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Oral Presentation

Submission from Northwatch

In the Matter of

Saskatchewan Research Council, SLOWPOKE-2 Reactor

Request by the Saskatchewan Research Council to authorize the decommissioning of the SLOWPOKE-2 reactor

Commission Public Hearing

September 26, 2019

Exposé oral

Mémoire de Northwatch

À l'égard de

Saskatchewan Research Council Installation nucléaire SLOWPOKE-2

Demande du Saskatchewan Research Council afin d'autoriser le déclassement du réacteur SLOWPOKE-2

Audience publique de la Commission

Le 26 septembre 2019

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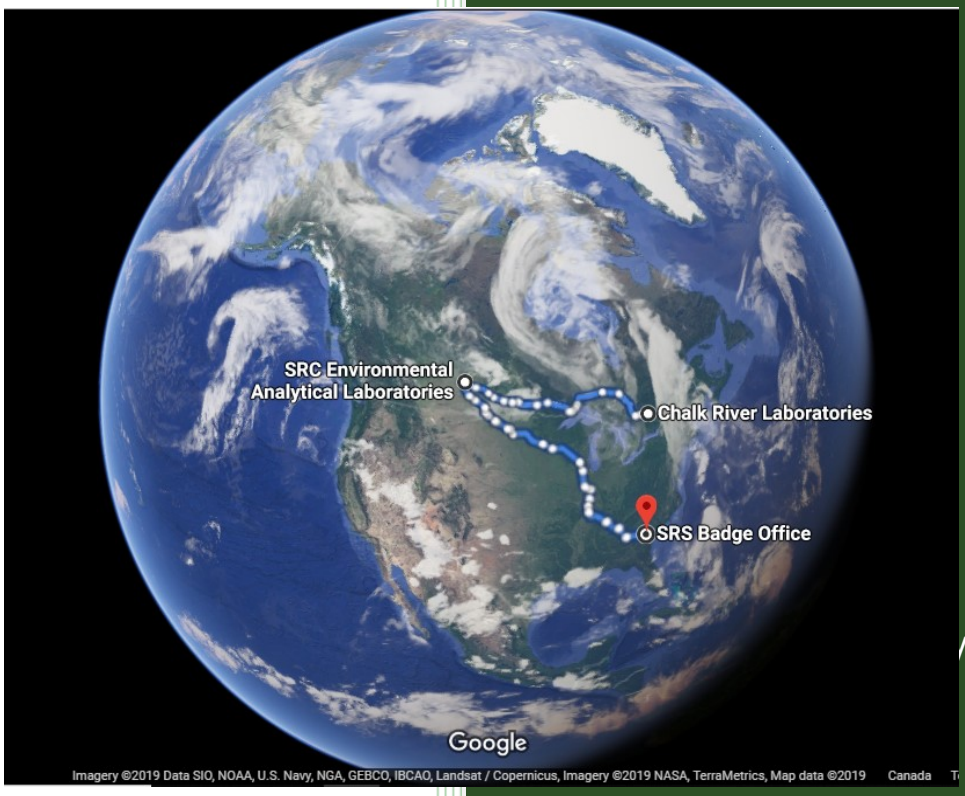
Comment on an Application from the Saskatchewan Research Council (SRC) to amend its Non-Power Reactor Operating Licence for its SLOWPOKE-2 reactor and associated facilities

Ref. 2019-H-100



8/28/2019

1. PROJECT SUMMARY

On June 12th, 2019 the Canadian Nuclear Safety Commission (CNSC) issued a Notice of Hearing in which they set out that written submissions were to be filed with the Commission Secretariat by June 25, 2019 and that the "Canadian Nuclear Safety Commission (CNSC) will conduct a hearing based on written submissions in July 2019 to consider an application from the Saskatchewan Research Council (SRC) to amend its Non-Power Reactor Operating Licence for its SLOWPOKE-2 reactor and associated facilities".

A revised notice was issued on June 27th announcing a deadline of August 26th for written submissions and requests to intervene . A public hearing would include oral submissions in addition to those of the licensee and CNSC staff. The hearing date was announced to be September 26th, with the note that "The Commission is considering conducting the public hearing via electronic means. Participants will be provided information on how to participate at a later date." At the time of filing written submissions, additional details on the hearing format had not yet been provided.

The hearing notices indicated that "the current licence authorizes SRC to operate the SLOWPOKE-2 facility and to transition the reactor into a safe state. The proposed licence amendment would authorize SRC to decommission the facility."
SRC's SLOWPOKE-2 reactor is located directly north of the campus of the University of Saskatchewan, approximately 400 metres east of the South Saskatchewan River, at 422 Downey Road in Saskatoon, Saskatchewan, in a " research park" which includes "affiliated industrial/commercial enterprises, where collaborative research is conducted in partnership with businesses and the university"

The 20 kilowatt thermal sealed-container-in-pool type research reactor has been operating since 1981. The reactor is water cooled and moderated, with a 93% enriched uranium core. The reactor is immersed in a pool of water, with the water providing shielding and acting as a moderator. The core and reflector are installed at the bottom of a water-filled sealed reactor

container, designed to keep the water in the reactor container separate from the pool water. [1] A total of 297 fuel elements were loaded into the SRCSF at the time of commissioning.[2]

The decommissioning approach includes:

- as much of the waste as possible will be classified for "unconditional release" and sent to the municipal landfill
- radioactive water from the reactor pool will be processed then released into the municipal sewage system
- the reactor pool will be "decommissioned" by filling it with concrete to the floor level
- the irradiated core will be transferred to a transportation flask while under water in the reactor pool
- the high level radioactive wastes (the reactor core) will be shipped to the U.S.
- low and intermediate level radioactive wastes will be shipped to Chalk River, in eastern Ontario, transiting northern Ontario en route
- beryllium oxide dust from SLOWPOKE-2 reactor components is a chemical and radiological hazard, the primary management strategy noted in the CMDs is to wrap them in plastic
- The collective dose for decommissioning is estimated to be 2.7 mSv (compared to 0.26 mSv for U of Alberta)
- the decommissioning work is being contracted to CANDU Energy, a branch of SNC Lavelin
- a financial guarantee of $5.76 M is in place, with SRC's President/CEO is authorized to expend up to $7.5M
- Six months of decommissioning begins after the CNSC approval; in 2020 SRC will apply for a Licence to Abandon
- CNSC staff determined that there is no duty to consult with Indigenous peoples about this project

The primary documents relied upon for this review by Northwatch were the Commission Member Documents prepared by the Canadian Nuclear Safety Commission staff and the licensee (CMD and .1), CNSC staff's Environmental Protection Review, the Decommissioning Plan prepared by SNC Lavalin, the Decommissioning Waste Management Plan.

Throughout these documents, much of the same information is provided in very similar format or repeated wording through some or several documents, but there are important inconsistencies between the documents. Some of these inconsistencies are identified in Section 5 of this report (Additional Issues).

