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Written submission from David Winfield

À l'égard de

In the Matter of the

École Polytechnique de Montréal

École Polytechnique de Montréal

Demande de l'École Polytechnique de Montréal concernant le renouvellement de son permis d'exploitation d'un réacteur non producteur de puissance pour l'installation SLOWPOKE-2

Application from École Polytechnique de Montréal to renew its non-power reactor operating licence for its SLOWPOKE-2 facility

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Comments on Application for the April 19, 2023 Renewal of the Class 1A Licence for the SLOWPOKE-2 Reactor Facility at Polytechnique Montréal

Reference: CMD 23-H2

D. J. Winfield

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Executive Summary

Polytechnique Montréal (PM) SLOWPOKE-2 reactor facility is requesting (CMD 23-H2.1) a licence renewal period of 10 years. My overarching comment for the Commission is that such a period is warranted and can be justified. This support is based upon the intervenor's technical knowledge of the reactor design and operational record, including review of the last decade of annual compliance reports. Section 1 provides more detail.

The intervenor concurs with the CNSC Staff proposal to remove the Operational Limits and Conditions (OLC's) from the licence to the LCH. Deficiencies in the proposed OLCs are identified by the intervenor in Section 2 below, in particular for omissions related to reactivity safety. These influence the original design basis of SLOWPOKE-2. The intervenor views Section 2 OLC comments as the most important topic of the review. Other section comments, regarding document version control quality are of lesser importance, but were selectively prioritized for being related, via documentation, to reactor operational safety.

Section 5 referenced link is provided as a overall general observation; that the extent of current required licensing documentation (189 pages for CMD 23 H-2) does not, to this intervenor, display much evidence of a graded approach, in the scope, level of detail and effort required. For a facility specifically designed for (and successfully operated for decades) with a very small staff complement, excessive non-prioritized details will inevitably lead to resources being spent on low value topics and documentation, but hopefully not, at the expense of more practical safety aspects.

1. Review

Since 1997, no changes have been made to the main structures and main components of the reactor. The most likely expectation is that this will not change in the next 10 years and also the utilization activities are unlikely to change. The main reactor container components have been maintained in good condition since May 1976. The reactor is now the oldest SLOWPOKE still in operation. This history demonstrates that water chemistry control specifications and adherence to associated procedures have been satisfactory for major component ageing management. Continual good water chemistry control will still be essential to minimize potential corrosion of the reactor container and its contents. Long-term component irradiation damage, requiring some form of major refurbishment is not predicted. Lack of high-pressure components and the low neutron flux should preclude the onset of the type of irradiation ageing damage that exhibits non-linear increase with time. The components that might be postulated as most susceptible to radiation damage are the beryllium reflectors. 2016 studies of long-term build up of ^{3}He, ^{3}H and ^{6}Li in SLOWPOKE reflectors did not predict any long-term safety or operational concern for reactor physics. Other recent (2020) experimental evidence of long-term beryllium reflector irradiation damage (embrittlement, swelling-induced stress, cracking) in much higher power research reactors, gives good confidence that SLOWPOKE-2 beryllium lifetime would exceed any conceivable reactor lifetime prediction and much longer than the lifetime until the proposed 2040 shutdown of PM. Inspection studies of decommissioned SLOWPOKE-2's beryllium reflectors have not though, to the intervenor's knowledge, been performed. Based on beryllium experience data from higher power research reactors, continued operation up to the

licensee-proposed shutdown date of 2040 should however be assured.

The intervenor refers to Commission questions from the 27 April 2022 p. 176-177 transcript from my CMD 22 H8-14 intervention for another small nuclear facility, regarding the length of a 10-year licence renewal period. If the same question were posed for PM, my answer regarding the arbitrariness of 10 years would be the same as given in that transcript, also bearing in mind the regulatory burden the intervenor mentioned[1].

2. CNSC Staff proposal (CMD 23-H2, page 19) to remove Operational Limits and Conditions (OLC's) from the licence to the LCH.

The intervenor concurs with this CNSC staff proposal. Listing OLC's in one document such as the LCH, if also consistent with item (i) below makes any changes needed to the OLCs, expected to be very infrequent, a simpler process than amending a licence. The move would also be consistent with para. 1.5 of IAEA SSG-4.4 on OLCs for research reactors[2].

