power Reactor Operating Licence for the Royal Military College SLOWPOKE-2 Reactor, NPROL-20.00/2023, June 26, 2013 (e-Doc 4097347).
3. Non-Power Reactor Operating Licence for the University of Alberta SLOWPOKE-2 Reactor, NPROL-18.01/2023, September 22, 2017 (e-Doc 5265794).
4. Non-Power Reactor Operating Licence for the Saskatchewan Research Council SLOWPOKE-2 Reactor, NPROL-19.00/2023, June 26, 2013 (e-Doc 4097307).
5. Permis d'exploitation d'un réacteur de faible puissance SLOWPOKE-2 et l'assemblage nucléaire non-divergent PERFP-9A.01/2023, June 30, 2016 (e-Doc 5014905).
6. Memorandum from Directorate of Environmental Radiation Protection and Assessment to Nuclear Laboratories and Research Reactors Division. CNSC Staff position Regarding the Environmental Protection Requirements for SLOWPOKE-2 Facilities (e-Doc 4059738).
7. Class IB Particle Accelerator Operating Licence for TRIUMF Accelerators Inc., June 20, 2012, PA1OL-00/2022 (e-Doc 3960855).
8. Class IB Particle Accelerator Operating Licence for the Canadian Light Source Incorporated, PA1OL-02.01/2022, March 30, 2015 (e-Doc 4703454).

A. Safety and Control Area Framework

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 SCAs that are grouped according to their functional areas of management, facility and equipment, and core control processes. These SCAs are further divided into specific areas that define the key components of the SCA. The following table shows the CNSC's SCA framework.

Functional area	Safety and control area	Definition	Specific areas
Management	Management system	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.	<ul style="list-style-type: none"> ▪ Management system ▪ Organization ▪ Performance assessment, improvement and management review ▪ Operating Experience (OPEX) ▪ Change management ▪ Safety culture ▪ Configuration management ▪ Records management ▪ Management of contractors ▪ Business continuity
	Human performance management	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 out their duties.	<ul style="list-style-type: none"> ▪ Human performance program ▪ Personnel training ▪ Personnel certification ▪ Initial certification examinations and requalification tests ▪ Work organization and job design ▪ Fitness for duty

Functional area	Safety and control area	Definition	Specific areas
	Operating performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	<ul style="list-style-type: none"> ▪ Conduct of licensed activity ▪ Procedures ▪ Reporting and trending ▪ Outage management performance ▪ Safe operating envelope ▪ Severe accident management and recovery ▪ Accident management and recovery
Facility and equipment	Safety analysis	Covers 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.	<ul style="list-style-type: none"> ▪ Deterministic safety analysis ▪ Hazard analysis ▪ Probabilistic safety analysis ▪ Criticality safety ▪ Severe accident analysis ▪ Management of safety issues (including R&D programs)
	Physical design	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.	<ul style="list-style-type: none"> ▪ Design governance ▪ Site characterization ▪ Facility design ▪ Structure design ▪ System design ▪ Component design

Functional area	Safety and control area	Definition	Specific areas
	Fitness for service	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 ensure all equipment is available to perform its intended design function when called upon to do so.	<ul style="list-style-type: none"> ▪ Equipment fitness for service / equipment performance ▪ Maintenance ▪ Structural integrity ▪ Aging management ▪ Chemistry control ▪ Periodic inspection and testing
Core control processes	Radiation protection	Covers the implementation of a radiation protection program in accordance with the <i>Radiation Protection Regulations</i> . The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained ALARA.	<ul style="list-style-type: none"> ▪ Application of ALARA ▪ Worker dose control ▪ Radiation protection program performance ▪ Radiological hazard control ▪ Estimated dose to public
	Conventional health and safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.	<ul style="list-style-type: none"> ▪ Performance ▪ Practices ▪ Awareness
	Environmental protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	<ul style="list-style-type: none"> ▪ Effluent and emissions control (releases) ▪ Environmental management system (EMS) ▪ Assessment and monitoring ▪ Protection of the public ▪ Environmental risk assessment
	Emergency management	Covers emergency plans and emergency preparedness programs that exist for	<ul style="list-style-type: none"> ▪ Conventional emergency