2. NORTHWATCH'S INTEREST

Northwatch is a public interest organization concerned with environmental protection and social development in northeastern Ontario. Founded in 1988 to provide a representative regional voice in environmental decision-making and to address regional concerns with respect to energy, waste, mining and forestry related activities and initiatives, we have a long term and consistent interest in the nuclear chain, and its serial effects and potential effects with respect to northeastern Ontario, including issues related to uranium mining, refining, nuclear power generation, and various nuclear waste management initiatives and proposals as they may relate or have the potential to affect the lands, waters and/or people of northern Ontario.

The decommissioning on the SLOWPOKE-2 reactor on the campus of the University of Saskatchewan in Saskatoon is outside Northwatch's geographic area, which is comprised of the six federal districts of northeastern Ontario, however the project and its approach – if approved by the CNSC – have the potential to impact Northwatch and Northwatch's interest in three respects, as set out below.

TRANSPORT OF RADIOATIVE WASTES THROUGH NORTHERN ONTARIO

At least three (and potentially five) of the six districts in northeastern Ontario will be directly affected by SRC's intended transportation of radioactive wastes from Saskatoon to Chalk River. The application identifies Chalk River Laboratory as the destination for low and intermediate level wastes, meaning the transportation routes will transverse northern Ontario, directly affecting our region and members.

In addition, the intention to transport high level radioactive waste to the U.S. may be contributing to a series of precedents that could cause harm to northern Ontario in the future by establishing precedents for the cross border transfer of radioactive wastes, including from the U.S. into Canada.

Transfer of High Level Radioactive Wastes to the U.S.

In addition, the intention to transport high level radioactive waste to the U.S. may be contributing to a series of precedents that could cause harm to northern Ontario in the future by establishing precedents for the cross border transfer of radioactive wastes, including from the U.S. into Canada and potentially to facilities in northern Ontario

SETTING OF PRECEDENTS

The project has the potential to be precedent-setting, particularly in the realm of federal decision-making with respect to decommissioning of nuclear facilities in Canada (including, potentially, facilities in northeastern Ontario). CNSC decisions on many of the issues associated with Saskatchewan Research Council / Candu Energy's proposed decommissioning approach project have potential implications for northern Ontario in the event that practices, policies and / or regulatory decision-making with respect to the management of radioactive wastes become precedent-setting or normative in Canada.

3. RADIOACTIVE WASTE MANAGEMENT AND DISPOSITIONING

Radioactive wastes to be generated through the decommissioning of SRC's SLOWPOKE-2 reactor are described in multiple documents, including and in the most detail in the Detailed Decommissioning Plan[3] produced by SNC-Lavalin and the SRC SLOWPOKE Decommissioning Waste Management Plan[4], also produced by SNC-Lavalin.

The wastes and waste management associated with the project are summarized by CNSC staff as follows:

> *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.*[5]

That a decommissioning project will generate wastes, including radioactive wastes, is not a matter of contention; nor is the decision to decommission this reactor facility. The areas of contention are primarily a) with the quality of information and planning, b) with the robustness of the plan in terms of its exercise of the precautionary principle and c) the degree to which the plan has optimized the protection of human health and the environment.

INFORMATION DEFICIENCIES

In general, the suite of documents (supporting the application) inadequately describe the hazards associated with the radioactive wastes that will be generated through decommissioning. Particular deficiencies are identified in the following sections of this report.

One challenging aspect is the contractor's method of presenting information about the radioactive wastes that will be generated through the decommissioning project. In various instances, the reports present some aspect of the waste inventory: such as listing the different categories of waste, or presenting a table such as Table 1 in the Decommissioning Waste Management Plan which includes very generalized waste descriptions and assigns a waste classification, or for some select items in the waste inventory providing in table format a listing of Actinide inventory such as in Table E-1 Radionuclide Inventory inside Flask F-257 (Actinides)[6] where in one table the inventory is presented in curies, in the next in grams, etc. The presentation is challenging in that it ranges from over-simplied to very technical, with insufficient detail assigned to the former and insufficient explanation assigned to the latter, and little to no correlation between the various information sets. While technical information may be particularly challenging for members of the public to interpret without any technical experts providing support, the presentation of the information is such that it is exacerbated.

Table 1
Classification of SRCSF Decommissioning Radioactive Waste

Waste Description	Waste Classification	Notes
Fuel assembly	HLW	Fuel assembly will be transferred into a dedicated shielding container (flask F-257) and transported to SRS.
Beryllium reflector assembly	ILW	Beryllium reflector assembly (including shims and shim tray) will be transferred into a dedicated beryllium shielding container. The beryllium shielding container will be placed into a Type A package for transport to CNL.
Lower reactor container, irradiation tubes, control rod, neutron detectors, thermocouple	LLW	These components will be transferred into a dedicated LRC shielding container. The LRC shielding container will be placed into a Type A package for transport to CNL.
Upper reactor container, reactor container water level, reactor headspace gas purge system, pool water level monitor, cadmium capsules, PPE&C, concrete core samples	LLW	These components will be placed into a Type A package for transport to CNL.

Figure 1 Source: SRC SLOWPOKE Decommissioning Waste Management Plan

Further, on examination, some of the information as presented raised questions about its reliability. For example, in Table 1 (see above) the lower reactor container and irradiation tubes are identified as low level waste, but are to be placed in an LRC shielding container. Generally speaking, LLW does not require shielding. In addition, in Table 1 the shim tray is identified as Intermediate Level Waste and the irradiation tubes are identified as Low Level Waste, but in

Table C-2 the shim tray is identified as having a lower level of radio-activity than the irradiation tubes (see below).

Table C-2
Estimated Radioactive Solid Waste from SRCSF Decommissioning

Item #	Description	Estimated quantity of waste	Package description	Final disposition
1	Fuel assembly	Mass: 3.6 kg Volume: 0.01 m^3 Activity: 1.1E+13 Bq	F-257 flask	SRS
2	Beryllium reflector assembly including shims	Mass: 70.8 kg Activity: 2.7E+10 Bq	Be shielding container Interior volume: 0.25 m^3	CNL
3	Shim tray	Mass: 14.4 kg Activity: 6.1E+08 Bq		
4	Lower reactor container	Mass: 59.3 kg Activity: 1.2E+09 Bq	LRC shielding container Interior volume: 0.57 m^3	CNL
5	Irradiation tubes	Activity: 6.8E+08 Bq		
6	Control rod	Activity: 1.7E+08 Bq		
7	Neutron detectors	Activity: 4.0E+05 Bq		
8	Thermocouple	Activity: 6.7E+08 Bq		
9	Upper reactor container	Volume: 2.5 m^3	Type A container Dimension: 76"x50"x50"	CNL
10	Reactor water purification system	Volume: 0.3 m^3		
11	Reactor container water level monitor	Volume: <0.001 m^3		
12	Reactor headspace gas purge system	Volume: 0.1 m^3		
13	Pool water level monitor	Volume: <0.001 m^3		
14	Cd capsules for auxiliary shutdown	Volume: <0.001 m^3		
15	Solid waste such as cleaning equipment or materials (paper, plastic, rubber/vinyl) and contaminated PPE	Mass: 100-200 kg Volume: 2 m^3		
16	Radiation Monitoring Devices	Volume: <0.001 m^3	n/a, UR	CNL
17	Capsule Transfer System	Volume: <0.001 m^3	n/a, UR	Recycling
18	Control Console	Volume: 1.5 m^3	n/a, UR	Recycling
19	Battery Assembly	Volume: 2 m^3	n/a, UR	Recycling
20	Sample Stations	Volume: 1.6 m^3	n/a, UR	Recycling
Total predicted volume of radioactive waste		Volume: 8 m^3		

