Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL

CMD: 19-H100

Date signed/signé le : June 10, 2019

A Licence Amendment

Saskatchewan Research Council

SLOWPOKE-2 Reactor Facility

Hearing in writing based solely on written submissions

Scheduled for:

July 2019

Submitted by:

CNSC Staff

Une modification de permis

Saskatchewan Research Council

Installation nucléaire SLOWPOKE-2

Audience fondée uniquement sur des mémoires

Prévue pour :

Juillet 2019

Soumise par :

Le personnel de la CCSN

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Summary

This CMD presents information about the following matters of regulatory interest with respect to Saskatchewan Research Council:

- Licence amendment to authorize the decommissioning of the Saskatchewan Research Council SLOWPOKE-2 Reactor

CNSC staff recommend the Commission take the following action:

- Amend the Non-Power Reactor Licence for the Saskatchewan Research Council SLOWPOKE-2 Reactor to include decommissioning activities

The following items are attached:

- Current licence
- Proposed licence
- Environmental Protection Review Report

Résumé

Le présent CMD présente de l'information sur un ensemble de questions d'ordre réglementaire concernant Saskatchewan Research Council :

- La modification du permis afin d'autoriser le déclassement du réacteur SLOWPOKE-2 de Saskatchewan Research Council

La Commission pourrait considérer prendre les mesures suivantes :

- Modifier le permis d'un réacteur de faible puissance SLOWPOKE-2 de Saskatchewan Research Council afin d'inclure les activités de déclassement

Les pièces suivantes sont jointes :

- Permis actuel
- Ebauche du permis proposé
- Rapport d'évaluation sur la protection de l'environnement

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Signed/signe le

June 10, 2019

Haidy Tadros

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice generate de la

Direction de la reglementation du cycle et des installations nucleates

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EXECUTIVE SUMMARY

Saskatchewan Research Council (SRC) operates a SLOWPOKE-2 research reactor, located at the SRC Environmental Analytical Laboratories complex within the Innovation Place Research Park, in Saskatoon, Saskatchewan.

SRC's current non-power reactor operating licence is valid until June 30, 2023. In December 2018, SRC decided to decommission the facility and submitted an application to the Canadian Nuclear Safety Commission (CNSC) to amend the current licence to include decommissioning as part of the licensed activities. The end-state objective is to return the decommissioned areas of the facility to a state that allows for unrestricted use. A future SRC application for a licence to abandon would allow that use, on approval by the Commission.

CNSC staff have performed annual compliance inspections of the SRC SLOWPOKE-2 reactor facility, which have confirmed SRC's performance as satisfactory in all 14 safety and control areas (SCAs). No releases to the environment have occurred that would pose a risk to the public or the environment, and the decommissioning project is not expected to cause any additional impact.

CNSC staff conducted an environmental protection review under the *Nuclear Safety and Control Act* (NSCA) for this licence amendment, and concluded that SRC has made adequate provision for the protection of the environment.

Based on CNSC staff's technical assessment of SRC's application and supporting documents, and considering SRC's performance during the current licence period, CNSC staff conclude that:

- SRC is qualified to carry out the activities authorized by the proposed licence; and
- SRC will, in carrying out those activities, make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

CNSC staff recommend amending SRC's licence in order to authorize the decommissioning of the SLOWPOKE-2 reactor facility.

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

PART ONE

This Commission Member Document (CMD) is presented in two parts.

Part One includes:

- An overview of the matter being presented;
- Discussion pertaining to the safety and control areas (SCAs) that are relevant to this submission;
- Discussion about other matters of regulatory interest;
- Overall conclusions and recommendations; and
- Addenda material that complements items 1 through 4 (including the Environmental Protection Review Report).

Part Two provides all available information pertaining directly to the current and proposed licence.

1. OVERVIEW

1.1 Background

SRC operates a SLOWPOKE-2 (Safe Low Power Kritical Experiment) nuclear research reactor under the Non-Power Reactor Operating Licence NPROL-19.00/2023 [1]. This licence was renewed by the Commission in June 2013 for a period of ten years, with an expiry date of June 30, 2023. The SLOWPOKE-2 reactor provides a source of neutrons for neutron activation analysis and isotope production. It is also used for teaching purposes in conjunction with the University of Saskatchewan. The reactor has been in operation since 1981.

The facility is located at 422 Downey Road, within the Innovation Place Research Park, in Saskatoon, Saskatchewan (Figure 1). The site is bound by: the University of Saskatchewan to the south and west; the Canadian Pacific Railway tracks to the north; Preston Avenue to the east; and 400 meters from the South Saskatchewan River.

Figure 1: Saskatchewan Research Council SLOWPOKE-2 Reactor Facility

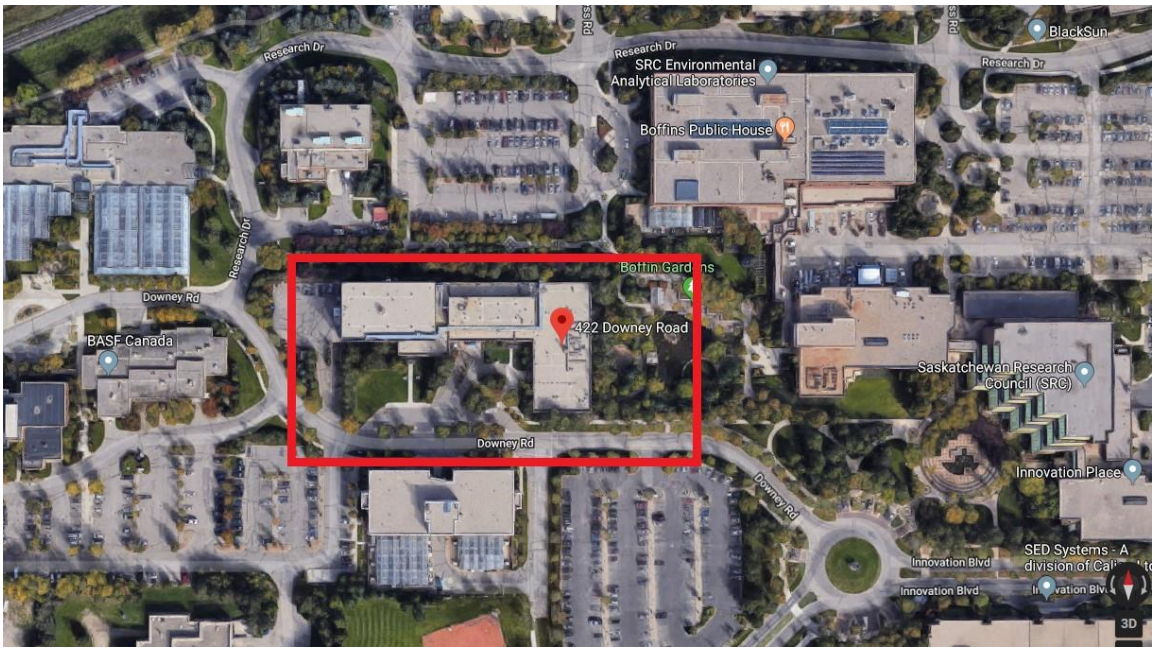

Figure 1: Aerial view of the building housing the SLOWPOKE-2 reactor within the Innovation Place Research Park. Credit: Google Maps

The SLOWPOKE-2 reactor is a 20 kW-thermal sealed-container-in-pool type research reactor. The reactor is light water cooled and moderated, and operates on 93% enriched uranium fuel, also known as high-enriched uranium (HEU). The core is cooled by natural convection and is surrounded by a beryllium reflector. SLOWPOKE-2 reactors are inherently safe by design, meaning that the reactor cannot exceed its safe design limits even if left unattended. The safety analysis for this reactor confirms that no credible event could result in any significant release that could be harmful to the public or the environment. SLOWPOKE-2 reactors

are considered low-risk in accordance with CNSC's risk-ranking process (Addendum A).

The facility consists of the reactor room, two rooms for support equipment and a sample storage room. The reactor itself is located in a concrete well underneath the floor of the reactor room. Figure 2 shows a cross section of the SLOWPOKE-2 reactor.

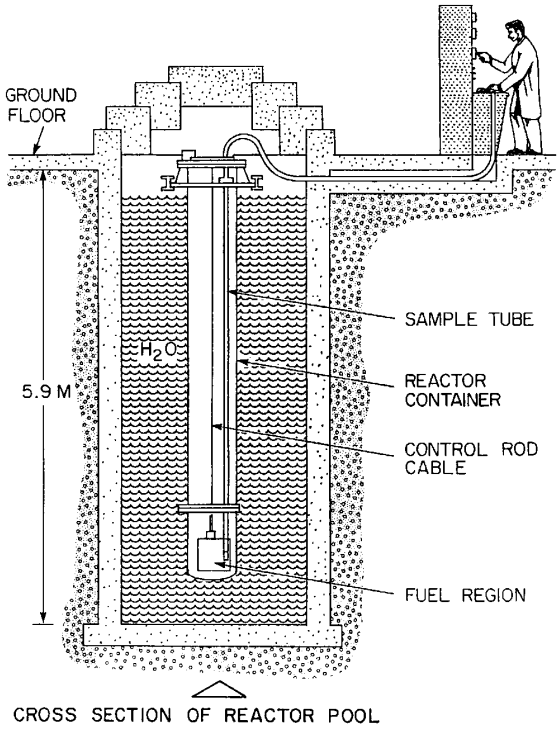

Figure 2: SLOWPOKE-2 Reactor. Credit: SRC.

