Regulating Liabilities at Chalk River

a submission from

Concerned Citizens of Renfrew County

concerning an application by

Canadian Nuclear Laboratories

to amend the CNSC licence for the

Chalk River Laboratories site

prepared by Dr. Ole Hendrickson of the

Concerned Citizens of Renfrew County (CCRC)

with input from Dr. Gordon Edwards of the

Canadian Coalition for Nuclear Responsibility (CCNR)

March 14, 2016

Recommendations: CCRC Submission to CNSC re CNL Licence Extension (March 2016)

1. The Commission should require the licensee to produce a new baseline assessment of costs for addressing nuclear legacy liabilities at CRL.

2. The Commission should ensure that details of the proposed Near Surface Disposal Facility be fully described and carefully examined through a full environmental assessment.

3. The Commission should require the licensee to develop and make public a spreadsheet that lists all identifiable CRL liabilities in the left-hand column, proposed corrective actions in the middle column, and estimated costs in the right-hand column.

4. The Commission should require that the NRU reactor decommissioning plan be addressed by a full environmental assessment.

5. The Commission should ensure that the scope of the environmental assessment for decommissioning of the NRU reactor is sufficiently broad to allow consideration of related facilities with a view to enabling integrated planning and reduced overall decommissioning costs.

6. The Commission should reject the Staff conclusion that financial guarantees are sufficient for complete decommissioning of the CRL site, and should take steps to initiate a comprehensive environmental assessment of nuclear legacy liabilities at CRL in conjunction with an updated decommissioning plan.

7. The Commission should include the initial steps for NRU reactor decommissioning (e.g., the sequence for removing fuel rods and experimental/isotope assemblies from the reactor) in the Licence Conditions Handbook for CRL.

8. The Commission should seek clarification of the purpose of including a number of optional outages in the outage schedule.

9. The Commission should verify that reliable back-up power is available for the U-2 test loop in the event of loss of site electrical power.

10. The Commission should verify that causes of action level exceedances at the Mo-99 processing facility have been addressed and will not be allowed to recur.

11. The Commission should ensure that any decision to re-start the Mo-99 processing facility is confirmed by an elected government official.

12. The Commission should require the licensee to store waste heavy water from the NRU reactor for a sufficient time to allow tritium to decay to a level that does not exceed drinking water standards.

13. The Commission should penalize any future failures by the licensee to report promptly on significant events such as the weld failure in the HEU transport cask caddy.

14. The Commission should not licence the transport of HEUNL (Highly Enriched Uranyl Nitrate Liquid) over public roads.

15. The Commission should require the licensee to cement and store FISST tank wastes on site, as it was envisaged at the time the existing licence was granted.

16. The Commission should clarify whether the “stand-by” status of the Mo-99 Processing Facility will enable initial steps to be taken to decommission the FISST tank and deal with its contents.

Recommendations (continued)

17. The Commission should require that the licensee equip tile holes containing Mo-99 wastes with activated charcoal filters.

18. The Commission should not permit recycling of radioactively contaminated metal off-site as a way of reducing liability if there is any chance that this metal will be mixed with non-radioactive metal and sold as uncontaminated scrap metal. The Commission should require the licensee to document how much radioactive metal has already been shipped from CRL, and where it has gone.

19. The Commission should clarify what the licensee will do to reduce air emissions in 2016-2018.

20. The Commission should require the licensee to produce a publicly accessible document that describes in detail the method and frequency of sampling of stack emissions, and the methods used to quantify radionuclides in samples of stack emissions.

21. The Commission should ensure that action level exceedances are described in future CNSC Staff annual reports on CRL performance and public hearing documents, and that results of investigations into their causes are summarized in sufficient detail to assure the public that appropriate corrective actions have been taken.

22. The Commission should require the licensee to provide a report on any event that is likely to result in more than a two-fold increase in annual releases of liquid or airborne radioactive effluents.

23. The Commission should require the licensee to create tables containing values (in SI units) for all substances included in the environmental monitoring program, post these on line, and regularly update them as new results are obtained. Analytical methodology should be clearly described in a publicly accessible document.

24. The Commission should require the licensee to post a copy of its derived release limits document on line.

25. The Commission should require the licensee to regularly post data on tritium levels in monitoring wells on line.

26. The Commission should ensure that CNSC Staff prepare an annual report on the performance of the Chalk River Laboratories.

27. The Commission should direct the licensee to produce a “weight-of-evidence” study to inform the question of whether remedial work is warranted on the NRU and NRX fuel bay plumes.

28. The Commission should incorporate new findings about the persistence of OBT in its regulation of tritium releases.

29. The Commission should ensure that Quebec residents living near CRL have an effective emergency warning system.

30. The Commission should ensure that Quebec residents living near CRL have received KI tablets and information about their use in both official languages.

31. The Commission should direct Staff to include adequate details on licensee performance in any documentation prepared for future CRL licensing hearings.