Functional area	Safety and control area	Definition	Specific areas
	and fire protection	emergencies and for non-routine conditions. This area also includes any results of participation in exercises.	preparedness and response <ul style="list-style-type: none"> ▪ Nuclear emergency preparedness and response ▪ Fire emergency preparedness and response
	Waste management	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 area also covers the planning for decommissioning.	<ul style="list-style-type: none"> ▪ Waste characterization ▪ Waste minimization ▪ Waste management practices ▪ Decommissioning plans
	Security	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.	<ul style="list-style-type: none"> ▪ Facilities and equipment ▪ Response arrangements ▪ Security practices ▪ Drills and exercises
	Safeguards and non-proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the <i>Treaty on the Non-Proliferation of Nuclear Weapons</i> .	<ul style="list-style-type: none"> ▪ Nuclear material accountancy and control ▪ Access and assistance to the IAEA ▪ Operational and design information ▪ Safeguards equipment, containment and surveillance ▪ Import and export
	Packaging and transport	Programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility.	<ul style="list-style-type: none"> ▪ Package design and maintenance ▪ Packaging and transport

Functional area	Safety and control area	Definition	Specific areas
			<ul style="list-style-type: none"> ▪ Registration for use
Other Matters of Regulatory Interest			
<ul style="list-style-type: none"> ▪ Environmental assessment ▪ CNSC consultation-Aboriginal ▪ CNSC consultation-other ▪ Cost recovery ▪ Financial guarantees ▪ Improvement plans and significant future activities ▪ Licensee public information program ▪ Nuclear liability insurance 			

B. Rating Methodology and Definitions

Performance ratings used in this report are defined as follows:

Fully Satisfactory (FS)

Compliance with regulatory requirements is fully satisfactory. Compliance within the area exceeds requirements and CNSC expectations. Compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Compliance with regulatory requirements is unacceptable, and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

C. Safety and Control Area Ratings for TRIUMF 2013 – 2017

Safety and control area	2013	2014	2015	2016	2017
Management system	SA	BE	SA	SA	SA
Human performance management	SA	BE	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	BE	SA	SA	SA	SA
Radiation protection	SA	FS	FS	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	BE	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	FS	FS	FS	FS
Packaging and transport	SA	SA	SA	SA	SA

D. Safety and Control Area Ratings for CLSI 2013 – 2017

Safety and control area	2013	2014	2015	2016	2017
Management system	BE	SA	SA	BE	SA
Human performance management	BE	SA	BE	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	FS	FS	FS	FS
Physical design	SA	FS	FS	FS	FS
Fitness for service	SA	SA	SA	FS	FS
Radiation protection	SA	FS	FS	FS	FS
Conventional health and safety	SA	SA	SA	SA	FS
Environmental protection	SA	FS	FS	FS	FS
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	FS	FS	FS	FS
Security	SA	FS	FS	FS	FS
Safeguards and non-proliferation*	N/A	N/A	N/A	N/A	N/A
Packaging and transport	SA	FS	FS	FS	FS

* N/A: There are no safeguards verification activities associated with this facility

E. Facility Specific Total Annual Load of Radionuclides Directly Released to the Environment

The CNSC REGDOC 2.9.1 requires Class I facilities to monitor and report on relevant radionuclide releases to the environment. As radionuclides differ in the types of radiation they release (e.g., simplified as alpha, beta, gamma/photon), their emission energy levels and other factors related to determining dose implications, releases presented in the main body of CNSC Regulatory Oversight Reports are often presented as a percentage of the derived release limit. The DRL, unless otherwise indicated, represents a release limit that, based on conservative modeling assumptions, represent a dose of 1 mSv/year to the most exposed member of the public. As a result, DRLs are extremely site specific.

For the sake of consistency and transparency, the CNSC is providing standardized reporting of total annual load for radionuclide released directly to the environment. As research reactors and Class IB accelerators are highly contained and controlled facilities, direct releases to the environment are limited to small residual releases to the atmosphere at two facilities, the McMaster Nuclear Reactor and the TRIUMF accelerator. There are no direct releases to surface waters, though some facilities have approved releases to sewer.