There is a concern however that the OLCs in the LCH now may not represent mandatory compliance, as part of the licence. This may perhaps be a language misinterpretation of the intervenor, but my understanding of page 5 is that the LCH (under the operating performance SCA) would now be degraded to non-mandatory guidance. If so this would not be compliant with IAEA SSG-4.4. As a minimum the intervenor suggests this should be clarified in the LCH for the OLCs. Comparison with OPG CANDUs indicates their LCH is not ambiguous and their OLCs are mandatory under the licence. The fact that SLOWPOKE OLCs are the shortest, simplest and easiest to comply with, of any other research reactor type (along with MNSRs) is not a reason to dilute their importance and remove them from mandatory compliance, if that is the case.

The intervenor disagrees with CNSC staff (CMD 23-H2 page 19) that no changes should be made to PM's OLCs. The intervenor provides justifications below to support this position. The OLCs in the two licensing documents referenced by CNSC staff (page 19) are not mutually consistent and are also not consistent with the proposed list (15.1 to 15.7). The intervenor submits this does not satisfy basic document revision control. Specific comments on the proposed OLCs (15.1 to 15.7), not in order of safety significance, are:

(i) The SAR (Rev. 1 1998) Chapter 11 OLCs are not consistent with the OLC proposals. Updating SAR Chapter 11 should rectify this by simply referring to the updated OLCs in the LCH. This avoids any future need to update Chapter 11. There should be one current and dated version and one version

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1 While document volume is not the only comparative factor, the intervenor notices the PM LCH is 77 pages and for a 6-unit CANDU plant is 166 pages, the latter with perhaps two orders of magnitude more staff and a many decades of orders of magnitude more fission product source term than the PM reactor.

2 This 2008 Safety Standard, dedicated to the topic of OLCs, indicates the importance given by the IAEA to OLCs as an essential part of a research reactor licence.

only of the OLCs. There should be no other 2023 license-related documents presenting different versions of OLCs.

(ii) The current OLC for limiting the amount of fissile material that may be irradiated, (OLC 11.4 of the SAR, RC-1598) has been removed. The intervenor submits this is a significant omission that should be rectified[3].

(iii) OLCs 15.7 (a), (b) and (c). The 'mc' unit typographical errors should be corrected.

(iv) OLC 15.5: 1 gm of ^{235}U is well above the safe amount from heat production, and fission product release aspects, if used inadvertently in an irradiation tube. The intervenor suggests this OLC should specify that any ^{235}U, used for test/calibration purposes, should be stored in a locked secure location, and only accessible to authorized personnel. The intervenor has confirmed this is indeed current practice at PM.

(v) OLC 15.6: The intervenor does not understand the reason the new licence requires an OLC to set a limit on 38 natural uranium metal fuel rods? Submission CMD 23-H2.1, page 9, confirms that the 38 fuel rods in question were permanently removed from the facility and site in August 2021.

(vi) OLC 15.4: 1.1522 kg of ^{235}U appears to be an unrealistically precise specification, given one element contains 5.8 gm of ^{235}U? Regardless, 204 elements would in any case exceed 1.15 kg, the current maximum 198-element loading. The purpose of this OLC is unclear. Adding more than 198 elements is not physically feasible, unless the core is removed and refuelled with a new core.

(vii) The OLCs do not include the 1985 historical licence conditions for authorizing reactor operation at power without a licensed operator in attendance in the facility. This historical licensing item is found in CPSR-362 Rev. 2 of 1984[4]. The new licence does not however provide any date or revision number for the CPSR-362 document, so the public reader would not know if the 1984 OLC is also a 2023 current licensing condition. Chapter 11 of the SAR was in error by its non-inclusion, although it could still be found in CPSR-362 Rev. 2. This is a key OLC, internationally unique to SLOWPOKE (and some of the MNSR) reactors and perhaps the most important operational condition that could be envisaged. From the public perspective this significant SLOWPOKE feature is often quoted in the literature and was quite recently quoted in the press from the design authority[5]. It is suggested this important OLC be retained in the LCH OLCs (i.e. in one location). Having deleted OLCs or outdated revisions of OLC's in different documents should be avoided for unattended operation in

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[3] The mass limit on irradiating fissile material has been a basic operational safety limit since the first SLOWPOKE-1 reactors.