32. The Commission should ensure that the CNSC Library play a proactive role in disseminating objective scientific, technical and regulatory information to the public

Submission from the Concerned Citizens of Renfrew County (CCRC)

concerning an application by the Canadian Nuclear Laboratories to amend the Nuclear Research and Test Establishment Licence for the Chalk River Laboratories site

Prepared by Dr. Ole Hendrickson of the CCRC, with input from Dr. Gordon Edwards of the Canadian Coalition for Nuclear Responsibility, for the April 6, 2016 CNSC hearing,

March 14, 2016

Nuclear Liabilities and Decommissioning – Costs and Environmental Implications

Licences issued by the CNSC routinely include financial guarantees to ensure that sufficient funds are set aside for site decommissioning and remediation activities. In the case of the Nuclear Research and Test Establishment Operating Licence NRTEOL-01.02/2016 for the Chalk River Laboratories, licence condition 16.5 states that "The licensee shall maintain in effect a financial guarantee for decommissioning of CRL that is acceptable to the Commission."

In section 4.4 of CMD 16-H2, entitled "Financial Guarantees", CNSC Staff state that "AECL's liabilities are ultimately liabilities of Her Majesty in Right of Canada. These liabilities have been officially recognized by the Federal Minister of Natural Resources in a letter dated June 26, 2009." CNSC Staff then conclude "that the financial guarantees are sufficient for the complete decommissioning of the CRL site" (CNSC 2016).

Is this a valid conclusion?

Decommissioning activities have been ongoing at the Chalk River Laboratories (CRL) site for a number of years, most recently funded by Canadian taxpayers through Natural Resources Canada's Nuclear Legacy Liabilities Project (NLLP). Few details of work carried out under the NLLP for the 2011-2016 licensing period are publicly available. A request to Natural Resources Canada for information went unanswered.

The most recent publicly accessible, comprehensive evaluation of the NLLP (Natural Resources Canada 2011) raised some serious issues:

> Actual costs of the NLLP decommissioning work are generally higher than estimated. Factors explaining the increased costs include: inadequate waste characterization information, lack of reliable site/building information, inadequate cost-estimates (for example, the original contingency estimates were too low), contracting practices, weak cost-estimating and risk assessment capacity, and a general initial reticence to obtain expertise from sources external to AECL for activities related to the NLLP.

Indeed, with regard to overall costs of the Government of Canada's nuclear liabilities, CRL's owner, the crown corporation Atomic Energy of Canada, Ltd. (AECL), raised its estimate in

March 2013 to $6 billion, an increase of $2.4 billion from the previous $3.6 billion estimate (Scoffield 2013). It is troubling that as ever more money is spent to clean up legacy liabilities at the Chalk River Laboratories, estimates of how much remains to be spent continue to increase.

Tracking the costs of the nuclear liabilities at CRL – and tracking progress in reducing these costs – represents a priority for all Canadian taxpayers. It is a special priority for residents of the Ottawa Valley in light of the potential health and environmental impacts (e.g. radioactive pollution of the Ottawa River) should a serious failure in managing these liabilities occur.

It is no secret that one of the Government of Canada's main motivations in placing the Canadian Nuclear Laboratories at Chalk River under a "Government-Owned, Contractor-Operated" (GOCO) model was to reduce the amount of legacy liabilities at CRL as quickly as possible. This, combined with the transfer of funding responsibilities from Natural Resources Canada to Atomic Energy of Canada, Ltd. (AECL), and the March 2018 closure of the NRU reactor, strongly indicates that **the Commission should require the licensee to produce a new baseline assessment of costs for addressing nuclear legacy liabilities at CRL.**

Recommendation #1: **The Commission should require the licensee to produce a new baseline assessment of costs for addressing nuclear legacy liabilities at CRL.**

The Preliminary Decommissioning Plan for CRL is now quite out of date. An updated plan is needed that reflects the best possible information regarding decommissioning costs. An updated plan also should reflect changes in direction for major proposed waste management facilities. Of particular importance is the shift from a proposed Deep Geologic Repository to a Near Surface Disposal Facility for managing CRL's low- and intermediate-level wastes.

Our initial view is that a near-surface facility might be preferable to a Deep Geologic Repository because it would facilitate remedial actions in the event that problems arise. However, public acceptance of a new near-surface facility would require details on its characteristics and its anticipated long-term performance. These details are not currently available. **The Commission should ensure that details of the proposed Near Surface Disposal Facility be fully described and carefully examined through a full environmental assessment.**

Recommendation #2: **The Commission should ensure that details of the proposed Near Surface Disposal Facility be fully described and carefully examined through a full environmental assessment.**

Creating an updated decommissioning plan for CRL through a full environmental assessment would be timely and would lead to more certainty for the public and for the contractors who currently must be entrusted to carry out the work. Such an environmental assessment process would necessarily involve CNL, CNSC, AECL, Natural Resources Canada, Environment Canada, Transport Canada, and the Province of Ontario.