Table E-1: Total annual releases to air from McMaster Nuclear Reactor

Year	Argon-41 (Bq)	Iodine-125 (Bq)
2013	1.05E+12	1.80E+08
2014	9.30E+11	1.70E+08
2015	8.40E+11	1.70E+08
2016	7.10E+11	2.50E+08
2017	6.90E+11	8.20E+08

Table E-2: Total annual releases to air from TRIUMF accelerator

Year	β^+ emitters (Bq)	Argon-41 (Bq)	Tritium (Bq)	Noble gases (Bq)	Volatiles and Particulates (Bq)
2015	6.59E+13	6.48E+12	1.28E+12	1.02E+12	4.17E+08
2016	6.64E+13	6.46E+12	1.22E+12	7.81E+11	4.32E+08
2017	6.78E+13	6.46E+12	1.20E+12	7.81E+11	1.20E+08

F. LOST-TIME INJURIES

Table F-1: Lost-time injuries, TRIUMF, 2017

Lost-time injury	Action taken
<p>A worker broke his wrist handling wire mesh taken down from a false ceiling</p> <p>After removing the sheets of wire mesh from the false ceiling as part of the renovation work, the worker set about to roll up the sheets for disposal. He yanked on one end of the sheet without realizing that he was standing on the other end. He lost his balance and broke his wrist trying to arrest his fall.</p>	<p>The incident was not related to the licensed activity. Corrective actions included ensuring that assistance is summoned when a job is too large to manage with one person.</p>
<p>A worker was injured while using an angle grinder</p> <p>The worker was cutting a piece of stainless steel pipe with a 5-inch angle grinder which had a new blade for this work project. As he was cutting into the pipe the blade caught and kicked back, cutting the protective glove and his right thumb on the posterior side, damaging the tendon.</p>	<p>The incident was related to the licensed activity. TRIUMF reviewed the incident and it was determined that all safety procedures were followed, the job was well planned and the appropriate work permit activated. The worker was skilled in the use of the tool and he was wearing the appropriate PPE for the job. No corrective action was identified.</p>
<p>A worker got back strain associated with working two extra shifts on the weekend.</p>	<p>The incident was not related to the licensed activity. The incident resulted in one day of lost time.</p>

Table F-2: Lost-time injuries, CLSI, 2017

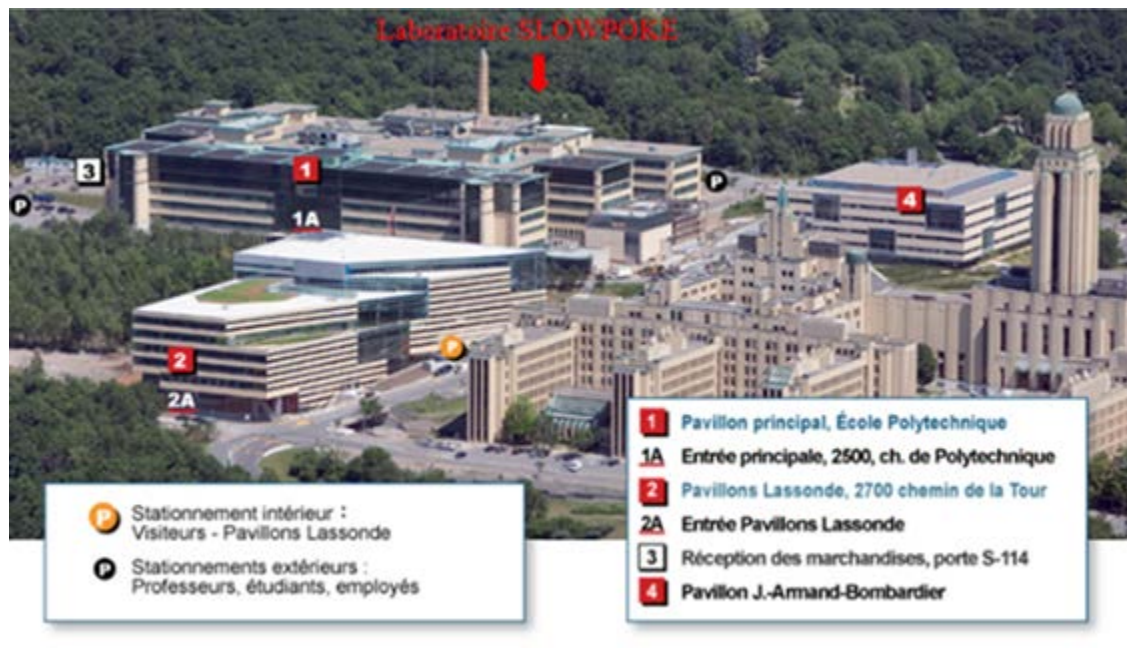
Lost-time injury	Action taken
<p>In preparation for completing an electrical installation, a CLSI electrician was removing insulation from the end of a wire with a knife. The knife slipped and the worker received a cut to the palm of the left hand. The cut required several stitches, and resulted in 1 lost day from work.</p>	<p>The incident was related to the licensed activity.</p>