[4] Condition de permis 6.1: Programme d'aptitude fonctionnelle Contrôle de version de documents, SLOWPOKE-2 Nuclear Reactor Operation and Routine Maintenance.

[5] In view of the public information, if unattended operation at power is no longer permitted this should be clarified.

particular, as the licensing conditions allowing this feature have progressively changed over many years.

(viii) OLC 15.2. For operational flexibility it is recommended that the CNSC specify an appropriate uncertainty allowance for the 4 mk measurement. The LCH is the appropriate place to document this.

(ix) The SLOWPOKE-2 has no automatic trip system. The minimum number of auxiliary shutdown system (ASDS) cadmium capsules and the minimum reactivity worth required to shutdown the reactor should be confirmed by at least one annual test. These three ASDS requirements should be listed in an OLC.

(x) The maximum number of irradiation sample vials that are allowed simultaneously in the inner irradiation sites should be specified in an OLC. The purpose is to ensure the ASDS cadmium capsules are capable of shutting down the reactor during sample irradiation activities.

3. Licensing documents that require notification of change: Description and Safety Analysis for the SLOWPOKE-2 Reactor with LEU Oxide Fuel CPR-77[6]

The intervenor questions the need for CNSC staff requiring inclusion of this document for PM license renewal. Inclusion would appear to be non-compliant with document version control as well as with LC 5.1 Design Program, LC G.2 Notification of Changes and LC 13.1: Safeguards and Non-Proliferation requirements, as per items (i) to (iv) below:

(i) Despite its title implication, CPR-77 was not a research reactor safety analysis report with content as defined by the IAEA when issued, nor subsequently. Its purpose was to predict the number of LEU fuel elements required for the first fuelling of the RMC SLOWPOKE-2 reactor in 1985. In 1997 the LEU core prediction of CPR-77 was known to be in significant error, by 18 fuel elements, since the 1985 RMC LEU commissioning. CPR-77 was therefore not used to support the licensing process for the 1997 LEU conversion of the Polytechnique Montréal SLOWPOKE-2 and was not part of the 1997 LEU Commissioning Manual. The latter accurately predicted an LEU core of 198 elements, which was then validated by the 1997 LEU Commissioning Report for PM. The current reactor LEU fuel cage content is thus incorrectly described by CPR-77.

(ii) The 1985 CPR-77 fuel prediction did not account for the addition of five new irradiation sites during the 1997 LEU conversion, which represented a core configuration design change. Use of the fuel prediction in CPR-77 as a current licensing reference document would thus not satisfy LC 5.1 Physical Design and LC G-2. CPR-77 incorrectly predicted a fuel core of 180 LEU elements for 3.3 mk excess reactivity with no beryllium shims. Additionally, the (non-conservative) 1985 prediction of the LEU coolant temperature reactivity

[6] The date of the intervenor's copy of CPR-77 is January 1985. In the absence of any revision or date being provided in the proposed LCH, these comments are based on the 1985 version.

coefficient of CPR-77 also was not validated by 1997 experimental results and was not in agreement with subsequent improved calculations[7]. Lack of validation for this important inherent safety feature, should invalidate the use of CPR-77 as an up-to-date 2023 licensing document.

(iii) CPR-77 provided no new thermal hydraulic safety analysis for the LEU core, other than to quote the same Critical Heat Flux (CHF) criteria used in 1975 for HEU fuel. Significant analytical and experimental progress for establishing thermal hydraulic safety limits for SLOWPOKE LEU fuel has since been made over the subsequent 47 years. Well established and acceptably validated thermal hydraulic safety limits, ranging from Onset of Nucleate Boiling (ONB) through Onset of Significant Void (OSV) up to CHF, are now available in the SLOWPOKE literature, obsoleting the 47 year old CHF information in CPR-77.

(iv) With respect to LC 13.1, Safeguards and Non-Proliferation the intervenor submits the CNSC staff requirement to use CPR-77 as a current licensing document is also not desirable due to its incorrectly-specified complement and configuration of LEU fuel elements in the fuel cage. IAEA historical safeguard inspections have been known to query SLOWPOKE licensing documentation discrepancies of a single fuel element, subsequently requiring documentation correction. Deleting CPR-77 as a 'contrôle de version du document' would remove the incorrect inventory documentation discrepancy. RC-1598, then remaining as the safety analysis 'contrôle de version du document', already documents the correct LEU fuel cage 198-element inventory. RC-1598 also directly refers to the 1997 LEU PM commissioning experiments. The latter validated the correct value of 198 elements for 4 mk of excess reactivity, as well as referencing the correct LEU fuel cage element geometrical configuration, which CPR-77 did not do.