One approach could be to develop a comprehensive list of all trouble spots (or liabilities) at CRL and to map them. **The Commission should require the licensee to develop and make public a spreadsheet that lists all identifiable CRL liabilities in the left-hand column, corrective actions proposed in the middle column, and estimated costs in the right-hand columns.**

Recommendation #3: **The Commission should require the licensee to develop and make public a spreadsheet that lists all identifiable CRL liabilities in the left-hand column, proposed corrective actions in the middle column, and estimated costs in the right-hand column.**

The list should be exhaustive. For example, we could not find any information about the status of the original NRX reactor vessel that was buried onsite and the melted fuel that arose from the December 1952 reactor accident. What is the status of these highly radioactive waste materials? How much funding is allocated for decommissioning of these particular "legacy" waste liabilities? And what exactly is the proposal for their long-term management?

With regard to decommissioning of the NRU reactor, the licensee's supplementary CMD 16-H2.1A concludes that "the need for an Environmental Assessment will be determined, and a Detailed Decommissioning Plan will be developed" (Canadian Nuclear Laboratories 2016c). There should be no question that **NRU reactor decommissioning must be addressed by a full environmental assessment**.

Recommendation #4: **The Commission should require that the NRU reactor decommissioning plan be addressed by a full environmental assessment**.

Given that NRU reactor closure must be coordinated with operation/decommissioning of other current facilities (Molybdenum-99 Production Facility, Nuclear Fuel Fabrication Labs, waste management areas) or proposed new facilities (Near Surface Disposal Facility), **the Commission should ensure that the scope of the environmental assessment for decommissioning of the NRU reactor is sufficiently broad to allow consideration of related facilities with a view to enabling integrated planning and reduced overall decommissioning costs**.

Recommendation #5: **The Commission should ensure that the scope of the environmental assessment for decommissioning of the NRU reactor is sufficiently broad to allow consideration of related facilities with a view to enabling integrated planning and reduced overall decommissioning costs**.

There is insufficient detail in section 4.4 of CMD 16-H2 to support the Staff conclusion that "financial guarantees are sufficient for the complete decommissioning of the CRL site." Noting that the Waste Management Safety and Control Area also covers planning for decommissioning, the "satisfactory" rating in this area proposed by CNSC staff in section 3.11 must also be called into question. Already the estimated costs have ballooned by more than $2 billion.

Recommendation #6: **The Commission should reject the Staff conclusion that financial guarantees are sufficient for complete decommissioning of the CRL site, and should take steps to initiate a comprehensive environmental assessment of nuclear legacy liabilities at CRL in conjunction with an updated decommissioning plan**.

Permanent Shutdown of the NRU Reactor

Community members have been aware of the March 2018 date for permanent shutdown of the NRU for more than a year. A February 2015 Pembroke Observer article was entitled "Chalk River's NRU Reactor closing in 2018" (Chase 2015). With more details now available for the steps involved in permanent shutdown (Canadian Nuclear Laboratories 2016c), **the Commission should include the initial steps for NRU reactor decommissioning (e.g., the sequence for removing fuel rods and experimental/isotope assemblies from the reactor) in the Licence Conditions Handbook for CRL.**

Recommendation #7: **The Commission should include the initial steps for NRU reactor decommissioning (e.g., the sequence for removing fuel rods and experimental/isotope assemblies from the reactor) in the Licence Conditions Handbook for CRL.**

With regard to the proposed amendment 16.1 dealing with outage scheduling, the visual comparison on page 7 of CMD 16-H2.1A indicates that there will be 14 planned outages in total, either under the current monthly schedule or with the proposed new schedule. However, three "optional" outages would bring the total to 17 under the proposed new schedule. **The Commission should seek clarification of the purpose of including optional outages in the outage schedule.**

Recommendation #8: **The Commission should seek clarification of the purpose of including a number of optional outages in the outage schedule.**

Reactor shut-down and start-up bring increased risks of unplanned events, so the proposed increase in number of outages means increased risks and warrants careful consideration. In general, outages should be used to inspect the reactor and maintain safety until permanent shutdown in March 2018. The outages should not be used to try and extend reactor life beyond 2018. If inspections indicate unexpected acceleration of corrosion, the reactor may need to be shut down before March 2018. No additional welding should be allowed on the 45-year-old reactor vessel.

Shut-down procedures should be reviewed with reactor operators in advance of each scheduled outage. Care should be taken to avoid a repeat of the February 27, 2013 incident when the valves for the main heavy water pumps were closed instead of the valves that control water to the secondary coolant to the heat exchangers. No low power experiments should be

permitted whatever, noting that such experiments were largely responsible for the NRX and Chernobyl reactor accidents.