Notes:
SRS – Savannah River Site, U.S. Department of Energy
CNL – Canadian Nuclear Laboratories, Waste Management Facility
SRC – Saskatchewan Research Council
UR – Unconditional Release
n/a – not applicable
For transportation, the Be shielding container and the LRC shielding container will be transferred into Type A containers.

Figure 2 SRC Decommissioning Waste Management Plan, page 22

In other instances, relevant information could not be located in the documents. For example,

- Beryllium is identified as "the primary chemical hazard associated with the decommissioning work arises from the beryllium which is contained in the lower reactor container. It presents both a chemical and radiological hazard" and past SLOWPOKE-2 reactor decommissioning experience has supported this statement of caution; however, despite this, we found no information responding to past failures and outlining how they would be avoided in this decommissioning experience, or information outlining the precautionary approach that would be employed specific to this chemical and radioactive hazard, other than the very generalized claim that the "removal and disposal of the beryllium reflector will be carried out in a manner which minimizes the risk of dispersal of beryllium dust, as is routinely done while performing reactivity adjustments on operational SLOWPOKE reactors…"
- The SRC CMD states that "additional potentially contaminated parts include metal chips from cutting the reactor component for fitting" but the documents provide no additional information about this waste type[7]
- The SRC SLOWPOKE Decommissioning Waste Management Plan erroneously identifies the location of the Savannah River Site – destination of the SRC SLOWPOKE-2 spent fuel – as being in Georgia, rather than its actual location of South Carolina
- The supporting documents identify the Chalk River Nuclear Laboratory site as the destination for low and intermediate solid and liquid radioactive waste, describing it as being dispatched there for "long-term storage". The documents provide no information about the means by which the waste will be "stored", including over short, medium and long time frames. Based on Northwatch's limited familiarity with the Chalk River site, this plan – or lack thereof – raises serious questions about the robustness of the plan and the potential for harm to the Ottawa River watershed by transferring additional radioactive burdens onto this site.

REQUEST: SRC or their contractor SNC-Lavalin be required to fill all information gaps prior to the hold point requested in the next sub-section.

IN SITU WASTE DISPOSAL

The CNSC staff Commission member document describes SRC/SNC-Lavalin's plan to take concrete core samples from the reactor pool for activation assessment, with the intent of confirming that the structural materials and inner surface coating are confirmed as being below the clearance criteria. The sequence described is as follows:

- Radiological survey is done by SRC/SNC-Lavalin
- CNSC staff conducts an inpection
- The Reactor pool is filled
- The SRC reports, incuding survey results[8]

The description lacks clarity around when the CNSC receives the survey results, and how decisions are made about whether the survey results demonstrate that the clearance level has been achieved.

Of note is that this description seems inconsistent with the information provided by SNC-Lavalin in the Detailed Decommissioning Plan.

In its description of the reactor pool, the Detailed Decommissioning Plan describes how the reactor pool floor will have become radioactive due to its close vicinity to the reactor core.[9] It describes the very limited sampling program (four "representative" samples from the pool floor and one from the lining) and communicates that the clearance levels will be exceeded without any removal of the pool floor and states that "the measured activity from the 5 concrete samples will be compared against the calculated values to confirm the size of the pool floor material to be removed to reduce the bulk concrete pool clearance index to less than one". [10]

Two observations are drawn:

- The CNSC CMD communicates a strong expectation that the sampling is simply to confirm that the clearance levels will be achieved, whereas the Detailed Decommissioning Plan communicates a definite expectation that the clearance levels will

not be achieved without the removal of portions of the pool floor, at minimum; these two communications are in conflict

- While the Detailed Decommissioning communicates a definite expectation that portions of the pool floor will be removed, we found no details on the manner in which those radioactive wastes would be categorized or managed, particularly over time, or what the hazard was they constituted

In addition, Northwatch has a concern with the very small number of samples (four in the floor and one in the pool wall) and the placement of those samples in what appears to be single diametrical line in the pool floor.

We are further concerned given that in the case of the University of Alberta SLOWPOKE, the post-decommissioning radiological survey found radiation levels in the floor of the reactor pool to be in excess of the "clearance level" of 0.5 microSieverts per hour. Despite this exceedence of the "clearance level", the CSNC allowed the reactor pool to be filled with concrete and abandoned – de facto create a long term waste management facility in the subsurface of the University of Alberta campus, albeit one operating without a license or regulatory oversight.[11]

REQUEST: Create a hold point through license conditions which require a public review of the radiological survey results of the reactor pool floor and wall, and a decision by a multi-member panel of the Commission to determine whether the clearance conditions have been met and the reactor pool can be filled.

REQUEST: require an augmented sampling of the reactor pool floor and walls to provide adequate information to support a determination as to whether clearance levels have been met.

4. RADIOACTIVE WASTE TRANSPORT

The SRC's overview document (CMD 19-H100.1) conveys the following information about waste transportation:

> *The irradiated reactor core will be safely transported in a Type B container (the F-257 flask) from the SRCSF to the Savannah River Site (SRS) in South Carolina. The F-257 flask requires approval from the CNSC. SRC requires approval from the CNSC to obtain the transport licence for transportation of the irradiated core in Canada. This transport license application will be made to the CNSC upon receiving the export license well before the transport of irradiated core.*
>
> *All remaining radioactive waste will be transported to CNL using pre-approved (certified) Type A package(s) that meet IAEA transportation requirements. No additional permits are required from the CNSC. Appropriate security arrangements will be established for this purpose.*

REQUIRED INFORMATION

A requirement of the license application is that the application provides the following information in addition to the information:

(*k*) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to

(i) assist off-site authorities in planning and preparing to limit the effects of an accidental release,

(ii) notify off-site authorities of an accidental release or the imminence of an accidental release,

(iii) report information to off-site authorities during and after an accidental release,