G. ÉCOLE POLYTECHNIQUE – VERSION FRANÇAISE

École Polytechnique (ÉPM) exploite un réacteur SLOWPOKE-2 en vertu du permis PERFP-9A.01/2023 [5], émis par la Commission canadienne de sûreté nucléaire (CCSN) en 2016 pour une durée de 7 ans.

Cette installation est située sur le campus de l'Université de Montréal, à Montréal, Québec, comme l'illustre la figure G-1. Le réacteur, qui est en exploitation depuis 1976, est utilisé pour la recherche, l'enseignement, l'analyse neutronique et la production d'isotopes. Le cœur du réacteur est composé d'uranium faiblement enrichi (UFE).

FIGURE G-1: VUE AÉRIENNE DE L'ÉCOLE POLYTECHNIQUE DE MONTRÉAL



Pendant la période 2016 – 2017, ÉPM a exploité le réacteur SLOWPOKE-2 de façon sécuritaire, et aucun problème lié à l'exploitation n'a été rapporté.

Le personnel de la CCSN a inspecté l'installation en décembre 2017, visant dix domaines de sûreté et de réglementation (DSR) ainsi que d'autres éléments d'ordre général liés au permis, tel que le programme d'information et de divulgation publiques (PIDP). Quatre mesures correctives reliées au système de gestion et au PIDP ont été soulevées et le personnel de la CCSN en assure le suivi jusqu'à ce que celles-ci soient complétées. Spécifiquement :

- ÉPM doit compléter la page web supportant le PIDP
- ÉPM doit exécuter des audits à une fréquence annuelle, conformément aux critères de son système de gestion
- ÉPM doit compléter sa révision de ses procédures, conformément aux engagements pris auprès du personnel de la CCSN

- ÉPM doit mettre à jour le registre des sources scellées afin d'inclure les trois sources provenant de l'assemblage sous-critique

École Polytechnique exploite aussi un assemblage sous-critique, situé dans une salle adjacente au réacteur SLOWPOKE-2. Cet assemblage est composé de tiges d'uranium naturel et de sources de neutrons qui sont insérées manuellement dans un ensemble de blocs de graphite. Cette installation est utilisée pour fins d'enseignement et de recherche. Quand l'installation n'est pas en usage, les tiges d'uranium sont entreposées dans un coffre verrouillé, et les sources de neutrons sont aussi entreposées dans des contenants blindés et verrouillés.

L'installation sous-critique faisait l'objet d'un permis distinct. Cependant, ÉPM a fait une demande auprès de la Commission afin de consolider ce permis avec celui du réacteur SLOWPOKE-2, ceci dans le but d'améliorer l'efficacité du processus de conformité réglementaire. La demande a été approuvée par la Commission le 30 juin 2016, et le permis PERFP-9A.01/2023 [5] a été émis, regroupant ainsi l'installation SLOWPOKE-2 et l'assemblage sous-critique sous un même permis. L'assemblage sous-critique n'est que rarement utilisé, sa dernière exploitation remontant à 2012. ÉPM n'a pas indiqué à la CCSN ses projets futurs ou changements pour ses installations.