Return to service of the U-2 test loop creates potential accident risks. When site electrical power was lost in November 1990 the main pumps of the U-2 test loop stopped almost immediately because they were not equipped with backup power. Five prototype CANDU fuel bundles overheated. Subsequent examination showed that their zirconium sheath had partly collapsed (Sears et al. 1995). **The Commission should verify that back-up power is available for the U-2 test loop in the event of loss of site electrical power.**

Recommendation #9: **The Commission should verify that reliable back-up power is available for the U-2 test loop in the event of loss of site electrical power.**

Medical Isotope Processing

On February 6, 2015 the Government of Canada announced the extension of funding for NRU operations until March 2018. The news release (Natural Resources Canada 2015) stated:

> Today's announcement of the extension of the NRU is designed to help support global medical isotope demand between 2016 and 2018 in the unexpected circumstances of shortages, and Canadian Nuclear Laboratories will now begin decommissioning the NRU after March 31, 2018… In 2010, the Government of Canada announced its decision to cease the routine production of molybdenum-99 (Mo-99) from the NRU in 2016 and is acting responsibly to ensure the security of supply of medical isotopes.
>
> Phasing out production over six years has allowed producers around the world to adjust accordingly. The global market has been diversifying, and it is now projected that under normal conditions global supply will remain sufficient to meet demand.

It is unfortunate that, instead of requiring a complete closure and the start of decommissioning of the Mo-99 Production Facility in October 2016, the former federal government directed that it be kept in "stand-by" mode through March 2018. Keeping the facility in stand-by mode will involve considerable expense, including ongoing staffing and staff training.

According to the 2013 CRL performance report there were "30 action level exceedances for airborne releases in 2013" (CNSC 2014, p. 42). The report goes on to say that "of particular note were 15 iodine-131 exceedances that occurred in October 2013. CNL conducted a consolidated investigation into these exceedances and identified that operational changes at the MPF [Molybdenum-99 Processing Facility] were a common cause." Further details that emerged at a Commission public meeting indicate that "over-cooking" of the Mo-99 targets in the NRU reactor was a contributing factor to these excessive radioiodine releases.

Recommendation #10: **The Commission should verify that causes of action level exceedances at the Mo-99 processing facility have been addressed and will not be allowed to recur.**

These action level exceedances caused by the Mo-99 Processing Facility illustrate the hazards of its continued operation. Risks of re-starting this facility after what may be a prolonged shut-down should be assessed and weighed carefully against benefits of Mo-99 production. Our preference would be that the facility remain closed unless there is compelling evidence of an emergency shortage of the Mo-99 isotope. As the decision to keep the facility in stand-by mode was a political one, **the Commission should ensure that any decision to re-start the Mo-99 processing facility is confirmed by an elected government official.**

Recommendation #11: **The Commission should ensure that any decision to re-start the Mo-99 processing facility is confirmed by an elected government official.**

The NRU reactor is used for production of other medical isotopes such as cobalt-60. As this isotope has a relatively long half-life (5.3 years), and other Canadian reactors can produce Co-60, there is no likelihood of "emergency" shortages. Reactor safety considerations must take precedence over any production targets for Co-60 or other medical isotopes during the final months of NRU operation.

Waste Management

Heavy water management has a potential to impact the Ottawa River. **The Commission should require the licensee to store waste heavy water from the NRU reactor for a sufficient time to allow tritium to decay to a level that does not exceed drinking water standards.**

Recommendation #12: **The Commission should require the licensee to store waste heavy water from the NRU reactor for a sufficient time to allow tritium to decay to a level that does not exceed drinking water standards.**

The October 29, 2015 incident of weld failure in the transfer caddy component of the NAC shielded transport cask raises concerns. The caddy was being used to transfer solid irradiated HEU fuel from the NRU pool into the shielded transport cask. The weld failure allowed irradiated fuel rods to drop out of the caddy directly to the bottom of the spent fuel pool. Evidently such a failure has the potential to cause fuel damage leading to the release of fission products. It is only by luck that such damage did not occur on this occasion. Subsequent visual inspection revealed defective welds in other caddies. This indicates poor quality control on the part of NAC, the manufacturer of these transport casks and the associated caddies.

The day following this event, CRL staff allowed another fully loaded NAC shielded transport cask to be trucked over public roads to a US destination without considering that the transfer

caddies involved in that shipment might also be defective, thereby causing similar failures in the caddies at the receiving end. This behaviour indicates a lapse in judgment that reflects unfavourably on the safety culture at CRL.

In addition, there was a failure on the part of CRL staff to notify CNSC immediately about the weld failure in the defective caddy. Twenty-five days elapsed between the date when NAC was notified of the caddy failure (November 2) and the date when CNSC was notified (November 27), and even then the notification to CNSC was verbal and informal. CNSC did not request a formal report on the October 29 incident until December 4. **The Commission should penalize any future failures by the licensee to report promptly on significant events such as the weld failure in the HEU transport cask transfer caddy.**

Recommendation #13: **The Commission should penalize any future failures by the licensee to report promptly on significant events such as the weld failure in the HEU transport cask transfer caddy.**

The NAC cask involved in the October 29, 2015, caddy failure incident is identical to the cask that would be used to transport the highly radioactive liquid contents of the FISST (Fissile Solutions Storage Tank) from Chalk River Laboratories to the Savannah River Site in South Carolina. The liquid waste stored in FISST is referred to as Highly Enriched Uranyl Nitrate Liquid (HEUNL). However, CCRC has determined that HEUNL stored at Chalk River is comparable in composition to the High Level Liquid Wastes (HLLW) left over from plutonium production operations, such as the HLLW stored in 177 tanks at the Hanford site in Washington State. At both sites, lightly irradiated uranium dissolved in nitric acid has yielded liquid waste containing virtually all the fission products and most of the transuranic elements.