1.2 Summary of SRC's Application

SRC notified CNSC staff of its intention to decommission the SLOWPOKE-2 reactor facility in May 2018 [2]. Decommissioning is not part of the licensed activities listed under Part IV of the current operating licence [1] and for this reason, the licence must be amended to authorize decommissioning.

On December 14, 2018, SRC applied to the CNSC [3] for an amendment to their existing licence to allow for decommissioning of the SLOWPOKE-2 reactor facility.

As part of its application, SRC submitted a Detailed Decommissioning Plan (DDP) [4], including a hazards assessment and Decommissioning Work Instructions [5], which provide the steps necessary to ensure the health, safety, and protection of workers, the public, and the environment. As part of the decommissioning project, SRC plans to dismantle the reactor, segregate and remove the materials for storage or disposal at licensed waste management

facilities, and restore the site to its original state for unrestricted use (referred to as the end-state).

The decommissioning project will include taking concrete core samples from the reactor pool for activation assessment. After the structural materials and inner surface coating are confirmed as below the clearance criteria, which are found in the *Nuclear Substance and Radiation Devices Regulations*, the reactor pool will be filled with concrete to the floor level. CNSC staff will perform an inspection to verify the completion of the decommissioning work and the results from the radiological survey before the pool is filled with concrete. SRC will prepare an End-State Report for submission to CNSC staff after completion of the project, which will include the survey results.

The fuel core will be removed and sent to a licensed facility. This activity, along with removal of the reactor water, is authorized under the current operating licence. The transport of the spent fuel will be subject to a separate licence and considered by a Designated Officer.

Similar decommissioning projects were successfully completed at a number of SLOWPOKE-2 facilities in Canada, including University of Toronto, Dalhousie University and recently, University of Alberta in 2017 [6]. The decommissioning process proposed by SRC, including selected tools and technologies, draws lessons from the above decommissioning projects, particularly the more recent decommissioning of University of Alberta SLOWPOKE-2 reactor facility. SRC is contracting CANDU Energy for the decommissioning work, which was also hired by University of Alberta for their SLOWPOKE-2 decommissioning project in 2017.

CNSC staff have reviewed SRC's request and the supporting documentation to amend the licence to authorize the final decommissioning of the facility. CNSC staff conclude that the application meets the requirements of the *General Nuclear Safety and Control Regulations* and the *Class I Nuclear Facilities Regulations* to support the licence amendment for the decommissioning project.

2. MATTERS FOR CONSIDERATION

2.1 Performance Ratings

CNSC staff assess the performance of licensees based on all fourteen SCAs on a continuous basis through annual inspections, ongoing performance monitoring and the review of licensees' annual compliance reports (ACR). See Addendum D, "Safety and Control Area Framework", for further information about SCAs.

Since SRC's last licence renewal in 2013, all SCAs have been consistently rated as Satisfactory (SA), as shown in Table 1.

Table 1: Safety and Control Areas Performance Ratings

SAFETY AND CONTROL AREAS	RATING 2013 – 2018
Management System	SA
Human Performance Management	SA
Operating Performance	SA
Safety Analysis	SA
Physical Design	SA
Fitness for Service	SA
Radiation Protection	SA
Conventional Health & Safety	SA
Environmental Protection	SA
Emergency Management and Fire Protection	SA
Waste Management	SA
Security	SA
Safeguards and Non-Proliferation	SA
Packaging and Transport	SA

2.2 Relevant Safety and Control Areas

The CNSC uses a risk-informed regulatory approach in the management and control of regulated facilities and activities. The depth of regulatory reviews of each SCA and the baseline frequency of regulatory compliance activities are established by the potential risk associated with the activities to be authorized.

For the purpose of this application, CNSC staff considered the following SCAs as they relate specifically to the decommissioning of the SRC facility:

- Human Performance Management
- Radiation Protection
- Environmental Protection
- Waste Management

These SCAs are discussed in Section 3 of this CMD.

All other SCAs are relevant in the broader context of the operation of the facility and are assessed through ongoing oversight activities. The baseline compliance program provides assurance that all SCAs remain satisfactory during the entire life cycle of the facility, including decommissioning operations.

2.3 Regulatory and Technical Basis

The regulatory and technical bases for the matters discussed in this CMD are provided in Addendum C of this document.

3. ASSESSMENT OF RELEVANT SCAS

CNSC staff's assessment of the SCAs that are relevant to this application is presented in the following sections. This assessment was based on the review of SRC's application, including supporting documentation and ongoing compliance verification activities carried out over the licence period.

3.1 Human Performance Management

The Human Performance Management SCA covers activities that enable effective human performance through the development and implementation of processes ensuring that licensee staff are sufficient in number, in all relevant job areas, and that licensee staff have the necessary knowledge, skills, procedures, and tools in place to safely carry out their duties.

3.1.1 Trends

Through the review of SRC's documentation and CNSC staff's compliance inspections, CNSC staff found that SRC's performance in the area of Human Performance Management meets CNSC regulatory requirements. CNSC staff rated SRC's performance for the Human Performance Management as satisfactory since the renewal of their licence on July 1, 2013.

HUMAN PERFORMANCE MANAGEMENT				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The training program is a specific area of the Human Performance Management SCA and is of particular interest for this assessment. CNSC staff continue to rate the Human Performance Management SCA at the SRC SLOWPOKE-2 reactor facility as "satisfactory".				

3.1.2 Discussion

A Systematic Approach to Training (SAT) is the framework endorsed by the CNSC for establishing and maintaining training for personnel working at a reactor facility. This framework is described in CNSC's REGDOC-2.2.2, *Personnel Training.* SRC has implemented a training program that meets the requirements set out in REGDOC-2.2.2.

The decommissioning project brings a number of activities that personnel of the facility do not normally perform. The decommissioning work will be performed by a small team of operating staff from CANDU Energy who are trained on these specific activities. As part of their application, SRC submitted the "*Decommissioning Training Plan for SRC SLOWPOKE-2 Facility*" [7], which supports the specific training needs associated with the decommissioning project. CNSC staff reviewed the document, including the advanced training schedule, which provides timelines for all tasks requiring training as identified in the job and task analysis. From this review, CNSC staff conclude that the decommissioning training and evaluation program meet the regulatory requirements.

The SRC SLOWPOKE-2 licence requires that any person appointed to the position of Reactor Operator, Reactor Engineer or Reactor Technician holds a certification pursuant to the *Class I Nuclear Facilities Regulations*. There are three reactor operators at SRC who are certified by the CNSC. The Reactor Engineer and the Reactor Technician are CANDU Energy employees who support the reactor dismantlement. These employees are also certified by the CNSC to work on the SRC reactor. Their roles and responsibilities are found in SRC's *Site Description and Operating Manual for the SLOWPOKE-2 Reactor* [8].

CNSC staff conclude that SRC's implementation of the training and certification program relating to this application is satisfactory.

3.2 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 as low as reasonably achievable (ALARA).

3.2.1 Trends

The following table provides the overall ratings for radiation protection over the current licensing period.

RADIATION PROTECTION				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
CNSC staff continue to rate the radiation protection SCA at the SRC SLOWPOKE-2 reactor facility as "satisfactory".				

3.2.2 Discussion

The *Radiation Protection Regulations* require licensees to establish a RP program to keep exposures ALARA, through the implementation of a number of controls including management control over work practices, personnel qualification and training, control of occupational and public exposures to radiation, and planning for unusual situations. The *Radiation Protection Regulations* also prescribe dose limits for workers and members of the public.

The RP program at SRC ensures that processes are implemented to control doses received by workers. This includes ensuring workers are trained and qualified, taking radiation protective measures to maintain doses as low as reasonably achievable (ALARA), limiting access to the SLOWPOKE-2 reactor facility, and establishing action levels for workers to ensure doses do not exceed the regulatory dose limits.

SRC uses a licensed dosimetry service to monitor, assess, record and report doses of ionizing radiation received by workers. The workers in the facility are not designated as a Nuclear Energy Workers (NEW) given their very low annual effective dose (see Table 2). During the licensing period, there were no worker exposures exceeding the dose limit of 1 mSv per calendar year for non-NEWs. SRC has been effective in controlling the radiological exposures for workers.