(iv) assist off-site authorities in dealing with the effects of an accidental release, and

(v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;

In response, the applicant provided the following references:

- Occupational Health and Safety Manual, OHS-MAN-1, SRC, February 2018.
- Radiation Safety Manual, OHS-MAN-2, SRC, February 2018.
- Fire Safety Manual, OHS-STD-11, SRC, February 2016.
- CPR-26, Rev. 1, Description and Safety Analysis for the SLOWPOKE-2 Reactor". M.E. wise and R.E. Kay, Atomic Energy of Canada, Ltd. February, 1981.
- SRC SLOWPOKE–2 Decommissioning Facility Emergency Response Plan, 147-01600-ERP-002, Rev. 0
- Hazard Assessment Report for Decommissioning SRC SLOWPOKE-2 Facility, 147-01600-HA-002, Rev. 0.
- SRC SLOWPOKE–2 Decommissioning Radiological Consequences Assessment, 147-03600-ASD-003, Rev. 0.
- SRC SLOWPOKE–2 Decommissioning Out-of-Reactor Criticality Assessment, 147-03340-ASD-002, Rev. 0.

While not all of these documents were available to Northwatch, we reviewed those that were, including the SRC SLOWPOKE–2 Decommissioning Facility Emergency Response Plan, which seemed the most likely to include information related to transportation emergencies or accidents or off-site releases related to transportation.

Section 5, titled "EMERGENCIES DURING TRANSPORTATION" was the only transportation related information provided in response to the above noted requirement to address accidental releases or off-site emergencies related to transportation. The 160 word description is replicated here, in its entirety:

> *Emergencies during transportation are not in the scope of this document. However, a brief description about the emergency during transportation is stated below.*
>
> *The SRCSF nuclear fuel will be transported to United States Department of Energy Receipt Facility in Aiken, South Carolina. The fuel will be carried in the F-257 flask specially designed for this fuel. It will take 5 hours (approx.) to transport the fuel from SRCSF to the U.S. border. A Fuel Transportation Security Plan (TSP) has been written that includes details on the security, communication, and emergency aspects of this shipment.*
>
> *This transportation will also require an Emergency Response Assistance Plan (ERAP) which includes emergency response procedures those will be implemented in case of an incident during the transportation.*
>
> *An ERAP registered with the Transport Canada will be used for this shipment which is applicable to the UN3328 shipment package*.[12]

SRC has not met the information requirements related to transportation related emergencies and accidental releases.

REQUEST: That the Commission require SRC to meet the information requirements related to transportation risk prior to giving further consideration to the SRC application.

AVAILABILITY OF INFORMATION

Section 13 of the Decommissioning Waste Management plan titled "Waste Transportation" indicates that "Detailed discussions on the SRCSF decommissioning waste transportation plan are given in the deliverable D13 in Appendix A". Appendix A does indeed list D13 as a "Deliverable Supporting SRCSF Decommissioning Project" but in the future tense, stating that "The following deliverables will be prepared by Candu to support the Transport Licence application:

- D13 147-01600-WP-003 Radioactive Waste Transportation Plan for SRC SLOWPOKE-2 Facility
- D14 - Transportation Security Plan

DOSE ESTIMATES

While, in the absence of an independent technical expert we were unable to verify them, we do note that the Detailed Decommissioning Plan provided dose estimates for key activities during decommissioning, including the removal of reactor components and auxiliary components, packaging of radioactive material and during pool cleanup.[13]

No dose estimates were provided for the transporation activities that are part of the proposed decommissioning approach.

According to the SRC Commission Member Document, the SRC will submit an application to the CNSC for an export licence, to export SLOWPOKE Nuclear Fuel to the United States. An application will also be submitted to the USNRC in order to obtain an import permit to the United States and to approve the use of F-257 flask for the transportation of irradiated core in USA.

Reportedly, the SRC requires route approval from the USNRC from SRC in Saskatoon to the final consignee for the irradiated fuel, the US Department of Energy-National Nuclear Security Administration (NNSA), South Carolina. The transportation details are provided in the "SRCSF Decommissioning Radioactive Waste Transportation Plan" prepared in support of the transportation licence (separate application).

SRC also requires approval from the CNSC to obtain the transport licence for transportation of the irradiated core in Canada. The CMD states that "This transport license application will be made to the CNSC upon receiving the export license well before the transport of irradiated core."

According to the CMD, all remaining radioactive waste will be transported to CNL using pre-approved (certified) Type A package(s) that meet IAEA transportation requirements. No additional permits are required from the CNSC. Appropriate security arrangements will be established for this purpose.[14] This information is consistent with that which is presented in the Detailed Decomissioning Plan.[15]

REQUEST: that in its Decision the Commission clarify and confirm that decommissioning activities such as removal and shipping of reactor fuel waste are to be undertaken only under a decommissioning license, not under an reactor operating license.

REQUEST: that in its Decision the Commission clarify and confirm that a separate license for the transport of the spent fuel will be subject to a separate licence will be the subject of a public notice, opportunity to comment, and a public hearing including oral submissions, and that the Commission will conduct the hearing.

With the support of the Ontario Law Foundation, Northwatch conducted an investigation during 2017 and 2018 into the information needs of small municipalities, volunteer fire fighters and First Responders around emergency response / right to know issues in the case of accidents and unintended releases related to the transportation of hazardous goods more generally and with respect to the transportation of radioactive materials and response to accidents and accidental releases in particular.

The following observations are a summary of responses from front line responders:

- The range of experiences and outlooks varies greatly among firefighters, both within a particular service, but even more so between the professional forces and the volunteer forces; further differences are in evidence between volunteer fire services in organized municipalities versus unorganized townships (with Local Service Boards)

- Volunteer forces generally appear to rely more on in-house training and passing expertise from senior more experienced members to younger members, while municipal forces appeared to rely more on formal training; that taken into account, respondents from both types of forces described some members as being more specialized, including in the area of responding to situations involving hazardous materials

- Particularly for volunteer forces, time constraints were noted as the key challenge in expanding training; force members regularly do three hours a week of training and equipment maintenance, outside of response to fire calls

- First responders consistently identified the Emergency Reference Guide 2018 as their primary information source for identifying hazards and developing appropriate responses

- There is a specific training module related to transportation, and most on the force would have Level 1 of this training which addresses how to read the truck placard and response accordingly; in situations where hazards are unknown, likely approach for volunteer forces would be to secure the site and invoke the Mutual Aid Agreement to bring in

support from a larger community with more specialized expertise, or from professional hazmat team

- Respondents indicated that there is no training provided specific to radiological events, with the exception of several pages in the Emergency Reference Guide

The Office of the Fire Marshall and Emergency Management Ontario were consistent both across agencies and internally in terms of the chain of command in emergency response and training and information transfer. Both agencies were also consistent in being largely silent on the training and tools being provided to fire fighters to respond to transportation accidents involving hazardous materials, and even more so with respect to radiological events.