For example, the concentration of cesium-137 in HEUNL from FISST is 70 TBq per litre according to Table 2 in the CNSC Technical Assessment Report "NAC-LWT Package Design for Transport of Highly Enriched Uranyl Nitrate Liquid" . But the average concentration of cesium-137 in Hanford's HLLW tanks is only 17 TBq per litre, using Tables 2.8 and 2.11 from the US Department of Energy Report DOE/RW-006, Rev. 11. That's a four-fold difference.

Given the highly radioactive nature of the HEUNL from FISST, given the much greater mobility of liquid waste in comparison with solid waste in the event of a breach of containment, given the questionable quality control surrounding the NAC manufacturing process, and given the tardiness of CRL authorities in reporting NAC equipment failures, **CNSC should not licence the transport of HEUNL over public roads in NAC casks.**

Recommendation #14: **The Commission should not licence the transport of HEUNL (Highly Enriched Uranyl Nitrate Liquid) over public roads.**

At the time that the existing CRL licence was granted in 2011, cementation was the stated plan for dealing with the FISST tank wastes. That licence is still in force, and is about to be extended. No clear safety rationale has ever been advanced for the decision to instead ship the wastes to the Savannah River Site. For the past several years, liquid waste from Mo-99 processing (i.e. HEUNL) has been cemented and managed at the CRL site, so there is no technical barrier to the cementation of HEUNL from FISST.

Recommendation #15: **The Commission should require the licensee to cement and store FISST tank wastes on site, as it was envisaged at the time the existing licence was granted.**

In addition, the option of down-blending to reduce U-235 concentrations should be examined. This procedure of down-blending HEUNL from isotope production was recently approved for Indonesia, where the level of enrichment is also over 90 percent uranium-235. There is no reason the same procedure could not be carried out at Chalk River. This would totally eliminate any security risk by rendering the uranium no longer weapons-usable.

The fitness for service of the FISST tank is indeed a concern. The issue of thermal welds inside the FISST tank that may need plugging should be closely monitored by CNL and CNSC. The tank's contents should be removed as soon as this can be done safely. **The Commission should clarify whether the "stand-by" status of the Mo-99 Processing Facility will enable initial steps to be taken to decommission the FISST tank and begin cementation of its contents.**

Recommendation #16: The Commission should clarify whether the "stand-by" status of the Mo-99 Processing Facility will enable initial steps to be taken to decommission the FISST tank and begin cementation of its contents.

As described in the article *Evaluation of potential mercury releases from medical isotope waste* (Ethier et al. 2013), activated charcoal has the capacity to trap mercury emissions (and possibly also radioiodine emissions) from the cemented Mo-99 Processing Facility wastes that are currently stored in tile holes. **The Commission should require that the licensee equip tile holes containing Mo-99 wastes with activated charcoal filters.**

Recommendation #17: **The Commission should require that the licensee equip tile holes containing Mo-99 wastes with activated charcoal filters.**

CCRC has expressed concerns at past hearings about the use of "clearance" levels to declassify radioactive waste, and the lack of adequate public consultation before regulations enabling this were put in place. **The Commission should not permit recycling of radioactively contaminated metal off-site as a way of reducing liability if there is any chance that this metal will be mixed with non-radioactive metal and sold as uncontaminated scrap metal. The Commission should**

require the licensee to document how much radioactive metal has already been shipped from CRL, and where it has gone.

Recommendation #18: **The Commission should not permit recycling of radioactively contaminated metal off-site as a way of reducing liability if there is any chance that this metal will be mixed with non-radioactive metal and sold as uncontaminated scrap metal. The Commission should require the licensee to document how much radioactive metal has already been shipped from CRL, and where it has gone.**

Environmental Monitoring and Reporting

CRL environmental performance reports identity argon-41, with a half-life of just under two hours, as the single largest contributor to public dose. The February 2016 monthly environmental performance report shows that annual Ar-41 emissions in 2015 were the highest for any year during the current licence period, approaching 6% of the 1 mSv derived limit (Canadian Nuclear Laboratories 2016a). Why were air emissions higher in 2015? **The Commission should clarify what the licensee will do to reduce air emissions in the 2016-2018 period.**

Recommendation #19: **The Commission should clarify what the licensee will do to reduce air emissions in the 2016-2018 period.**

Emissions of radioisotopes of xenon, krypton and iodine have potential health and environmental impacts. Few details have been provided about the fifteen iodine-131 action level exceedances that occurred in October 2013. The 8-day half-life of I-131 means that it can be broadly dispersed throughout the Ottawa Valley, and there is a potential for residents living far from the CRL facility to encounter it in a radioactive plume. I-131 is one of the isotopes of greatest concern in the wake of a major nuclear reactor accident because of its well-documented potential to be taken up in the thyroid gland and cause thyroid cancer. In the Fukushima region, 2,251 young people aged 19 years or less out of 298,577 screened developed thyroid cancer during the three-year period following the 2011 reactor meltdowns (Tsuda et al. 2015).