Table 2: Average and Maximum Effective Doses to Workers

Dose data	2013	2014	2015	2016	2017	2018	Regulatory limit
Average effective dose (mSv) *	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**N/A**
Maximum individual effective dose (mSv)	<0.1	<0.1	0.16	<0.1	0.28	0.12	**1 mSv**
Number of workers monitored	19	19	23	19	17	16	**N/A**

* Note: 0.1 mSv is the minimum reporting threshold for the dosimeter

During normal operations of the SRC facility, the estimated maximum dose to members of the public is assessed to 0.08 μSv/year, which is several orders of magnitude below the regulatory public dose limit of 1 mSv/year, and the dose rates to non-human ecological receptors are several orders of magnitude lower than conservative benchmarks. The decommissioning project is not expected to change the dose rates to the public and to the environment.

Radiation protection measures will be required for activities that involve opening of the reactor container, handling of the components and equipment removed from the reactor pool, temporary storage of those materials prior to shipment from the SLOWPOKE-2 reactor facility, and pool cleanup. Personnel directly involved in decommissioning activities will be designated as NEWs and their required training is detailed in the *Decommissioning Training Plan* [7].

The fields that workers may be exposed to are assessed between 0.30 μSv/h and 0.37 mSv/h, as detailed in SRC's Radiological Work Plan [9]. SRC established action levels for this project to ensure that radiation exposure and doses are kept ALARA. These action levels of 1 mSv effective dose, 50 mSv for skin and 50 mSv for extremities ensure occupational dose remains low for the duration of the project. This is based on operational experience from previous decommissioning projects and SRC's *Radiation Physics Assessment* [10]. Exposures will be monitored by personal dosimeters complemented by real-time monitoring using personal alarming dosimeters. If an action level has been reached, SRC will conduct an investigation and actions will be taken to restore the effectiveness of the radiation protection measures.

Measures in place to mitigate the risk to workers include: radiological monitoring and surveys of working and surrounding areas; personnel dosimetry consisting of external dosimetry and in-vivo bioassays; and the use of plastic covering to protect exposed surfaces susceptible to the spread of radioactive contamination. All decommissioning staff performing radiation work will have a whole body

scan before starting and after completion of the project for internal radiation monitoring.

The irradiated core will be transferred to the transportation flask while under water to take advantage of the shielding factor. Once the transportation flask and the core are removed from the pool, the fuel no longer represents a radiation hazard to workers. Integrated continuous air monitoring will be used to monitor ambient radioactivity levels to inform work planning and selection of protective equipment.

The beryllium components, when removed from the pool, are considered a radiological and chemical hazard to workers due to the beryllium oxide dust that forms when exposed to air. To minimize dispersal of beryllium dust, the beryllium components will be wrapped in plastic sheets once removed from the reactor pool. In addition to standard personal protective equipment (PPE) and using long handed tools, all staff directly handling, or in the vicinity of beryllium components are required to wear respirators to mitigate the dust exposure. An air sampling radiation monitor will be in operation to monitor for airborne contamination. All the beryllium components will be transferred into a dedicated beryllium shielded container.

These radiation protection measures will ensure that doses received by workers from occupational radiation do not exceed the regulatory limits stipulated in the CNSC's *Radiation Protection Regulations*. The collective dose for the decommissioning project is estimated to 2.7 mSv [10]. For comparison, the collective dose for the University of Alberta SLOWPOKE-2 reactor decommissioning project was 0.26 mSv, and the highest dose to a worker was 0.15 mSv [11].

CNSC staff conclude that the submissions made by SRC in support of the decommissioning of the SLOWPOKE-2 reactor project meets CNSC's radiation protection regulatory requirements and that SRC will continue to implement effective RP programs during decommissioning, in compliance with *Radiation Protection Regulations*, and ensuring the health and safety of the public and persons working at this facility.

3.3 Environmental Protection

The environmental protection SCA 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.

3.3.1 Trends

The following table provides the overall ratings for the environmental protection SCA over the current licensing period:

ENVIRONMENTAL PROTECTION				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
CNSC staff continue to rate the environmental protection SCA at the SRC SLOWPOKE-2 reactor facility as "satisfactory". The environmental releases from the facility are small and present negligible risk. There have been no releases to the environment that would pose a risk to the public or the environment.				

3.3.2 Discussion

CNSC staff use REGDOC-2.9.1 *Environmental Protection: Environmental Principles, Assessments and Protection Measures* to assess environmental protection measures proposed by licensees as part of licence applications and licence amendments.

SRC's environmental protection related commitments are documented in its *Decommissioning Environmental Protection Requirements* [12], *Environmental Impact Statement* [13], and the DDP [4].

To mitigate potential atmospheric releases from decommissioning activities, the ventilation system is equipped with a high efficiency particulate air (HEPA) filter, which will capture any airborne particulate resulting from the decommissioning work. The exhaust from the ventilation system downstream of the HEPA filter will be periodically tested. An integrated continuous air monitor will be utilized at work locations where there is a potential for airborne contamination [9]. Airborne releases to the environment are expected to be negligible and the resulting radiation dose to the public is expected to be indiscernible from the normal exposure to naturally occurring radiation fields.

During the decommissioning, the only source of liquid effluent will be the reactor pool water, after it is processed through ion exchange columns, and demonstrated to be free of contaminants. Prior to the planned release of this liquid, the water will be processed through the purification system until it meets the release criteria described in REGDOC-1.6.1*: Licence Application Guide: Nuclear Substances and Radiation Devices* and criteria specified in of the City of Saskatoon Sewage Use Bylaw No. 9466. Under these conditions, the liquid releases to the environment will be negligible and the health of persons and the environment will continue to be protected.

CNSC staff conclude that the submissions made by SRC in support of environmental protection during the decommissioning project meet CNSC's regulatory requirements outlined in REGDOC-2.9.1, and that they will continue to make adequate provisions for the protection of the environment and the health of persons.

3.3.3 Environmental Protection Review

The CNSC conducts Environmental Protection Reviews (EPR) under the NSCA for all projects, in accordance with its mandate, to ensure the protection of the environment and health of persons. An EPR is a science-based environmental technical assessment by CNSC staff as set out in the NSCA.

The decommissioning of an existing nuclear reactor is not included on the Designated Project list for an environmental assessment (EA) under the Canadian Environmental Assessment Act (CEAA), 2012, as decommissioning is not an activity identified in the *Regulations Designating Physical Activities*.

CNSC staff conducted an EPR [14] for SRC's decommissioning project. The EPR focuses on items of regulatory oversight and on typical topics of public interest related to the decommissioning of a nuclear facility, such as releases to air and surface water and radiation protection.

Based on the EPR conducted for this licence amendment application, CNSC staff conclude that SRC has and will continue to make adequate provision for the protection of the environment and the health of persons throughout all decommissioning activities.

3.4 Waste Management

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

3.4.1 Trends

The following table provides the overall rating trends for the Waste Management SCA over SRC's current licensing period:

TRENDS FOR WASTE MANAGEMENT				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The licensee maintains an adequate Waste Management Program that has been satisfactory over the licence period. CNSC staff reviewed SRC's application and conclude that SRC will continue to manage the waste during decommissioning activities in accordance with regulatory requirements.				

3.4.2 Discussion

SRC's application to amend its licence to include decommissioning the facility includes a *Decommissioning Waste Management Plan* (DWMP) [15]. The objectives of this plan are to describe how the waste during decommissioning of the facility will be handled, and to ensure that the waste is managed in accordance with CNSC regulatory requirements. The DWMP describes how waste will be managed during the decommissioning project, including storage, recycling and removal/transfer activities.

The DWMP identifies the materials and estimated quantities that will result from the decommissioning of the facility, which are categorized as:

- Radioactive waste;
- Non-radioactive, hazardous waste; and
- Non-radioactive, non-hazardous waste.

To minimize waste from decommissioning of the facility, SRC plans to decontaminate, segregate and remove non-radioactive, hazardous waste and chemicals, and reuse and recycle to the extent possible. The DWMP provides the waste clearance process, and contamination limits for unconditional release.

The decommissioning of the facility is expected to produce an estimated volume of eight cubic meters of solid radioactive waste, which will be transported to a licensed radioactive waste management facility. The fuel will be repatriated to the United States under the Canada-U.S. agreement to return spent HEU fuel to its country of origin.

The small inventory of non-radioactive, hazardous materials will be disposed of in accordance with SRC's hazardous material management procedures and applicable regulations. Non-radioactive, non-hazardous waste and items, which may include some equipment, will be either reused or sent for disposal. SRC will monitor all materials movements to prevent the spread of contamination and to ensure that waste is in compliance with clearance levels.

CNSC staff assessed SRC's DWMP against the requirements of CSA standards N292.0-14, *General principles for the management of radioactive waste and irradiated fuel,* and N292.3-14, *Management of low and intermediate-level radioactive waste*. CNSC staff consider the DWMP and supporting documents as satisfactory to support this licence application.

Decommissioning Plans

SRC submitted a Detailed Decommissioning Plan [4] in support of its application. The DDP outlines the strategic approach for the decommissioning process and describes the decommissioning work packages. The DDP also describes the preventative measures that SRC will take to ensure the health, safety and protection of workers, the public (including SRC staff), and the environment during the SRCSF decommissioning process.