4. REGDOC-367 Design of Small Reactor Facilities

CNSC staff submission CMD 23-H2 refers the licensee to about 28 LCH REGDOCs, quite a large quantity of material, which the intervenor makes no comments on. It is not clear to the intervenor however whether all these substantial LCH REGDOC requirements are enforceable by the licence. Clarity would be very useful. Regardless of that query, the intervenor is familiar with REGDOC-367 and would ask why perhaps this REGDOC is not found in the LCH, or anywhere else in the licensing documentation? This document covers topics in other REGDOCs but with topic content tailored to small research reactors. The SLOWPOKE-2 falls within the reactor scope defined in REGDOC-367; used for research, isotope production and 'other' applications. Indeed, REGDOC-367 is particularly based upon IAEA Safety Standard, NS-R-4, Safety of Research Reactors[8]. While not for a new reactor, a SLOWPOKE-2 10-year licence renewal would seem more directly relevant, than any of the many REGDOCs in the quoted package, to include RD-367 in the LCH, in order to show for public transparency, how well SLOWPOKE-2 can still meet current national and international research reactor design standards.

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[7] Published data in 2017 now provides coolant temperature and related reactivity coefficients for LEU-fuelled SLOWPOKE's that are validated to acceptable accuracy by experiment.

[8] IAEA NS-R-4 was superseded by IAEA SSR-3 in 2016.

5. Graded approach and the SCA process

The graded approach and the SCA process discussion refer to in CMD 22-H8.14, Section 2 is not repeated here, but is submitted by the intervener for longer term CNSC staff consideration as even more applicable to PM SLOWPOKE licensing with its smaller staff complement than the CMD 22-H8 facility.

6. Conclusions and recommendations summary

(i) Approval of a 10-year licence request is concurred with.

(ii) Moving OLCs from the licence to the LCH is concurred with.

(iii) The list of proposed OLCs without change is not concurred with. Recommended changes are listed in Sections 2(i) to 2(x). The most important additions suggested are items 2(ii), (iv), (vii), (ix) and (x).

(iv) Reference to CPR-77 is recommended to be deleted from the LCH.

(v) Lack of inclusion of CNSC RD-367 is questioned.

(vi) Intervenor comments from CMD 22-H8.14, regarding the graded approach and the SCA process are considered to be still relevant for licensing activities of PM in the longer term.

7. Acknowledgment

The intervenor would like to acknowledge the Director of the Polytechnique Montréal SLOWPOKE-2 Laboratory for responding to and answering a number of questions raised in the preparation of this review. An offer for a facility visit by the Director was much appreciated, but was not taken up due to time constraints. It is therefore noteworthy to commend to the Commission the public openness and transparency provided by the Director of the Polytechnique Montréal SLOWPOKE-2 Laboratory for responding to all queries from this intervenor, while preparing this review.

8. Intervenor conflict and background statement

The intervenor has no past or current direct financial interest in the Polytechnique Montréal SLOWPOKE-2 reactor, nor has any indirect-financial interests (nearby property ownership, family, personal or professional relationships). The intervenor was the sole author of the 1997 Rev. 0 and the 1998 Rev. 1 SARs, prepared for the 1997 LEU fuel conversion of the Polytechnique Montréal SLOWPOKE-2, while an employee of AECL. The intervenor was also the sole author of the first revision of the University of West Indies, Kingston, Jamaica, SLOWPOKE-2, 2015 LEU fuel conversion SAR, of technical relevance to the current Polytechnique Montréal licence submission. The intervenor has CANDU power reactor and research reactor facility operating experience, research reactor safety analysis and licensing experience, has participated in 22 IAEA international research reactor safety review missions; which included safety review missions to the Jamaican SLOWPOKE-2 and to the MNSR in Ghana. The intervenor was employed by the IAEA Vienna in the research reactor safety department and is currently an advisory member of a nuclear safety committee with a national nuclear regulatory body in Europe.