Xenon-133 is another longer-lived isotope (with a 5.24-day half-life) that creates a radioactive hazard distant from its point of release. It is one of the radioisotopes of concern emitted during nuclear explosions. It is used to detect nuclear weapons testing. Concerns have emerged recently that Xe-133 emissions from medical isotope processing facilities are interfering with the International Monitoring System used to verify compliance with the Comprehensive Nuclear-Test-Ban Treaty. Elevated levels of Xe-133 are being detected by monitors in the Ottawa-Gatineau area, and have been traced to emissions from Mo-99 processing at CRL (Bowyer et al. 2013).

According to Milton et al. (1995), "Stack emissions at CRL were not measured until 1993." Accurate measurement of radioisotopes released both from the NRU stack and the Mo-99 Processing Facility stack is a priority. Stack monitoring is a key component of environmental monitoring at CRL. **The Commission should require the licensee to produce a publicly accessible document that describes in detail the method and frequency of sampling of stack emissions, and the methods used to quantify radionuclides in samples of stack emissions.** Given the use of mercury in Mo-99 processing, it should also be clarified if mercury emissions from the Mo-99 stack are being accurately monitored.

Recommendation #20: **The Commission should require the licensee to produce a publicly accessible document that describes in detail the method and frequency of sampling of stack emissions, and the methods used to quantify radionuclides in samples of stack emissions.**

CMD 16-H2 does not that indicate if there have been any action level exceedances at CRL since October 2013. **The Commission should ensure that action level exceedances are described in future CNSC Staff annual reports on CRL performance and public hearing documents, and that results of investigations into their causes are summarized in sufficient detail to assure the public that appropriate corrective actions have been taken.**

Recommendation #21: **The Commission should ensure that action level exceedances are described in future CNSC Staff annual reports on CRL performance and public hearing documents, and that results of investigations into their causes are summarized in sufficient detail to assure the public that appropriate corrective actions have been taken.**

The February 2016 environmental performance report 2015 also indicates that a major spike in liquid emissions occurred in 2014 (Canadian Nuclear Laboratories 2016a). Total emissions for 2014 exceeded all other years during the current licensing period by roughly a factor of four. The report states that "The increase in liquid effluents was related to a known event that occurred at the end of August 2014. The event was not reportable to the CNSC, there were no limit exceedances and negligible impact to the public or to the environment." However, given the magnitude of the increase in liquid effluents in 2014, the licensee should have voluntarily provided details about this event, including its cause and the amounts and types of individual radionuclides released to the Ottawa River. **The Commission should require the licensee to provide a report on any event that is likely to result in more than a two-fold increase in annual releases of liquid or airborne radioactive effluents.**

Recommendation #22: **The Commission should require the licensee to provide a report on any event that is likely to result in more than a two-fold increase in annual releases of liquid or airborne radioactive effluents.**

In general, it is frustrating that so little detail is provided in environmental monitoring reports for CRL. Emissions of a variety of substances to the environment (radionuclides, hazardous chemicals, greenhouse gases, etc.) to air and water are clearly a matter of public interest. **The Commission should require the licensee to create tables containing values (in SI units) for all substances included in the environmental monitoring program, post these on line, and regularly update them as new results are obtained. Analytical methodology should be clearly described in a publicly accessible document.**

Recommendation #23: **The Commission should require the licensee to create tables containing values (in SI units) for all substances included in the environmental monitoring program, post these on line, and regularly update them as new results are obtained. Analytical methodology should be clearly described in a publicly accessible document.**

Radioisotope emissions to the environment are routinely expressed as a percentage of derived release limits in CNL's environmental performance reports. To our knowledge, the document containing these derived release limits (CRL-509200-RRD-001, "Derived Limits for AECL's CRL") is not currently available on line. **The Commission should require the licensee to post a copy of its derived release limits document on line.**

Recommendation #24: **The Commission should require the licensee to post a copy of its derived release limits document on line.**

A lack of transparency in providing environmental monitoring results from the Canadian Nuclear Laboratories was discussed during the December 18th, 2014 public meeting under the agenda item *CNSC Staff Report on the Performance of CNL's Nuclear Sites and Projects: 2013* (CNSC 2014). President Binder stated that it would be good to have "actual data as to the -- what is the tritium level in some of those monitoring wells." We agree. Another CNSC licensee in our area makes its tritium data publicly available. **The Commission should require the licensee to regularly post data on tritium levels in monitoring wells on line.**

Recommendation #25: **The Commission should require the licensee to regularly post data on tritium levels in monitoring wells on line.**

Environmental monitoring data allow elected officials and members of the public, as well as Commissioners, to track performance of a licensee on an ongoing basis. Demonstrating progress in reducing levels of environmental contaminants at CRL would be an excellent indicator of progress in reducing nuclear legacy liabilities. The taxpayers of Canada are funding this monitoring work and are entitled to see the results.