The proposed decommissioning project will generate conventional waste, which will be disposed of in a waste management facility. The quantity of this waste is small and represents a small fraction of the total waste to landfill per annum from the facility. The project will also generate an estimated volume of eight cubic metres of solid radioactive waste, which will be transported to a licensed radioactive waste management facility.

SRC's end-state objective is to return the facility to a condition that allows for unrestricted use, and to request a Licence to Abandon, with no institutional control required. This is consistent with past SLOWPOKE-2 decommissioning projects such as University of Alberta, as outlined in the *Record of Decision for a Licence to Abandon* [16].

CNSC staff have reviewed and verified that the DDP meets CNSC Regulatory Guide G-219: *Decommissioning Planning for Licensed Activities* and CSA N294-09 *Decommissioning of Facilities Containing Nuclear Substances*. CNSC staff also assessed the sections of the DDP relating specifically to the Waste Management SCA against the following documents:

- CSA N292.0-14, General principles for the management of radioactive waste and irradiated fuel
- CSA N292.3-14, Management of low and intermediate-level radioactive waste
- CNSC Regulatory Document G-219, Decommissioning Planning for Licensed Activities
- CSA N294-09 (R2014), Decommissioning of Facilities Containing Nuclear Substances

CNSC staff are satisfied that the DDP meets the guidance and requirements identified in the above reference documents. The DDP provides reasonable assurance that the decommissioning of the facility will be executed responsibly, and that SRC will continue to make adequate provision for the protection of the environment and the health of persons throughout all decommissioning activities.

4. OTHER MATTERS OF REGULATORY INTEREST

4.1 Indigenous Consultation

The common law duty to consult with Indigenous peoples applies when the Crown contemplates actions that may adversely affect established or potential Indigenous and/or treaty rights. Based on the information provided in SRC's application, CNSC staff have determined that the proposed decommissioning activities will take place within the facility and have no adverse impact to the surrounding environment. As such, CNSC staff have determined that the activities to be conducted will not cause an adverse impact on potential or established Indigenous and/or treaty rights. Therefore, the duty to consult does not arise in relation to the proposed licence application.

4.2 Financial Guarantees

SRC has a financial guarantee in the amount of $5.76 M, which will be used to fund a large proportion of the decommissioning project. SRC's Board of Directors has approved the decommissioning of the SLOWPOKE-2 reactor and authorized the President/CEO to negotiate and execute any contracts required up to $7.5M.

The existing financial guarantee will not be required after the completion of this project.

4.3 Public Information Program

SRC's public information program provides the framework to communicate key information about the decommissioning project to stakeholders, employees and the public.

Since 2017, SRC has conducted both internal and external communications activities in support of the decommissioning project. SRC posted a news release and facilitated discussions with the public. A factsheet and Frequently Asked Questions (FAQ) were posted along with contact information were posted on the SRC SLOWPOKE-2 webpage. In December 2018, SRC hosted a public meeting regarding the decommissioning of the SLOWPOKE-2 reactor facility. There has been a very low level of public interest regarding the facility in general. Responses received have been either neutral or positive.

4.4 Decommissioning Schedule

SRC plans to execute the decommissioning activities over approximately six months, staring as soon as the Commission renders a decision on this request to amend the licence. This schedule is consistent with the decommissioning experience of University of Alberta and Dalhousie University. SRC anticipates producing the End-State Report in January 2020 and apply to the Commission for a licence to abandon in June 2020.

4.5 Regulatory Oversight

CNSC staff have reviewed SRC's application to amend the licence to include decommissioning, including the supporting documents. CNSC staff are satisfied that the project is planned, documented and supported with all required programs, processes and procedures so that the project can be conducted safely and in accordance with all regulations.

CNSC staff will continue to exercise regulatory oversight during the project. A final inspection will be conducted to verify the final state of decommissioning and decontamination, before the reactor pool is filled with concrete.

CNSC staff will assess the End-State Report to ensure it reflects the actual condition of the facility.

5. OVERALL CONCLUSION AND RECOMMENDATIONS

CNSC staff assessed SRC's request to amend the operating licence to include decommissioning of the SLOWPOKE-2 reactor facility, including the programs and documents in support of the application.

CNSC staff conclude that:

- Saskatchewan Research Council is qualified to carry out the activity authorized by the proposed licence; and
- Saskatchewan Research Council will, in carrying out that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Should the Commission decide to amend SRC's operating licence, the Licence Conditions Handbook will be updated to include references to the Detailed Decommissioning Plan and other documents submitted in SRC's application.

CNSC staff recommend the Commission to amend the Non-Power Reactor Operating Licence for the Saskatchewan Research Council SLOWPOKE-2 reactor to include decommissioning activities.

REFERENCES

1. Non-Power Reactor Operating Licence Slowpoke-2 Reactor Saskatchewan Research Council, NPROL-19.00/2023 (e-Doc 4097307).
2. *Initial Application for Authorization to Decommission Saskatchewan Research Council SLOWPOKE-2 Reactor*, May 14, 2018 (e-Doc 5543536).
3. *Application for an Amendment to the NPROL-19.00/2023 for the SRC SLOWPOKE-2 Facility (SRCSF),* December 14, 2018 (e-Doc 5751811).
4. *SRC Detailed Decommissioning Plan*, March 04, 2019 (e-Doc 5851109).
5. *Decommissioning Work Instructions*, February 18, 2019 (e-Doc 5794978).
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15. *SRC SLOWPOKE Decommissioning Waste Management Plan*, November 21, 2018 (e-Doc 5717202).
16. Record of Decision, *Application to Revoke the Non-Power Reactor Licence and to Issue a Licence to Abandon for the University of Alberta SLOWPOKE-2 Reactor Facility*, May 2018 (e-Doc 5553121).

A. RISK RANKING

The CNSC uses a risk-informed regulatory approach in the management and control of regulated facilities and activities. CNSC staff have therefore established an approach to identifying appropriate levels of regulatory monitoring and control for specific classes of licensed facilities and types of licensed activities based on risk ranking.

Risk ranking is applied to each SCA, and is determined by considering the probability and consequence of adverse incidents associated with each SCA as it relates to the given facility and activity types.

The methodology used to determine risk ranking is based on Canadian Standards Association guideline CAN/CSA-Q850, Risk Management: Guideline for Decision Makers. This guideline provides a description of the major components of the risk management decision process and their relationship to each other, and describes a process for acquiring, analyzing, evaluating, and communicating information that is necessary for making decisions.

The risk rankings are not static and may change over time for a given facility and activities (e.g., facilities age, facilities and equipment are upgraded, activities cease or begin, licensees change, technology and programs mature, knowledge and understanding of impacts and probabilities increase, etc.).

The following matrix provides a high-level overview of risk ranking, and the management and monitoring approach associated with the various degrees of risk.

APPROACH TO ASSESSING AND MANAGING POTENTIAL RISK				
CONSEQUENCE	**MANAGEMENT/MONITORING APPROACH**			
Significant Impact	Considerable management of risk is required	Must manage and monitor risk with occasional control	Extensive management is essential. Constant monitoring and control	
Moderate Impact	Occasional monitoring	Management effort is recommended	Management effort and control is required	
Low Impact	Random monitoring	Regular monitoring	Manage and monitor	
Probability of Occurrence	Unlikely to Occur	Might Occur	Expected to Occur	
RISK RANKING SCALE				
L	Low Risk	**M**	Moderate Risk	**H** High Risk

On this basis, a high-risk SCA would be subject to increased regulatory scrutiny and control while a low-risk SCA would generally require minor verification and control.

B. RATING LEVELS

Fully Satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the safety and control area (SCA) or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the SCA meets requirements and CNSC expectations. Any deviation is 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)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the SCA 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 is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the SCA 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 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 FRAMEWORK

The safety and control areas identified in this CMD are comprised of specific areas of regulatory interest which vary between facility types.

The following table provides a high-level definition of each SCA. The specific areas within each SCA are to be identified by the CMD preparation team in the respective areas within section 3 of this CMD.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee staff is sufficient in number in all relevant job areas and that licensee staff have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
	Operating Performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Facility and Equipment	Safety Analysis	Maintenance of the safety analysis that supports that 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.
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled.
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
	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.
	Emergency Management and Fire Protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.
	Waste Management	Covers internal waste-related programs which 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. Also covers the planning for decommissioning.
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.
	Safeguards and Non-Proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.
	Packaging and Transport	Programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

ENVIRONMENTAL PROTECTION REVIEW REPORT

e-Doc 5794571 (Word)

e-Doc 5868287 (PDF)

Canada's Nuclear Regulator

Environmental Protection Review Report:

Amendment of the Operating Licence for Saskatchewan Research Council's Safe Low-Power Kritical Experiment Reactor (SLOWPOKE-2)

June 2019

e-Doc: 5794571 (Word)
e-Doc: 5868287 (Pdf)

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

REVISION HISTORY

The following table identifies the revision history of this document.