Available trainings and training materials were also consistent with this, generally providing minimal attention to these risk areas. In particular, these gaps were evident in the Incident Management and the Basic Emergency Management trainings. While several references were made during interviews to the 2018 Emergency Response Guidebook[16] as the go-to resource when responding to a hazardous materials event, the 400 page guide is largely a listing of materials with relatively general instructions in how to respond in a fire situation. Eleven pages deal with six different groupings of radioactive materials, ranging from low level to high level (in terms or radioactivity) and including wastes, fissile material, and uranium hexafluoride. Disconcertingly, each of the six sections begins with the statement "Radiation presents minimal risk to transport workers, emergency response personnel and the public during transportation accidents. Packaging durability increases as potential hazard of radioactive content increases."

These findings, particularly coupled with the absence of a Radioactive Waste Transportation Plan and the omission of transportation emergencies from the Emergency Response Plan prepared for the SRC SLOWPOKE-2 decomissioning project, present the potential for first responders in rural communities and in remote locations along the transportation route to be particularly at risk.

REQUEST: That in considering the application for a transportation license, the Commission ensure that there is a public hearing with notice and opportunity for interested parties along transportation routes to contribute, including and particularly First Responders.

5. ADDITIONAL ISSUES

Northwatch's review is not comprehensive, and has prioritized those issues which are most directly relevant to northern Ontario, i.e. the transportation of radioactive wastes through the region and by necessary extension the characterization and management of those wastes. However, in the course of this review we have identified a number of areas of concern with the proposed decommissioning approach more generally. These additional issues are summarized in this section.

END STATE OBJECTIVES

Throughout the various documents, the end state objectives of the decommissioning program are described in various albeit largely similar ways.

For example, SRC summarizes the end-state objectives as follows:

> *The objective for the decommissioning of the SRCSF is to achieve conditions that will allow SRC the unrestricted use of the building and services remaining in the facility*.[17]

While SNC-Lavalin describes it as follows:

> *The end state objective for the decommissioning of the SRCSF (which includes all rooms associated to the facility as detailed in Section 2.3) is to obtain a licence to abandon allowing SRC the unrestricted use of the building and services remaining in the area currently occupied by the facility.* [18]

And CNSC staff as follows:

> *The end-state objective is to return the decommissioned areas of the facility to a state that allows for unrestricted use*.[19]

However, in at least one instance, the end state objectives are stated differently, with CNSC staff including in its summary the expectation that the site would be returned to its "original state":

> *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)*.[20]

This qualification that the end state objective includes returning the site to its "original state" is an important one, but is absent from other documents.

In fact, in the contractor SNC-Lavalin's Detailed Decommissioning Plan, after summarizing the decommissioning of the Reactor Room (Room 146), the plan author then indirectly confirms that the intention is to not return Room 146 to "original" condition, stating instead that "*All other rooms and corridors will be cleaned to original condition as was received prior to decommissioning*."[21] (emphasis added).

In an earlier more detailed description of the decommissioning of Room 146, in a section titled "4.4 End State Objectives - Room 146", the Detailed Decommissioning Plan states that "The only end state objective of this room is to be clean of all radioactive and hazardous material" and then goes on to list, bullet form, items which it very generally describes as "end state objectives" but are actually a series of activities, those being to:

- *Remove irradiated fuel and ship to SRS (Savanah River Site) in F-257 flask.*
- *Remove all reactor components from the reactor pool and ship to CNL as radioactive waste in Type A containers, this includes upper reactor container, LRC, all irradiated beryllium components, irradiation tubes, thermocouple, flux detector, control rod, and all fasteners etc.*
- *Remove reactor water purification system will be shipped to CNL as radioactive waste in Type A container.*
- *Remove pool water purification system and reuse.*
- *Remove reactor control console and reuse or recycle.*
- *Remove sump pump to dispose as non-radioactive waste.*
- *Remove all irradiation controllers and receivers for reuse or recycle.*
- *Remove all fixed or loose radioactive contamination in excess of regulatory limits.*
- *Process the reactor pool water (mixed water) through ion exchange columns and dispose the water in the sewer after achieving the free release criteria.*
- *Remove irradiated part of the reactor pool floor which will include the concrete and the rebar and dispose as radioactive waste (see text below for further details).*
- *Ensure there is no hazardous material left in the room e.g. radioactive samples resulting from irradiation in the reactor, waste materials (gloves, irradiated vials and swipes).*
- *Fill the reactor pool and the trenches with concrete after necessary inspection and clearance from the CNSC.*[22]

While in the majority of instances the "end-state objective" is stated only in administrative terms - to achieve unrestricted use or obtain a licence to abandon - by both the regulatory staff and the proponent, this important part of the application to amend the SRC license is deficient in at least three respects:

- Stating the end-state objective in simply administrative terms is inadequate and circular
- There are inconsistencies in the application with respect to the radiological aspects of the application's approach to end-state objectives
- The approach is not consistent with international practices, as set out by the International Atomic Energy Agency and standards to which Canada is a Signatory[23]

While some of the Application's supporting documents do include references to the "clearance levels" as set out in Schedule 2 of the *Nuclear Substances and Radiation Devices Regulations*, including a poor quality replication of Schedule 2 as Appendix D to the Detailed Decommissioning Plan[24], the end state objectives for the decommissioning program – or the anticipated outcomes – are not stated in radiological terms.

Not only does this not satisfy the needs of the concerned public and of the Commission to understand in precise terms what the decommissioning outcomes are expected – and required – to be, it also places the license amendment application and the decommissioning program it outlines in contravention with IAEA standards for decommissioning.

The IAEA safety standard for decommissioning, the "*Safety Assessment for the Decommissioning of Facilities Using Radioactive Material*"[25] provides guidance and sets requirements that the approach proposed by SNC-Lavalin on behalf of their client does not meet.

For example, the safety standard requires that the safety assessment for decommissioning include "Assessment outputs" that are radiological in nature (e.g. effective dose or risk) and that these outputs should correspond to the relevant safety requirements and criteria including "the defined end states of decommissioning".[26]

The standard also sets out the requirement for "*A clear definition of the decommissioning phases and their end points, including specific information about the physical, chemical and radiological end state objectives. The end point for each of the individual phases should not result in a condition that precludes achieving the final end state for the decommissioning of the facility*".[27]

In stating the end-state objective in simply administrative terms, such as achieving unrestricted use or obtaining a licence to abandon the facility, this requirement to first identify and then meet end-state objectives that are radiological (of chemical, or physical) in nature is not met.

Further, as discussed in Section 3 of this report, the suite of documents inadequately describe the hazards associated with the radioactive wastes that will be generated through decommissioning.