Beginning in fall 2012, CNSC staff committed to prepare an annual stand-alone performance report on Chalk River Laboratories. According to the CNSC website, "Each year, the Canadian

Nuclear Safety Commission (CNSC) produces a report on the performance of Atomic Energy of Canada Limited (AECL) Chalk River Laboratories." The most recent of these reports appears to be the *CNSC Staff Report on the Performance of CNL's Nuclear Sites and Projects: 2013*. Was a report done for 2014? If so, will it be made public? Are there plans to continue this reporting?

Recommendation #26: **The Commission should ensure that CNSC Staff prepare an annual report on the performance of the Chalk River Laboratories.**

The Commission should ensure that there are accurate and complete agendas for its public meetings. In theory, when agendas are revised, a revised version is made public. However, the revised agenda CMD 16-M2.B for the January 28th public meeting still does not include the caddy incident mentioned above, even though this item took up much of the time at that meeting. This should be corrected.

Using Science to Inform Action

AECL is to be commended for publishing the AECL Nuclear Review and making it available on line. We are pleased to see that it will continue as the CNL Nuclear Review. Articles in the December 2013 special issue, *Radiation in Our Environment*, were helpful in preparing this written submission.

The radioactively contaminated sediments in the Ottawa River beneath the process sewer outfall have received considerable attention in recent years (e.g., Rowan et al. 2013). The Environmental Stewardship Council has discussed to whether it would be best to remove these sediments or leave them in place. Whether radionuclides in these sediments are entering the food chain, and the potential for certain radionuclides such as cesium-137 to accumulate at higher trophic levels, are important considerations in this regard. Rowan et al. (2013) investigated concentrations of Cs-137 in Ottawa River biota, along with two other anthropogenic radionuclides (Co-60, Nb-94) and several primordial and cosmogenic radionuclides (Be-7, K-40, Pb-210, Ra-226, Ra-228). They documented that uptake from the contaminated sediments was responsible for elevated levels of Cs-137 in biota.

A recent "weight-of-evidence" study concludes that despite these elevated levels of Cs-137, overall risks to biota associated with the radioactively contaminated sediments are low (Bond et al. 2015). This implies that leaving the sediments in place is acceptable, and our group can accept this conclusion, but only if on-going monitoring is ensured to detect any deterioration.

In addition to discharges from the process sewer, radioactive plumes from leaking waste facilities at CRL are major sources of radioactive contamination of the Ottawa River. Plumes from the NRX and NRU fuel bays are among the most problematic. The source term for radionuclides in the NRX fuel bay plume (mainly tritium and strontium-90) was removed when this fuel bay was dewatered, and most of the tritium in that plume has already reached the river. However, large amounts of Sr-90 continue to enter the river along a broad stretch of shoreline (Olfert et al. 2013).

Tritium and Sr-90 are also found in the NRU fuel bay plume, although tritium is presently the dominant radionuclide. As noted in CNSC (2014), "Tritium concentrations downgradient of NRU are expected to decrease over time following the swap of the NRU rod bays water which occurred in November 2012." The source term for the NRU plume has also been reduced by repairs to the fuel bay. However, if tritium concentrations downgradient of the NRU fuel bay are adopting the new, lower concentration within the fuel bay itself, it is obvious that there are ongoing uncontrolled releases of this isotope.

This raises additional questions. What was done with the contaminated water that was "swapped" out of the NRU fuel bay? How leaky is it today? How do levels of Sr-90 in the NRU plume compare with levels in the NRX plume? What concentrations of Sr-90 occur in Ottawa River biota and sediments?

As was done for the contaminated sediments near the process sewer outfall, **the Commission should direct the licensee to produce a "weight-of-evidence" study to inform the question of whether remedial work is warranted on the NRU and NRX fuel bay plumes.** Olfert et al. (2013) did not report on levels of Sr-90 in Ottawa River biota, although it is very likely that high concentrations occur (e.g., in shoreline vegetation and freshwater mussels).

Recommendation #27: **The Commission should direct the licensee to produce a "weight-of-evidence" study to inform the question of whether remedial work is warranted on the NRU and NRX fuel bay plumes.**

Tritium is released both in liquid form and to the air from various CRL facilities (laboratory roof vents and the NRU and Mo-99 stacks). Annual airborne tritium releases from CRL are roughly 10^{15} Bq/yr (1 PetaBecquerel = 1000 Terabecquerels), comparable to amounts released from the entire Bruce reactor complex (CNSC 2009). Tritium, as an isotope of hydrogen, is highly reactive and is found in radioactive water molecules as HTO. Tritium is also readily incorporated into organic carbon compounds within living cells matter as organically-bound tritium (OBT). The area around two upper Ottawa Valley nuclear facilities (CRL in Chalk River and SRB Technologies in Pembroke) are now extensively contaminated with OBT, and researchers are using both of these locations for studies of OBT's behaviour in the environment.

