Canadian Environmental Law Association
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A REVIEW OF HUMAN HEALTH AND ENVIRONMENTAL PROTECTIONS IN RESPONSE TO BWXT NUCLEAR ENERGY CANADA INC. (BWXT) 10-YEAR LICENCE RENEWAL FOR ITS PETERBOROUGH AND TORONTO FACILITIES (REF. 2020-H-01)

INTERVENTION BY THE CITIZENS AGAINST RADIOACTIVE NEIGHBOURHOODS (CARN) TO THE CANADIAN NUCLEAR SAFETY COMMISSION (CNSC)

February 3, 2020

Prepared by:

Theresa McClenaghan, Executive Director and Legal Counsel, CELA
Kerrie Blaise, Legal Counsel, CELA
Morten Siersbaek, Legal Counsel, CELA

Expert Reports by:

Dr. Tanya Markvart
Dr. Gordon Edwards

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Senior Tribunal Officer, Secretariat
Canadian Nuclear Safety Commission
280 Slater Street, P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9

Sent by email cnsc.interventions.ccsn@canada.ca

RE: BWXT Nuclear Energy Canada Inc. (BWXT) 10-year Licence Renewal for Class IB Fuel Facilities – Peterborough and Toronto (Ref. 2020-H-01)

I. INTRODUCTION

On behalf of the Citizens Against Radioactive Neighbourhoods ("CARN"), the Canadian Environmental Law Association ("CELA") submits this intervention in response to the Canadian Nuclear Safety Commission's ("CNSC") Public Notice dated December 20, 2019 requesting comments on the proposed licence renewal for BWXT Nuclear Energy Canada ("BWXT") for a 10-year renewal of its Class IB fuel facility operating licence at its Peterborough and Toronto sites.[1] A hearing for this matter is scheduled for March 2-3 in Toronto and March 5 – 6 in Peterborough.

For the reasons detailed below, CARN submits the Commission has insufficient evidence with which to conclude BWXT has made adequate provisions for protecting human health and the environment, as required by section 24(4) of the *Nuclear Safety and Control Act*, and on this basis should deny the requested 10-year licence. Due to deficiencies in BWXT's licensing documents and troubling emissions data from the Peterborough site,[2] under no circumstance does CARN support BWXT's request for a flexible licence, which would allow uranium pelleting production to commence at its Peterborough facility.

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[1] Canadian Nuclear Safety Commission, "Revised Noticed of Public Hearing" (Ref. 2020-H-01, Revision 3), online: https://www.nuclearsafety.gc.ca/eng/the-commission/pdf/NoticePublicHearing-BWXT-March2020-Revision3-e.pdf

[2] CNSC, "Independent Environmental Monitoring Program: BWXT Nuclear Energy Canada Inc. – Peterborough" (2020), online: https://nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/bwxt-peterborough.cfm

II. INTEREST AND EXPERTISE OF THE INTERVENOR

By way of this submission and pursuant to the CNSC's *Rules of Procedure* ("Rules"), CELA, on behalf of CARN, requests status to participate as an intervenor in the public hearing respecting the BWXT licence renewal application and an opportunity to present oral submissions in Peterborough.

As CARN has hundreds of members, many of whom are also intervening individually in this hearing, we support the Commission's decision to allow CELA, acting on behalf of CARN, and other CARN members to intervene orally at the hearing.[3] CELA, with the members of CARN, have been working in collaboration to ensure all interventions to the Commission provide value-added information and reflect the views and concerns of those most directly affected by the licensing decision. For this reason, we submit that allowing CELA and any member of CARN who wishes to orally intervene at the hearing is not duplicative nor an inefficient use of the Commission's hearing process.

As noted below, we meet the test set out in the *Rules* for intervening on the basis of both: (1) interest in the matter being heard; and (2) expertise or information that may be useful to the CNSC in coming to a decision.[4]

(a) Citizens Against Radioactive Neighbourhoods

Citizens Against Radioactive Neighbourhoods (CARN) is a Peterborough-based non profit whose membership has an interest in nuclear facilities and the licensing process. CARN is specifically concerned about impacts related to the emission of radionuclides and the health of communities and the environment adjacent to nuclear facilities.[5]

CARN is a volunteer led, unincorporated group of concerned citizens that works with the local community to raise awareness about nuclear facilities and advocates for stringent human health and environmental safeguards. CARN was created in response to BWXT's request to the CNSC for a flexible license that would allow it to commence pelleting production at their Peterborough facility.

CARN is very concerned about the oversight and monitoring of industrial processes located in residential areas, with specific concerns about threats to vulnerable populations like children. CARN is of the firm view that industrial processes that carry significant risks should be subject to full environmental assessments and demand the full scrutiny of public attention.