PLANNED LOCAL RADIOLOGICAL RELEASES

While framed as expected to be within allowable limits, the decommissioning plan for the SRC's SLOWPOKE-2 reactor relies extensively on the free release of radiologicaly contaminated liquid and solid materials into the local environment, including into local waste water systems, the local solid waste landfill, and potentially to local recyclers.

Numerous sections in the Commission Member Documents produced by both SRC and CNSC staff establish that:

- as much of the decommissioning waste as possible will be classified for "unconditional release" and sent to the municipal landfill; this includes wastes with "very" low levels of radioactivity
- radioactive water from the reactor pool will be processed through an ionization process and then released into the municipal sewage system

As set out in the CNSC staff's overview document[28] the decommissioning plan sets out that "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". Consistent with that and as set out in the SRCs overview document[29] " demolition debris will be determined to be free of contamination, as defined by allowable release limits, and transported to a landfill authorized to accept the particular type of waste".

The Decommissioning Waste Management Plan provides limited and incomplete information about the wastes that will be categorized as eligible for "unconditional release", as it does more generally for all waste types. While the various documents filed by CNSC staff and by SRC or their contractor SNC-Lavalin state that the levels will be below clearance levels, this clearly does not mean that the materials are not radioactive or that there is not the potential for a cumulative or additive risk. However, relying on the filed materials, we were unable to determine the volume of the radiological loading of the materials that will be disposed of outside of the management system for radioactive wastes.

What is clear, however, is that the placement of radioactive materials in the Saskatoon landfill is a violation of the City of Saskatoon's bylaw[30] and operating procedures for the municipal landfill, which has a prohibition on the placement of radioactive materials in the landfill.[31] And while SNC-Lavalin does not clearly state that the very low level radioactive wastes (i.e. the wastes that have gained an "unconditional release" categorization) would be placed in the City of Saskatoon landfill, it creates an impression that this would be the case, and fails to –in the alterative – identify where or how it would be dispositioned if <u>not</u> to the City of Saskatoon landfill.

Similar concerns must be registered with respect to the proposed free release of radiologically contaminated water into the City of Saskatoon's sewer system.

As set out in the CNSC staff's overview document[32] the radioactive reactor pool will be processed through ion exchange columns "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".

According to the Environmental Protection Report produced by CNSC staff, approximately 28,380 litres of water would be released.[33] Section 6 of the Detailed Decommissioning Plan provides some additional information about the radiological hazards associated with the reactor pool water, but insufficient information about the "processing" of the water to remove the radionuclides, particularly after the reactor and pool water has been mixed.

The Detailed Decommisioning Plan provides a brief description of the Pool Water Purification and Level Monitoring System and the Reactor Water Purification and Level Monitoring System[34], the description also states that "the pool water and reactor container water are maintained at specified purity levels by separate water treatment plants to ensure that there is no mixing of pool and reactor container waters", whereas the SRC CMD reports that *"upon separation of the reactor container sections, water from the container will mix with water from the reactor pool.*[35]

We note that while the City of Saskatoon's Sewer Bylaw 9466 includes radioactive material on the Schedule A list of unacceptable wastes, it does so with the qualifier "except within such limits as are permitted by licence issued by the Canadian Nuclear Safety Commission", thus creating a circular condition for the release of these radioactive waters.

In our view a careful assessment must be undertaken by the City of Saskatoon of the potential for cumulative or additive effects of the planned release, as we think it unlikely that the loading of the entire contents of the reactor pool water – albeit after some treatment - into the Saskatoon sewers was anticipated by the Council or staff of the City of Saskatoon when they included that qualifier on the unacceptability of radioactive materials. However, as discussed elsewhere in this section, there is no indication in the CNSC staff submission that they have engaged with the City of Saskatoon, despite the grave implications for the City's water system of the proposed free release of the "processed" pool and reactor water.

It appears to be a circular condition: CNSC staff argue that this unprecedented release will meet the sewer bylaw, while the sewer bylaw allows this release if it is approved by the CNSC.

SRC's overview document describes both the cause of the radiological contamination and the general intent to "process" the waters, but no substantive description of the treatment process. The net impression is of a rush to release, to treat until the release limits are met, and then discharge the now-mixed reactor and pool water into the public common:

> *The main source of liquid wastes is the water from the reactor container. The reactor container water contains small quantities of radionuclides from fission products. Upon separation of the reactor container sections, water from the container will mix with water from the reactor pool. The mixture will be processed using the reactor purification system until the release limits to the sewer system are met. The mixture of reactor container water and reactor pool water will be discharged into the Saskatoon city sewer system after it had been treated to reduce the activity to below the release limits which comply with the CNSC regulatory requirements and the city of Saskatoon bylaws. Contaminated liquids, if any, arising from decontamination activities, will be placed in approved containers and transported for storage*.[36]

Little to no details is provided on the contingency plan for managing liquids that are not below the release limits. As noted above, SRC puts forward a general expectation that – should such wastes form part of the waste stream – they will be sent away. This is repeated, with very little additional detail, in the *SRC SLOWPOKE Decommissioning Waste Management Plan*:

> *Contaminated liquids, if any, arising from decontamination activities, will be placed in approved containers and transported for storage. CNL's waste management division will be consulted prior to the liquid waste being placed into containers and transported, to ensure that waste acceptance criteria are met*.[37]

While we certainly agree with the need for a contingency plan if/when the radiologically contaminated waters do not meet the release criteria, we expect the Commission will agree that the requirement is for an actual contingency plan, rather than a summary statement of expectation that a contingency will be available. Evidence that this is not the case, that a contingency plan is not in place, includes a) the absence of any description of such a plan, and b) the absence of any listing or identified packaging for liquid waste in Appendix E and Appendix F of the SRC SLOWPOKE Decommissioning Waste Management Plan.

UNPLANNED RELEASES

As noted in the CNSC staff Commission Member Document, decommissioning projects have already been completed for the SLOWPOKE-2 reactors at the University of Toronto, Dalhousie University and the University of Alberta in 2017 . CNSC staff indicate in their CMD that the decommissioning process proposed by SRC will draw heavily on the tools and technologies and lessons from the above decommissioning projects, and that SRC is contracting CANDU Energy (a unit of SNC-Lavalin) for the decommissioning work.[38] Candu Energy was also the contractor for the three previous SLOWPOKE-2 reactor decommissioning projects.