Revision number	Change	Summary of changes	Date
000	Initial release	N/A	June 2019

EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) conducts Environmental Protection Reviews (EPR) under the *Nuclear Safety and Control Act* (NSCA) for all projects, in accordance with its mandate, to ensure the protection of the environment and health of persons. An EPR is a science-based environmental technical assessment by CNSC staff as set out in the NSCA. The safety component of the CNSC's mandate is covered in the safety case assessment carried out for all projects.

This EPR report, written by CNSC staff for the Commission, Indigenous peoples and the public, describes the scientific, evidence-based findings of the EPR completed for the licence amendment application by the Saskatchewan Research Council (SRC) to decommission its Safe Low-Power Kritical Experiment (SLOWPOKE-2) Non-Power Nuclear Research Reactor currently licensed under NPROL-19.00/2023.

CNSC staff's assessment of the SRC's 2018 licence application and environmental protection documents that support compliance verification activities (e.g., inspections and desktop reviews) conducted at the SRC SLOWPOKE-2 reactor by CNSC staff.

The EPR Report focuses on items of regulatory oversight and on typical topics of public interest related to the decommissioning of a nuclear facility such as releases to air and surface water and radiation protection.

CNSC staff's conclusions are based on, but are not limited to, the following:

- SRC's Detailed Decommissioning Plan
- SRC's Environmental Impact Statement
- SRC's Decommissioning Radiation Physics Assessment
- CNSC staff's assessment of environmental protection requirements for SLOWPOKE-2 reactors

Based on the EPR conducted for this licence application, CNSC staff conclude that the SRC has made and will continue to make adequate provision for the protection of the health of persons and the environment throughout all decommissioning activities.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Environmental Protection Review (EPR) is to report the outcome of Canadian Nuclear Safety Commission (CNSC) staff review of licensing and environmental compliance activities conducted under the *Nuclear Safety and Control Act* (NSCA). These serve to determine whether the Saskatchewan Research Council (SRC) has and will continue to make adequate provision for the protection of the environment and the health of persons. This EPR Report supplements the environmental protection information detailed in CNSC staff CMD19-H100 for SRC's licence amendment application to decommission its Safe Low-Power Kritical Experiment (SLOWPOKE-2) reactor facility (SRCSF) [1] and supports staff's recommendations to the Commission.

1.2 Project Background

The current Non-Power Reactor Operating Licence (NPROL-19.00/2023) [2] for the SRCSF, was issued on July 1, 2013 and is valid for a period of 10 years, with an expiry date of June 30, 2023. The current licence allows the SRC to proceed with defueling and dewatering of the reactor and packaging and shipment of the reactor fuel and activated components.

In December 2018, the SRC submitted a licence application for an amendment to the existing licence to allow decommissioning of their SLOWPOKE-2 reactor [3]. An amendment to the current operating licence would allow for transitioning to decommissioning which includes defueling and dismantling the reactor, segregating and disposing of the waste, and site restoration for unrestricted use (end state). At the completion of the decommissioning work, SRC intends to apply to the CNSC for a licence to abandon to allow unrestricted use of the site.

The SRCSF is located at SRC's Environmental Analytical Laboratories in the Innovation Place Research Park located at 422 Downey Road in Saskatoon, Saskatchewan (figure 1). The research park is situated directly north of the University of Saskatchewan campus, and contains affiliated industrial/commercial enterprises, where collaborative research is conducted in partnership with businesses and the university. The reactor is located 400 metres east from the South Saskatchewan River. The SRCSF has been operating safely and without incident since commissioning in 1981.

The reactor is a 20 kilowatt thermal sealed-container-in-pool type research reactor. The reactor is water cooled and moderated, with a 93% enriched uranium core. The core is cooled by natural convection and is surrounded by a beryllium reflector.

The general assembly of the unit has the reactor immersed in a pool of water providing shielding from the reactor core and acts as a moderator. The core and reflector are installed at the bottom of a water-filled sealed reactor container, which ensures that water in the reactor container is kept separate from the pool water (figure 2). The reactor container is constructed in two sections, an upper and lower section, with the critical assembly being contained in the lower section and the upper section providing a depth of water to ensure effective radiation shielding. Through this design, the core can be removed from the reactor at the end of its lifecycle without the loss of shielding.

The reactor support systems include water purification and level monitoring, cooling water, auxiliary power and radiation monitoring systems. The pool water and reactor container water have separate water treatment plants to ensure there is no mixing.

The SRCSF contains the reactor room, which is 55.7 m^2 and this is where the proposed decommissioning operations will be focused. Major activities associated with the proposed decommissioning, include the following:

- preparation of the building where the reactor is located, by removal of all items not required for the defueling and decommissioning process
- preliminary surveys to identify areas with potential radioactive contamination
- defueling the reactor and disposal of fuel
- dismantling reactor components and identifying radioactive, contaminated, hazardous, or clean components
- packaging and transporting all radioactive components
- disposal of other radioactive and non-radioactive waste
- decontamination of the site
- backfilling the pool with concrete

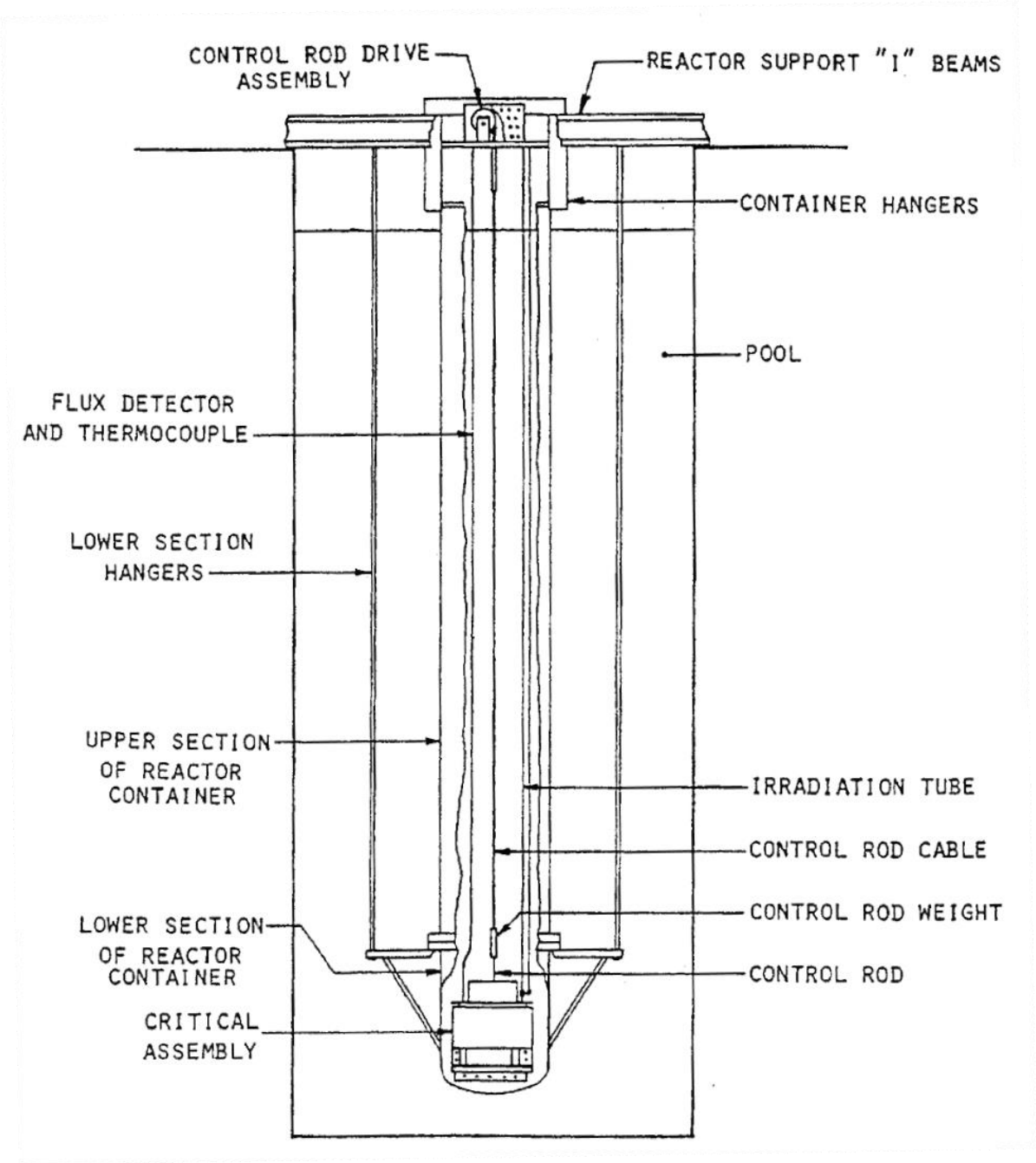
As part of the process, the SRC will be required to submit an end-state report demonstrating that the decommissioning is complete, there are no nuclear substances or residual radiological risks, and no activities are performed at the location of the former SLOWPOKE-2 reactor that would require a CNSC licence. CNSC inspectors will perform an inspection to verify the end-state report to be prepared by SRC.