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[3] Personal correspondence between K Blaise and M Leblanc (9 January 2020).
[4] *Rules of Procedure*, SOR/2000-211, s. 19(1)(a)(b).
[5] [5] Citizens Against Radioactive Neighbourhoods, online: https://www.nopellets.ca/

(b) Canadian Environmental Law Association

CELA is a non-profit, public interest law organization. CELA is funded by Legal Aid Ontario as a speciality legal clinic to provide equitable access to justice to those otherwise unable to afford representation for environmental injustices. For nearly 50 years, CELA has used legal tools to advance the public interest, through advocacy and law reform, in order to increase environmental protection and safeguard communities across Canada. CELA has been involved in number of nuclear facility licensing and regulatory matters before the CNSC. CELA has an extensive library of materials related to Canada's nuclear sector which is publicly available on our website.[6]

In advance of this hearing, CELA and its experts hosted multiple public legal education events in Peterborough. This included a public information night on December 3, 2019 with Dr. Gordon Edwards and a workshop on January 7, 2020 with legal counsel Kerrie Blaise, regarding intervention writing and public participation in CNSC's licensing process.[7] CARN and its members have also attended in-person workshops with the CNSC and the licensing proponent, BWXT.

III. BACKGROUND

BWXT's licence for its Peterborough and Toronto facilities expires December 31, 2020. The current consolidated licence authorizes BWXT to produce and test fuel bundles from natural and depleted uranium dioxide pellets at its Peterborough facility, and produce natural and depleted uranium dioxide pellets at its Toronto facility.

BWXT now seeks a 10-year renewal of its licence and an authorization by the Commission to commence pelleting production at its Peterborough facility. According to BWXT's licence application (dated November 2018), BWXT seeks a change in its current licence which would provide it the flexibility to conduct pelleting operations at its Peterborough facility, in addition to Toronto.[8] Per section IV of its current licence, BWXT is only authorized to produce depleted uranium dioxide pellets at its Toronto facility. While no change in use or operation is contemplated for BWXT's Toronto facility, the requested licencing change for the Peterborough facility is a significant departure from current licence authorizations.

Therefore, this intervention is submitted in response to BWXT's licence renewal application to the Commission. As CARN is most concerned by BWXT's request to commence uranium pelleting

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[6] Canadian Environmental Law Association, online: www.cela.ca
[7] CARN, Dr. Gordon Edwards, online: https://www.nopellets.ca/media; CARN, Interventions, online: https://www.nopellets.ca/interventions
[8] BWXT Licence Application, p 33

at the Peterborough BWXT facility, the issues raised in this intervention for the Commission's consideration pertain to:

a) The length of the licence being requested, given deficiencies in safeguards for the public and environment;

b) The lack public information and disclosure;

c) The troubling trend emerging from recently released 2019 environmental monitoring data;

d) The critical need for a greater range of nuclear projects and facilities to be included within the federal *Impact Assessment Act;*

e) The inadequacy of BWXT's Application and Environmental Risk Assessment in demonstrating adequate provisions for the protection of the environment and the health and safety of persons (see ***Expert Report 1****);* and

f) The critical need to examine the health implications of the proposed licence change, particularly on vulnerable populations (see ***Expert Report 2***).

IV. SCOPE OF REVIEW & EXPERTS

CARN received participant funding to review BWXT's licence application and related documentation, including BWXT and CNSC Commission member documents, with a focus on the environment and human health in order to make recommendations aimed at improving licence and LCH parameters specific to environmental protection, public awareness and human health.

To facilitate CELA's review, we retained Dr. Tanya Markvart, an expert in sustainability assessments, to review BWXT's licence renewal application and related documentation, including BWXT and CNSC Commission member documents, and conduct a sustainability-based analysis of the BWXT site and make recommendations on the fuel fabrication processes (see ***Expert Report 1*** appended to this submission).

We also retained Dr. Gordon Edwards, an expert on the human health effects of radionuclides, to review the Commission member documents and comment on the sufficiency of the monitoring data and parameters, as well as the potential health effect (see ***Expert Report 2*** appended to this submission).

This intervention is directly relevant to the Commission's duty under section 24(4) of the *Nuclear Safety and Control Act* (NSCA) to ensure the adequate protection of the environmental and human health.[9] CELA's findings and recommendations, below, aim to advance the objectives of the Commission and are directly relevant to this licence renewal hearing. CELA's review also recommends how the CNSC, enabled by section 24(4) of the *NSCA*, can incorporate principles of international environmental law, such as the precautionary principle, in its licensing decision.