Of particular concern is the history of unplanned releases or areas where the decommissioning objectives were not achieved in each of these projects. These include:

- logistical issues of radioactive waste during transportation
- excess radioactive field prior to transportation
- potential exposure of workers in other buildings and errors in notification
- unexpectedly high levels of radiation associated with berrylium transportation containers
- errors in reading radiation field surveys[39]
- For both the U of T and Dalhousie reactors there were "reportable events" in which decommissioning staff received excessive radiation doses during removal of the reactor beryllium reflectors
- During decommissioning of the Dalhousie reactor, a control rod was inadvertently extracted out of the guide tube in the shim tray above the reactor core during removal of the reactor beryllium reflectors, resulting in an increase in radiation dose to four decommissioning personnel required to spend additional time in the reactor room (increase of 12 μSv per worker involved)[40].
- In the case of the University of Alberta SLOWPOKE, the post-decommissioning radiological survey found radiation levels in the floor of the reactor pool exceeding a “clearance level” of 0.5 microSieverts per hour. Hard-to-measure radiation from other substances would have added to this level. Despite this excedence of the “clearance

level", the CSNC allowed the reactor pool to be filled with concrete and abandoned – leaving a permanent radioactive waste dump on campus.[41]

PROCESS CONCERNS

PUBLIC PROCESS

On June 20th 2019 the Canadian Environmental Law Association ("CELA") sent a letter on its own behalf and that of Northwatch, the Inter-Church Uranium Committee Educational Cooperative (ICUCEC) and the Concerned Citizens of Renfrew County (CCRC) with respect to the Notice of Hearing in Writing (Ref. 2019-H-100) released June 12, 2019 setting out that a hearing in writing would be held with respect to the proposed decommissioning of SRC's SLOWPOKE-2 reactor in Saskatoon, with a deadline for written submissions and requests to intervene of June 25, 2019. The signator groups expressed opposition to the CNSC's decision to provide only 13 days for preparation and filing of materials and to hold the hearing in writing, absent any provision of participant funding, and requested that the CNSC grant an extension of time so that the public has at least 60 days for filing of interventions, and that an in-person public hearing be held, with the opportunity to make oral submissions.

We appreciated the Commission's positive response to these concerns and requests, as set out in their letter of July 3rd, advising that the Commission had published on June 27, 2019 a revised notice of public hearing and that the Commission has rescheduled the hearing to be held as an oral hearing on September 26, 2019 and extended the deadline for submitting intervention requests to August 26, 2019.

However, on a less positive note, our attention was drawn to one statement in the Commission's letter:

> "*The Commission's recent experience within similar matters regarding the decommissioning of SLOWPOKES, where no requests to intervene were submitted and no requests for participant funding were made, despite both being offered, gave rise to*

the initial determination to conduct this public hearing in writing, as an efficient process."

For clarity, we reviewed the notice of hearing for the three completed SLOWPOKE decommissioning license amendments, including the most "recent", that being for the decommissioning of the SLOWPOKE reactor at the University of Alberta.

For the decommissioning of the SLOWPOKE reactor at the University of Alberta, the hearing notice is dated August 15, 2017, Ref. 2017-H-106, and is a thirteen day notice for written submissions only.

For the decommissioning of the SLOWPOKE reactor at the University of Dalhousie, the January 11, 2011 notice, Ref. 2011-H-100 also stated that there will be no public hearing, and that written submissions will be limited to those of the CNSC staff and the licensee:

"The Commission has determined that a public hearing is not necessary to consider Dalhousie University's request in this case. The hearing will be conducted by way of written submissions from CNSC staff and Dalhousie University."

For University of Toronto, the February 1, 2012 notice with respect to the revocation of the License to Abandon, Ref. 2012-H-102, was similar:

"The Commission has determined that a public hearing is not necessary to consider the University of Toronto's request in this case. The hearing will be conducted by way of written submissions from the University of Toronto and CNSC staff."

We were unable to locate the Notice of Hearing for the University of Toronto amendment of the license for decomissioning in 2000, but note that the Record of Proceedings indicate that perhaps the one day public hearing on the license to abandon its SLOWPOKE-2 reactor was made in response to a request for a public hearing by the University of Toronto:

"The Canadian Nuclear Safety Commission granted the request from the University of Toronto to hold a one day Public Hearing on the application to abandon its SLOWPOKE-2 Reactor. The public hearing is scheduled for December 13, 2000, in the CNSC Public Hearing Room, 280 Slater St., 14th Fl., Ottawa, Ontario."

We provide this background simply to set out to the Commission that it appears to have been the practice with each of the SLOWPOKE-2 decommissioning license hearings to limit public involvement and conduct closed hearings, with the exception of the University of Toronto which was course-corrected in response to a request from the University, and in 2019 in response to a request from CELA, Northwatch, ICUCEC and CCRA.

REQUEST: that future proceedings related to the decommissioning and abandonment of SLOWPOKE-2 reactors be conducted as public hearings, with adequate notice and the opportunity for both written and oral submissions by interested parties.

DECOMMISSIONING DECISION SCOPE AND SEQUENCE

The CNSC staff commission member document frames the scope of decisions to be made via the requested amendment to the license in order to move to a decommissioning phase as follows:

> *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.*[42]

However, in the Environmental Protection Report – included in the same CMD – the CNSC staff present the scope of the decommissioning license differently:

> *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.*[43]

According to the former statement from CMD 100, the decisions with respect to the fuel core removal and shipment and removal of reactor water are to be – or have been - made under the current operating license, i.e. with no opportunity for public input, no input from the City of Saskatoon, or Indigenous peoples and others along the transportation route for both the high level radioactive

wastes en route to the southeastern United States via southern Saskatchewan, or the low and intermediate level radioactive wastes en route to Chalk River via eastern Saskatchewan, Manitoba, and northern Ontario. According to the latter statement, the activities of defueling, dewaterig and waste shipments are activities that would be undertaken only under an amendment to the existing licence to allow decommissioning.

The SNC-Lavalin contribution to this confusion includes a statement in the Decommisisonig Waste Management plan that "under the existing NPROL [7] the work leading up to removal of irradiated fuel and reactor components can be performed".[44]

REQUEST: that in its Decision the Commission clarify and confirm that decommissioning activities such as removal and shipping of reactor fuel waste are to be undertaken only under a decommissioning license, not under an reactor operating license.

REQUEST: that in its Decision the Commission clarify and confirm that a separate license for the transport of the spent fuel will be subject to a separate licence will be the subject of a public notice, opportunity to comment, and a public hearing including oral submissions, and that the Commission will conduct the hearing.

ENGAGEMENT WITH THE CITY OF SASKATOON

Submissions from the CNSC staff provided no indication that there has been any engagement with the City of Saskatoon as part of this review to potentially amend SRC's operating license to allow decommissioning of their SLOWPOKE-2 reactor.

Both the CNSC staff Commission Member Document[45] and the Environmental Protection Report[46] reference the City of Sasktoon's waste and sewer bylaws, but there is no further discussion of the City of Saskatoon's involvement or of potential impacts on the City of Saskatoon, its operations, or its residents.

Not only is this poor practice, but it is another area in which the decommissioning plan and associated preparations fail to meet international standards.