Detailed in the SRC's Environmental Impact Statement (EIS) [4], the licensee is applying lessons learned from the most recent experience from the University of Alberta (U of A) SLOWPOKE-2 reactor decommissioning, which was successfully completed in 2018. Given that the same personnel and contractors will be involved in SRC's proposed decommissioning project, SRC anticipates that the very-low risks would be further reduced with greater awareness and training that resulted from this most recent experience. The U of A decommissioning in turn had the benefit of drawing from the experiences gained from SLOWPOKE-2 decommissioning projects at Dalhousie University and the University of Toronto.

As part of its application, the SRC submitted a Detailed Decommission Plan (DDP) [5], Decommission Work Instructions [6] and Decommissioning Work Packages, providing the steps necessary to ensure the health, safety and protection of workers, the public, and the environment. Work packages cover the activities to be carried out from dismantling the SCRSF to packaging and shipment of fuel and activated components and eventual clean-up and restoration of the reactor room for future use.

Figure 1: Aerial view of the Innovation Place Research Park, Saskatoon, SK [7]

Figure 2: SRC SLOWPOKE-2 reactor general assembly [4]



1.3 Detailed Decommissioning Plan

The SRC's DDP [5] outlines the strategic approach for the decommissioning process. The DDP also describes the preventative measures that SRC will take to ensure the health, safety and protection of workers, the public (including SRC staff), and the environment during the SRCSF decommissioning process. This section provides an overview of the proposed decommissioning activities to provide context for the following sections as it relates to the protection of people and the environment.

The proposed decommissioning project will generate conventional waste, which will be disposed of in a waste management facility. The quantity of this waste is small and represents a small fraction of the total waste to landfill per year from the SRCSF.

The project will also generate an estimated volume of eight cubic metres of solid radioactive waste which will be transported to a licensed radioactive waste management facility. Approximate quantities of radioactive waste are outlined in table 1.

Table 1: Estimated radioactive solid waste from decommissioning [4]

Component	Total estimated mass (kg)	Total estimated packaging volume (m^3)	Final disposition
Fuel Assembly (fuel and other structural components)	Mass: 3.6 kg Volume: 0.01 m^3 Activity: 1.1E+13 Bq	F-257 flask	U.S. Department of Energy, Savannah River Site, SC
Beryllium (Be) reflector assembly, including shims	Mass: 70.8 kg Activity: 2.7E+10 Bq	Be shielding container Interior volume: 0.25 m^3	Canadian Nuclear Laboratories, Waste Management Facility in Chalk River, ON
Be Shim tray	Mass: 14.4 kg Activity: 6.1E+08 Bq	Be shielding container Interior volume: 0.25 m^3	CNL
Lower reactor container (LRC)	Mass: 59.3 kg Activity: 1.2E+09 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
Irradiation tubes	Activity: 6.9E+08 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
Control rod	Activity: 1.7E+08 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
Neutron detectors	Activity: 4.0E+05 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
Thermocouple	Activity: 6.7E+08 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
Upper reactor container	Volume: 2.5 m^3	Type A container Dimension: 76"x50"x50"	CNL
Reactor water purification system	Volume: 0.3 m^3	Type A container Dimension: 76"x50"x50"	CNL
Reactor container water level monitor	Volume: <0.001 m^3	Type A container Dimension: 76"x50"x50"	CNL

Component	Total estimated mass (kg)	Total estimated packaging volume (m^3)	Final disposition
Reactor headspace gas purge system	Volume: 0.1 m^3	Type A container Dimension: 76"x50"x50"	CNL
Pool water level monitor	Volume: <0.001 m^3	Type A container Dimension: 76"x50"x50"	CNL
Cadmium capsules for auxiliary shutdown	Volume: <0.001 m^3	Type A container Dimension: 76"x50"x50"	CNL
Solid waste such as cleaning equipment or materials (paper, plastic, rubber/vinyl) and contaminated PPE	Mass: 100-200 kg Volume: 2 m^3	Type A container Dimension: 76"x50"x50"	CNL
Radiation Monitoring Devices	Volume: <0.001 m^3	Not Applicable / Unconditional Release	CNL
Capsule Transfer System	Volume: <0.001 m^3	Not Applicable / Unconditional Release	Recycling
Control Console	Volume: 1.5 m^3	Not Applicable / Unconditional Release	Recycling
Battery Assembly	Volume: 2 m^3	Not Applicable / Unconditional Release	Recycling
Sample Stations	Volume: 1.6 m^3	Not Applicable / Unconditional Release	Recycling
Total predicted volume of radioactive solid waste	**Volume: 8 m^3**		

As outlined in the SRC's DDP [5], the spent fuel reactor core will be highly radioactive and will need to be shielded at all times to protect workers. It is proposed that the reactor core comprising the fuel elements and the fuel cage will be transferred to a transport package container underwater to maintain shielding. A temporary crane will be used to lower the transport container into the pool in the reactor room and retrieve it for shipping. Once the upper and lower reactor container sections are separated, the reactor fuel and fuel cage will be removed and transferred into the transport package. The Type B transport container is a CNSC-certified Irradiated Fuel Core Transport Packaging Model F-257 flask. The F-257 flask will be removed from the pool, decontaminated, and prepared for transport from the SRC to the Savannah River Site (SRS) in South Carolina in the United States.

The beryllium assembly will be removed and transferred into the dedicated beryllium shielding container. The shielding container will be packaged in approved Type A transport containers in accordance with the CNSC's *Packaging and Transport of Nuclear Substances Regulations* and transported for long term storage at the Canadian Nuclear Laboratories' Chalk River Laboratories waste management facility in Chalk River, Ontario.

The upper reactor container will be packaged in approved Type A transport containers. The lower section of the reactor container and other reactor internal components will be disposed of in the Lower Reactor Container (LRC). The LRC will be sheathed and sealed in plastic sheeting to prevent potential inhalation and will be packaged in approved Type A transport containers. The Type A transport containers will be transported for long term storage at the Chalk River Laboratories site.

Separation of the upper and lower sections of the reactor container will result in the mixing of the reactor container water with the pool water. This is the main source of liquid radioactive waste. Before the upper and lower sections of the reactor container are separated to remove the core, the reactor container water will be purified by circulating it through the reactor container water deionizer in order to minimize the contamination of the pool water. Section 3.3 provides detail as to how liquid releases are to be safely managed.

Once the reactor is dismantled and the pool water is drained, the reactor pool will be checked for contamination. Structural materials and inner surface coatings will be assessed against clearance criteria found in Schedule 2 of the *Nuclear Substance and Radiation Devices Regulations, Unconditional Clearance Levels* [8]. Once clearance criteria are met, the reactor pool will be filled in with concrete up to the floor level.

CNSC staff have reviewed and verified that the DDP meets CNSC Regulatory Guide G-219: *Decommissioning Planning for Licensed Activities* [9] and CSA N294-09 *Decommissioning of Facilities Containing Nuclear Substances* [10]. The DDP provides reasonable assurance that the decommissioning of the facility will be conducted responsibly and that SRC will continue to make adequate provision for the protection of people and the environment throughout all decommissioning activities.

2.0 SCOPE OF ASSESSMENT

An EPR is a technical review by CNSC staff of SRC's environmental protection information and data used to support the Commission's determination on whether the SRC has and will continue to make adequate provision for the protection of the environment and the health of persons while carrying out a licensed activity. This EPR is commensurate with the scale and complexity of the environmental risks associated with the SRCSF decommissioning project.

This EPR includes CNSC staff's assessment of the licence application and environmental protection documents submitted in support of the application, including: the SRC's Environmental Impact Statement (EIS), DDP and Decommissioning Radiation Physics Assessment [4] [6] [11]. These documents combined together form the foundation that ensures the public, workers and the environment will be protected during all decommissioning activities.

CNSC staff's assessment of environmental protection requirements for a SLOWPOKE-2 reactor was also taken into account [12]. In 2013, CNSC staff completed a highly conservative estimate of doses to the public and a sector specific environmental risk assessment consistent with CSA N288.6-12 *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* to determine the environmental protection requirements for SLOWPOKE-2 facilities. The estimated dose to the public was assessed to be less than 0.1 microsievert per year (μSv/year), which is several orders of magnitude below the regulatory public dose limit of 1 milliesivert per year (mSv/year).Through this assessment, CNSC staff concluded that formal

release limits and an environment monitoring program are not required for SLOWPOKE-2 facilities.

Note: Taking into consideration the CNSC's graded approach to regulatory oversight for low-risk facilities and with no known public or Indigenous concerns with the operation of the SRCSF, the CNSC does not conduct sampling near this facility or at similar facilities through its Independent Environmental Monitoring Program (IEMP). As a result, the scope of this assessment does not include IEMP result findings. Also, due to the low risk of the facility's operations this review does not include information from other regional monitoring programs and health studies.