While most tritium releases from the CRL are in the form of HTO, some elemental tritium gas is released as HT from the Chalk River site during the process of "splitting" the contents of bulk tritium containers obtained from the Darlington Tritium Recovery Facility of Ontario Power Generation into smaller containers. The main "customer" for the tritium gas dispensed into these smaller containers is SRB Technologies in Pembroke, which uses it to make glow-in-the-dark glass tubes.

Kim et al. (2013) have studied how levels of organically-bound tritium (OBT) in soils and vegetation vary with distance from the CRL Controlled Areas. They documented that OBT is retained in soil organic matter in the terrestrial environment, "related to previously deposited organic compounds coming from plant leaves, microorganisms, etc."

Evidence for persistently high amounts of OBT in terrestrial environments near nuclear facilities is relatively recent. Particularly high retention of OBT in soil was reported by Kim et al. (2013) at a site where a historical experimental HT gas release had been conducted roughly 20 years earlier, in a remote area on the CRL property that had not been disturbed since 1994.

Hendrickson (2015) notes that bacteria avidly take up hydrogen gas and incorporate it into their cells in organic forms, so in hindsight it is unsurprising that OBT can accumulate in considerable amounts near nuclear facilities that release HT. The CNSC's radiation protection measures and models of tritium behaviour do not account for this phenomenon, even though the need to do so has been noted by CNSC staff (Thompson et al. 2015). Not fully acknowledging the risks associated with nuclear facilities that release HT leaves the CNSC open to charges that it is not limiting the risks to the health and safety of persons and the environment associated with use of nuclear substances to a reasonable level. **The CNSC should incorporate new findings about the persistence of OBT in its regulation of tritium releases.**

Recommendation #28: **The Commission should incorporate new findings about the persistence of OBT in its regulation of tritium releases.**

Nuclear Emergencies

Emergency preparedness in Quebec is a topic of concern. Cottages along the Ottawa River in the Fort William area of the Municipality of Sheen are very close to the CRL, and residents in that area would potentially be among those most greatly affected in the event of a serious accident at CRL. The Mayor of the Municipality of Sheen has noted that there is no mechanism, such as a siren, to warn residents about an accident and to enable them to take appropriate action such as evacuation of the area. **The Commission should ensure that Quebec residents living near CRL have an effective emergency warning system.**

Recommendation #29: **The Commission should ensure that Quebec residents living near CRL have an effective emergency warning system.**

It is unclear whether potassium iodide (KI) has been distributed in areas of Quebec adjacent to CRL. If tablet distribution occurred, was it accompanied by information explaining the risks associated with radioiodine uptake, how KI works to mitigate these risks, and appropriate dosages for different age groups? **The Commission should ensure that Quebec residents living near CRL have received KI tablets and information about their use.**

Recommendation #30: **The Commission should ensure that Quebec residents living near CRL have received KI tablets and information about their use in both official languages.**

General Comments

The Staff CMD 16-H2 prepared for the April 6, 2016 licence renewal hearing contains few details on licensee performance – notably less than CMDs prepared for previous licence renewal hearings. In preparing this report we relied on a variety of other information sources. Members of the general public who are interested in the performance of Canada's main, publicly-funded nuclear research laboratory would not likely have the time and resources to seek out information in this way. **The Commission should direct Staff to include adequate details on licensee performance in any documentation prepared for future CRL licensing hearings.**

Recommendation #31: **The Commission should direct Staff to include adequate details on licensee performance in any documentation prepared for future CRL licensing hearings.**

I was also frustrated in my efforts to use the CNSC Library to acquire information about the Chalk River Laboratories. According to the CNSC website, "CNSC Library in Ottawa is open to the public! The Library is a depository for all CNSC publications." However, upon arrival at 280 Slater Street, a security guard informed me that the Library is not open to the public. After some polite but persistent questions the guard phoned a librarian. The librarian said that the Library is only open by prior appointment, but that he would make an exception that day. The CNSC website does not indicate that a prior appointment is necessary to use the Library. Moreover the librarian decided to close the library just after noon and I was asked to leave.

The Library catalogue does not list all CNSC publications. Commission Member Documents do not appear in the catalogue, even though most of these are a matter of public record. The majority of publications in the catalogue are from the pre-2000 Atomic Energy Control Board period. No "e-Doc" numbers appear in the catalogue, suggesting that there is an internal classification system for documents that is not accessible to the public. Unlike the past, when members of the public could browse stacks containing technical reports, there is now only a single bookshelf with a few standard references.

One of the objects of the Commission, pursuant to section 9(b) of the Nuclear Safety and Control Act, is "to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph (a)." The current status of the CNSC Library calls into question whether the Commission is adequately discharging its responsibilities in this regard. **The Commission should ensure that the CNSC Library plays an active role in disseminating objective scientific, technical and regulatory information to the public.**

Recommendation #32: **The Commission should ensure that the CNSC Library plays an active role in disseminating objective scientific, technical and regulatory information to the public.**

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