The IAEA's Safety Assessment for the Decommissioning of Facilities Using Radioactive Material set out a clear expectation for the involvement of interested parties, and specifically identifies local municipalities:

> *... interested parties shall be provided with an opportunity to provide comments on the final decommissioning plan prior to its approval. This should include information about the safety assessment for the planned decommissioning activities, in accordance with national legislation. The involvement of local municipalities will be particularly important during the decision making process associated with the end state of the site (or facility) following the completion of decommissioning (e.g. its redevelopment for future, possibly restricted, use). Thus the process of involvement of interested parties should include provision for engagement of local municipalities in the safety assessment for end states. ... As such, a process should be established so that interested parties can be provided with information, in an understandable and useful form, from the safety assessment for decommissioning so as to enable them to provide input into the regulatory body's decision making process for approval of the decommissioning plan (e.g. via public hearings or the solicitation of comments via the Internet).*[47]

REQUEST: That the Commission ensure that the City of Saskatoon has had a full opportunity to provide meaningful input in advance of the Commission coming to a conclusion on the license application. The Commission should consider delaying its decision in order to achieve this.

DUTY TO CONSULT

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" and therefore concluded that "the duty to consult does not arise in relation to the proposed licence application"[48] .We disagree.

Specific to the transportation of radioactive wastes, the potential to adversely affect Aboriginal and treaty rights has been repeatedly identified, including by Indigenous peoples who have intervened in previous CNSC proceedings.

The decommissioning plan includes shipping high level radioactive waste through Treaty 6 and Treaty 4 territories, south of Saskatoon, on a route between Saskatoon and the Savannah River National Laboratory in South Carolina, in southeastern U.S.A.

These shipments of highly radioactive waste through Treaty 6 and Treaty 4 territories poses a risk to these territories, and to the people, land and waters of these territories. These radioactive shipments are included in the decommissioning "activities", and subsequently the Canadian Nuclear Safety Commission had a duty to consult the First Nations on the route, and to accommodate their interests and concerns.

The same can be said of the low and intermediate level radioactive wastes that will be transported through northern Ontario, and so across the territories of Treaty 3, Treaty 9, and the Robinson-Huron and /or Robinson-Superior Treaty areas. The political leadership of the Anishnabek Nation - which includes the Robinson-Huron , Robinson-Superior and other Treaty areas – have recently and clearly gone on record as having a concern and interest with respect to the transportation of radioactive materials across their territories.[49]

6. CONCLUSIONS

As set out in this submission, Northwatch has numerous concerns with the application as prepared and submitted by the Saskatchewan Research Council and their contractor Candu Energy / SNC-Lavalin.

At this point it is our assessment that the Application does not meet the regulatory requirements, and the best course of action would be for the Commission to issue a deficiency notice and allow the licensee the opportunity to address the deficiencies.

Without prejudice to that preferred approach, we would – in the alternative – ask that the Commission proceed in accordance with the requests we have included throughout this submission.

All of which is respectfully submitted on behalf of Northwatch.

August 28th, 2019

ENDNOTES

[1]Environmental Protection Review Report: Amendment of the Operating Licence for Saskatchewan Research Council's Safe Low-Power Kritical Experiment Reactor (SLOWPOKE-2), Canadian Nuclear Safety Comission, 2019, Page 1

[2] PDP (Preliminary Decommissioning Plan), Reference [8] Decom plan p 19

[3] SRC SLOWPOKE-2 Detailed Decommissioning Plan, Report 147-01600-DDP-002, SNC-Lavalin, 2019

[4] SRC SLOWPOKE Decommissioning Waste Management Plan, 147-01622-REPT-002, SNC-Lavelin, 2019

[5] CMD: 19-H100

[6] SRC SLOWPOKE Decommissioning Waste Management Plan, page 24

[7] Page 25 Cmd 100.1

[8] CMD 100

[9] Detailed Decommissioning Plan, page 27

[10] Detailed Decommissioning Plan, page 28

[11] Record of Decision, 2018-H101, University of Alberta SLOWPOKE-2 Decommissioning. 2018

[12] Emergency Response Plan for Decommissioning of SRC SLOWPOKE-2 Facility, Doc#: 147-01600-ERP-002. Page 26

[13] Detailed Decommissioning Plan, Page 33

[14] Page 26 Cmd 100.1

[15] Detailed Decommissioning Plan, page 47

[16] "Emergency Reference Guide 2018", as found at https://www.tc.gc.ca/media/documents/tdg-eng/EnglishERGPDF.pdf

[17] Page 20 cmd 100.1

[18] 4. DECOMMISSIONING END STATE OBJECTIVES Decomm plan p 25

[19] CMD 19-H100, Executive Summary

[20] 19-H100, pages 4-5

[21] SRC SLOWPOKE-2 Detailed Decommissioning Plan, SNC-Lavalin, Page 45

[22] SRC SLOWPOKE-2 Detailed Decommissioning Plan, SNC-Lavalin, Page 27

[23] Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-G-5.2, International Atomic Energy Agency, Vienna, 2008

[24] SRC SLOWPOKE-2 Detailed Decommissioning Plan. Pages 66 - 73

[25] Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-G-5.2, International Atomic Energy Agency, Vienna, 2008

[26] Ibid, page 21

[27] Ibid, page 22

[28] CMD 19-H100, page 14

[29] CMD 19-H100.1, page 25

[30] Waste Bylaw 8310, as found at https://www.saskatoon.ca/sites/default/files/documents/city-clerk/bylaws/8310.pdf

[31] See https://www.saskatoon.ca/services-residents/waste-recycling/garbage/landfill

[32] CMD 19-H100, page 12

[33] Environmental Protection Review Report: Amendment of the Operating Licence for Saskatchewan Research Council's Safe Low-Power Kritical Experiment Reactor (SLOWPOKE-2), CNSC, June 2019, Table 2: Radionuclide Concentrations in Reactor Container Water and Pool Water before Purification and Release Criteria

[34] Detailed Decommissioning Plan, pages 21-22

[35] CMD 19-H100.1, D.6.2 Liquid Radioactive Waste, Page 26-27

[36] CMD 19-H100.1, D.6.2 Liquid Radioactive Waste, Page 26-27

[37] SRC SLOWPOKE Decommissioning Waste Management Plan, page 14

[38] CMD 100, page 5

[39] CMD 00-H34 Transcript

[40] section 2.4 of CMD 11-H122

[41] Record of Decision, 2018-H101, University of Alberta SLOWPOKE-2 Decommissioning. 2018

[42] CMD 100 page 5

[43] Environmental Protection Review, Page 1, June 2019

[44] CMD 100.1, page 55

[45] CMD 100 page 12

[46] Env Protection Repot page 9

[47] Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-G-5.2, International Atomic Energy Agency, Vienna, 2008, page 39

[48] CMD 19-H100, page 15

[49] See, for example, the intervention of Chief Glen Hare at the licensing hearing for the Chalk River Nuclear Laboratory in January 2018. Reference # 2018-H-01