3.0 ASSESSMENT FINDINGS

The following sections of this EPR Report include summaries of the project-environment interactions as detailed in SRC's EIS [4] and DDP [5] and as reviewed by CNSC staff. The provided summaries below include releases to air and surface water and assessments of radiation on human health and the environment.

3.1 Releases to the Environment

The SRC's environmental protection commitments are documented in their environmental protection requirements document, EIS, and DDP. The SRC is planning on carrying out decommissioning activities in accordance with these documents. SRC's documents demonstrate that operational experience from the previous decommissioning of SLOWPOKE-2 reactors have been considered when assessing interactions between decommissioning activities and the environment. For example, the experience gained from the Dalhousie University SLOWPOKE reactor and the University of Alberta SLOWPOKE reactor decommissioning work, demonstrated that the use of the deionizing system is effective in reducing radionuclide concentrations from the reactor water and pool water until concentrations meet release criteria.

As there will be limited potential project-environment interactions from the proposed decommissioning activities the estimated dose to the public is predicted to be several orders of magnitude below the regulatory public dose limit of 1 mSv/year and the dose rates to non-human biota are to be several orders of magnitude lower than the most conservative benchmarks. These results indicate that people and the environment would be protected during decommissioning activities.

Atmospheric Releases

During the proposed decommissioning activities, air quality in the reactor room will be continuously monitored using an air sampling monitoring device. Air will be vented to the atmosphere using a newly installed high efficiency particulate air (HEPA) filter and existing ventilation exhaust system. Any radioactive or hazardous substances released inside the reactor room from decommissioning work, will be captured locally on particulate filters in the ventilation exhaust system. SRC's EIS identified the potential sources of radioactive and hazardous substances released through the ventilation system to be very low and not requiring further mitigation measures, as no residual adverse effects to the environment are expected. Potential substances released to the ventilation system include low concentrations of short-lived radionuclides and noble gases such as Xenon (Xe) and beryllium dust, which is both a

radioactive and hazardous substance. Air will be periodically surveyed upstream and downstream of the ventilation system for further monitoring.

Liquid Releases

During normal operations, the reactor does not release radioactive liquid effluents. While decommissioning, the main source of effluent releases would be the reactor container water and pool water. Prior to release, most of the radionuclides in the effluent will be captured by an ion exchange resin of the deionizing system. As the reactor water is purified weekly through the deionizing system, SRC has an existing approved process in place for the removal and safe disposal of ion exchange resign containing radionuclides.

Effluent will be monitored for radioactive and hazardous substances utilizing gamma ray spectroscopy following the application of the purification system [4]. Once the effluent meets the release criteria in Appendix R of REGDOC 1.6.1 *Licence Application Guide: Nuclear Substances and Radiation Devices* [13] and the City of Saskatoon's Sewer Use Bylaw [14] for hazardous substances, it will be discharged to the municipal wastewater treatment system. Approximately 28,380 litres of water would be released (27,000 litres of pool water and 1,380 litres of reactor container water). See table 2 for the list of radionuclide concentrations in the reactor water and pool water before purification and release criteria, as detailed in the DDP. Very-low concentrations of noble gases and short-lived radionuclides, which decay away in hours or days, would be present in the reactor and pool water and do not require release criteria. CNSC staff have determined the risk to people and the environment to be negligible. This is due to very-low concentrations of radioactivity, the application of the purification process and further dilution when released to city's wastewater treatment system.

Based on CNSC staff's review of SRC's EIS and DDP staff conclude SRC's proposed decommissioning activities meet the CNSC's environmental protection requirements as outlined in REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [15] to protect the health of persons and the environment.

Table 2: Radionuclide Concentrations in Reactor Container Water and Pool Water before Purification and Release Criteria [5]

Radionuclide	Activity in liquid waste before purification (28,380 L of reactor container and pool water) MBq	Release criteria from REGDOC 1.6.1, App. R, [13] MBq/year
Cd-109	0.954	10
Ce-139	0.020	1
Co-57	0.026	1000
Co-58	0.035	100
Co-60	0.069	0.1
Cr-51	0.299	100
Cs-134	0.026	0.1
Cs-137	0.127	1

Radionuclide	Activity in liquid waste before purification (28,380 L of reactor container and pool water) MBq	Release criteria from REGDOC 1.6.1, App. R, [13] MBq/year
Fe-59	0.082	1
Hg-203	0.026	10
I-131	4.788	10
La-140	3.104	0.1
Mn-54	0.037	1
Mo-99	0.142	100
Na-24	0.478	100
Ra-226	0.816	1
Sb-124	0.033	0.1
Se-75	0.038	1
Sr-85	0.026	1
Tc-99M	13.813	1000
Zn-65	0.068	1

3.2 Radiation Protection Measures

The *Radiation Protection Regulations* of the NSCA [16] require licensees to implement a radiation protection program for protection of workers as well as the public. As noted above, there is negligible effect on the public from the work proposed.

Radiation protection measures will be required for decommissioning activities that involve opening of the reactor container, handling of the components and equipment removed from the reactor pool, temporary storage of those materials prior to shipment from the SRC, and pool cleanup. These measures include personal dosimetry, the use of respirators and an integrated continuous air monitor, whole body monitoring before and after the project to verify no internal uptakes, personal protective equipment and clothing such as radiation protection work coveralls, and the use of radiological work zones to control the spread of contamination.

Based on CNSC staff's review of the SRC's EIS, DDP and Decommissioning Radiation Physics Assessment, staff have concluded that the SRC has sufficient measures in place to meet the requirements of the *Radiation Protection Regulations* to protect workers and the public.

3.3 Accidents and Malfunctions

SRC's EIS evaluated the effects to the environment during potential accidents and malfunctions during the proposed decommissioning activities and determined that the conclusions made for normal operations remain valid. The public and the environment would remain protected should a potential accident and malfunction occur during decommissioning activities.

4.0 CONCLUSION

The EPR conducted for the proposed SRCSF decommissioning project concludes that the SRC has and will continue to make adequate provision for the protection of the environment and the health of persons throughout all decommissioning activities. Through ongoing licensing and compliance reviews, as well as review of the SRC's EIS, DDP, Decommissioning Radiation Physics Assessment, CNSC staff continue to confirm and ensure that the environment and the health of persons is protected at, and around, the SRCSF.

The information provided in this EPR Report supports the conclusions made by CNSC staff in CMD 19-H100 and the recommendation to the Commission to amend the SRC's operating licence (NPROL-19.00/2023) in order to allow decommissioning of its SLOWPOKE-2 non-power nuclear research reactor and to restore the facility for future unrestricted use.

ACRONYMS

Acronym	Term
ALARA	As low as reasonably achievable
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DDP	Detailed Decommissioning Plan
EPR	Environmental Protection Review
EA	Environmental Assessment
EIS	Environmental Impact Statement
HEPA	High efficiency particulate air
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program
LRC	Lower Reactor Container
NPROL	Non-Power Nuclear Research Reactor
NSCA	*Nuclear Safety and Control Act*
SRC	Saskatchewan Research Council
SRS	Savannah River site
SLOWPOKE-2	Safe Low-Power Kritical Experiment
U of A	University of Alberta

REFERENCES

1) CNSC Staff CMD 19-H100, SRC's licence amendment to authorize the decommissioning of the SRC SLOWPOKE-2 reactor facility, e-Doc: 5880419

2) Non-Power Reactor Operating Licence Slowpoke-2 Reactor Saskatchewan Research Council, NPROL-19.04/2013, e-Doc: 3910553

3) SRC, Letter to the Marc Leblanc from Dr. Laurier Schramm, Application for the Licence to Decommission the SRC's SLOWPOKE-2 reactor, December 14, 2018, e-Doc: 5751811

4) SRC, Environmental Impact Statement, SRC's SLOWPOKE-2 Reactor Decommissioning, Saskatoon, Saskatchewan, April 2019, e-Doc: 5915706

5) SRC, SLOWPOKE-2 Detailed Decommissioning Plan, March 04, 2019, e-Doc: 5851109

6) SRC, Decommissioning Work Instructions (draft), February 18, 2019, e-Doc 5794978

7) Adapted from Google Maps

8) CNSC, *Nuclear Substance and Radiation Devices Regulations, Unconditional Clearance Levels*, 2000

9) CNSC, Regulatory Guide G-219: *Decommissioning Planning for Licensed Activities*, 2000

10) CSA, N294-09 *Decommissioning of Facilities Containing Nuclear Substances*, August 2014

11) SRC, SLOWPOKE-2 Decommissioning Radiation Physics Assessment, October 10, 2018, e-Doc: 5669086

12) CNSC, Environmental Protection Requirements for SLOWPOKE-2 Reactors, March 8, 2013, e-Doc: 4059738

13) CNSC, REGDOC 1.6.1 *Licence Application Guide: Nuclear Substances and Radiation Devices*, May 2017

14) City of Saskatoon, Sewer Use By-law No. 9466, 2017

15) CNSC, *REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures*, April 2017

16) CNSC, *Radiation Protection Regulations*, 2000

PART TWO

Part Two provides all relevant information pertaining directly to the licence, including:

- Any proposed changes to the conditions, licensing period, or formatting of an existing licence;
- The proposed licence; and
- The current licence.

PROPOSED LICENCE CHANGES

Overview

The content of the proposed licence is the same as the current licence with a change to the licensed activities under IV LICENCED ACTIVITIES. The Licence Period is updated to reflect an issuance date of August 1, 2019.

PROPOSED LICENCE CHANGES	
Current Licence	**Proposed Licence**
IV) LICENSED ACTIVITIES (a) operate the Saskatchewan Research Council SLOWPOKE-2 reactor and associated facilities (hereinafter "the facility"), located in the Analytical and Radiochemical Laboratory of the Council in the Innovation Place Research Park, in Saskatoon, Saskatchewan	**IV) LICENSED ACTIVITIES** (a) operate and decommission the Saskatchewan Research Council SLOWPOKE-2 reactor and associated facilities (hereinafter "the facility"), located in the Analytical and Radiochemical Laboratory of the Council in the Innovation Place Research Park, in Saskatoon, Saskatchewan

Licence Period

New licence period: August 1, 2019 to June 30, 2023, unless suspended, amended, revoked or replaced.

PROPOSED CHANGES TO THE LICENCE PERIOD	
Current Licence	**Proposed Licence**
July 1, 2013 to June 30, 2023	August 1, 2019 to June 30, 2023

PROPOSED LICENCE

e-Doc 5899570 (Word)

e-Doc 5905832 (PDF)

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Word Ref: e-Doc 5899570
PDF Ref: e-Doc 5905832
File: 2.03

NON-POWER REACTOR OPERATING LICENCE
SLOWPOKE-2 REACTOR

SASKATCHEWAN RESEARCH COUNCIL

I) LICENCE NUMBER: **NPROL-19.01/2023**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act*, this licence is issued to

Saskatchewan Research Council
15 Innovation Boulevard
Saskatoon, Saskatchewan
S7X 0X1

III) LICENCE PERIOD: This licence is valid from **August 1, 2019**, to **June 30, 2023**, unless otherwise suspended, amended, revoked, or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(a) operate and decommission the Saskatchewan Research Council SLOWPOKE-2 reactor and associated facilities (hereinafter "the facility"), located in the Analytical and Radiochemical Laboratory of the Council in the Innovation Place Research Park, in Saskatoon, Saskatchewan;

(b) produce, possess, transfer, use, package, manage, and store the nuclear substances that are required for, associated with or arise from the activities described in (a); and

(c) possess and use prescribed equipment and prescribed information required for, associated with or arise from the activities described in (a).

V) EXPLANATORY NOTES:

(a) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(b) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* (hereinafter "NSCA") and associated regulations.

(c) The Saskatchewan Research Council Licence Conditions Handbook (hereinafter "SRC-LCH") provides

(i) compliance verification criteria in order to meet the conditions set out in this licence;
(ii) information regarding delegation of authority to CNSC staff; and
(iii) applicable versions of documents and a process for version control of codes, standards or other documents that are used as compliance verification criteria.

VI) CONDITIONS:

1. GENERAL

1.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis for the facility, unless otherwise approved in writing by the Commission.

1.2 The licensee shall give written notification of changes made to the licensee documents submitted to support the licence application.

1.3 The licensee shall maintain a preliminary decommissioning plan for the facility, and shall review and revise the plan at such times as the Commission may require and in any event, no later than ten years from previous revision.

1.4 The licensee shall maintain in effect a financial guarantee for decommissioning of facility that is acceptable to the Commission. The licensee shall report annually that the financial guarantee is valid and in effect.

1.5 The licensee shall implement and maintain a public information program including a public disclosure protocol.

1.6 The licensee shall, in the event of any conflict or inconsistency between licence conditions, codes or standards or regulatory documents used as compliance verification criteria in the SRC-LCH, refer the matter to the Commission for resolution.

2. MANAGEMENT SYSTEM

2.1 The licensee shall implement and maintain a management system for activities carried out under this licence.

3. HUMAN PERFORMANCE MANAGEMENT

3.1 The licensee shall ensure that persons appointed to the positions of reactor engineer, reactor technician, or reactor operator hold certifications in accordance with the requirements of the NSCA.

3.2 The licensee shall establish and maintain a training program for certified persons.

4. OPERATING PERFORMANCE

4.1 The licensee shall operate the facility subject to the terms and conditions of this licence and within the limits specified in Appendix A to this licence.

4.2 The licensee shall maintain an accurate inventory of their sealed sources, both in use and in storage, and provide details of this inventory when requested.

4.3 The licensee shall report to the Commission unplanned situations or events at the facility.

4.4 The licensee shall submit annual compliance monitoring and operational performance reports to the Commission.

5. SAFETY ANALYSIS

5.1 The licensee shall conduct and maintain safety analyses that are representative for the current hazards of the facility or process analyzed.

6. PHYSICAL DESIGN

6.1 The licensee shall ensure that the defence-in-depth principle is applied and maintained in the design of the nuclear facility in order to prevent, or if prevention fails, to mitigate the consequences resulting from radioactive releases.

7. FITNESS FOR SERVICE

7.1 The licensee shall develop, implement and maintain documented programs of maintenance, testing, surveillance, and inspection of structures, systems and components important to safety to ensure that their availability, reliability and functionality remain in accordance with the design over the lifetime of the facility.

7.2 The licensee shall develop, implement and maintain an aging management program for the facility to identify all aging mechanisms relevant to structures, systems and components important to safety; to evaluate their possible consequences; and to provide direction for the activities required to maintain the operability and reliability of these structures, systems and components.

8. RADIATION PROTECTION

8.1 The licensee shall implement and maintain a radiation protection program which includes action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

9. CONVENTIONAL HEALTH AND SAFETY

9.1 The licensee shall implement and maintain an occupational health and safety program at the facility.

10. ENVIRONMENTAL PROTECTION

10.1 The licensee shall control, monitor and record releases of radioactive nuclear substances and hazardous substances from the facility.

11. EMERGENCY MANAGEMENT AND FIRE RESPONSE

11.1 The licensee shall implement and maintain an emergency management program to prepare for and respond to emergency events, including fires, initiating at or impacting the facility, and for dealing with the effects of such emergencies both in the facility and outside the facility.

12. WASTE MANAGEMENT

12.1 The licensee shall implement and maintain a waste management program documenting handling, processing, transportation, storage and disposal of nuclear wastes, including nuclear wastes mixed with other hazardous substance.

13. SECURITY

13.1 The licensee shall implement and maintain a nuclear security program to prevent persons from carrying out malevolent actions capable of affecting the safe operation of the facility.

14. SAFEGUARDS AND NON-PROLIFERATION

14.1 The licensee shall implement and maintain safeguards measures required to ensure safeguards implementation at the facility.

15. PACKAGING AND TRANSPORT

15.1 The licensee shall implement and maintain a program for the packaging and transport of nuclear substances.

SIGNED at OTTAWA, this day of July, 2019.

_____

Rumina Velshi, President
on behalf of the Canadian Nuclear Safety Commission

APPENDIX A

Operating Limits

1. The licensee shall ensure that the total thermal power from the reactor fuel does not exceed 20 kilowatts under steady-state operating conditions.

2. The licensee shall ensure that the maximum excess reactivity of the reactor does not exceed 4.0 mk.

3. The licensee shall not operate the reactor at neutron flux levels exceeding 1.05×10^{12} n cm^{-2} s^{-1}, except that while increasing power under automatic control a peak power of no more than 1.4×10^{12} n cm^{-2} s^{-1} may be permitted for a time of no more than one minute.

4. The licensee shall not allow the reactor to contain more than 300 finished SLOWPOKE-2 fuel elements except otherwise approved in writing by the Commission. The total amount of uranium-235 in the reactor shall not exceed 0.95 kg. The fuel elements shall consist of only an uranium-aluminum alloy containing 28% by weight uranium and the uranium enriched to no more than 95% by weight uranium-235.

5. The facility may contain sealed sources of uranium-235 for use as testing or calibration devices. The licensee shall ensure that no sealed source contains more than 1.0 grams of uranium-235.

CURRENT LICENCE

e-Doc 3910553 (Word)

e-Doc 4097307 (PDF)

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

e-Doc 3910553 (Word)
e-Doc 4097307 (PDF)
File: 2.03

NON-POWER REACTOR OPERATING LICENCE
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S7X 0X1

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(a) operate the Saskatchewan Research Council SLOWPOKE-2 reactor and associated facilities (hereinafter "the facility"), located in the Analytical and Radiochemical Laboratory of the Council in the Innovation Place Research Park, in Saskatoon, Saskatchewan;

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15. PACKAGING AND TRANSPORT

15.1 The licensee shall implement and maintain a program for the packaging and transport of nuclear substances.

SIGNED at OTTAWA, this 26th day of June, 2013.

M. Binder

Michael Binder, President
on behalf of the Canadian Nuclear Safety Commission

APPENDIX A

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