V. FINDINGS

(a) Ten-year licence would put human health and environment at risk

For the following reasons, CARN opposes BWXT's request for a 10-year licence.

First, 10-year licences significantly reduce public scrutiny of licensee operations and access to information because of the duration of time between hearings and the accompanying lack of meaningful ways for the public to engage with the Commission and licensee. Shorter licences and more frequent hearings, which are responsive to the operations being undertaken by licensees, would better enable public engagement and awareness of activities occurring in their community.

Secondly, CARN is concerned that issues which should be considered during this licensing hearing have been deferred by way of licence conditions and will not be subject to a full, public hearing. For instance, CNSC Staff have recommended that in granting a 10-year licence, the licensee submit an updated environmental monitoring program and commission a report about fuel pelleting prior to commencing production of fuel pellets at the Peterborough facility (proposed licence conditions 15.1 and 15.2). These issues are of critical importance to the community and the reports resulting from these proposed licence conditions should not be reviewable by the CNSC alone. It is precisely these reports and studies which should have been commissioned and made public prior to this hearing, for consideration during the renewal process.

Thirdly, a public hearing before the Commission provides greater procedural rights and protections than other Commission forums, such as the annual Regulatory Oversight Reports and meetings. Even if these proposed licence conditions, noted above, were reviewed at annual RORs, it has been CELA's experience that the intent of RORs is not to change or amend licences or licence conditions, but rather to receive updates on licensee activity. Further, as in the majority of instances the public is excluded from oral interventions, the ROR is ill suited to resolving the concerns being made by CARN in the context of this licence renewal.

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[9] *Nuclear Safety and Control Act*, SC 1997, c 9

Fourthly, as further detailed in Section C below, CARN submits the licensee has not demonstrated that they have taken all reasonable precautions to limit and control its emissions to the environment. Further, because of the deficiencies in environmental monitoring data required by the CNSC, there is not sufficient evidence for the Commission to conclude that indeed, in carrying out its licence, human health and the environment will be protected. In this regard, we endorse the submission of Dr. Julian Aherne who in their submission notes that due to limitations of the CNSC's Independent Environmental Monitoring Program (IEMP) "the IEMP data cannot independently verify that the public and the environment around licensed nuclear facilities are safe."[10]

Lastly, because of the above noted deficiencies in BWXT's materials, CARN submits that should the Commission grant a 10-year licence, it would be inconsistent with the international law principle, the precautionary principle. The precautionary principle was adopted into Canadian law by the Supreme Court of Canada in *Spraytech* 2001.[11] As the court held:

> In order to achieve sustainable development, policies must be based on the precautionary principle. Environmental measures must anticipate, prevent and attack the causes of environmental degradation. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.[12]

Therefore, in circumstances of potentially serious or irreversible environmental harm,[13] the CNSC must only licence decommissioning activities which prioritize environmental protection, and human health and safety. As this threshold has not been met, it would be contrary to the precautionary principle to grant a 10-year licence.

Recommendation No. 1: Matters of critical public interest and importance to safeguarding human health and the environment should not be delegated to licence conditions, only reviewable by the Commission and licensee at a later date.

Recommendation No. 2: Regulatory Oversight Reports and meetings are not sufficient alternatives to licensing hearings given their limited scope and exclusion of oral intervention

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[10] Julian Aherne, "BWXT Nuclear Energy Canada Licence Renewal" (27 January 2020)
[11] *114957 Canada Ltée (Spraytech, Société d'arrosage) v. Hudson (Town)*, [2001] 2 SCR 241 at paras 30 – 32.
[12] *Ibid*
[13] European Environment Agency, Late Lessons from Early Warnings: The Precautionary Principle 1896-2000 (Copenhagen: EEA, 2002) at 13, 15; Nicolas de Sadeleer, "The Principles of Prevention and Precaution in International Law: Two Heads of the Same Coin?", chapter 9 in Research Handbook on International Environmental Law, Malgosia Fitzmaurice, David M. Ong and Panos Merkouris, eds (United Kingdom: Edward Elgar, 2014) at 184.

opportunities. They should not be relied upon to remedy outstanding issues resulting from licensing hearings.

Recommendation No. 3: The Commission must ensure its decision-making aligns with the precautionary principle and thus, only licence BWXT's activities to the extent that they are carried out in a way which ensures protection of the environment and human health and safety in accordance with the precautionary principle.

(b) Inequitable Access to Information and Disclosure Among the Public, CNSC and BWXT

i. Environmental Justice and Meaningful Public Engagement

Convenient access to information is a cornerstone of fair public participation in decision making. Accountability of decision makers is enhanced when citizens have access to relevant documents, and there is a direct link between accessibility of information and the ability of citizens to influence decision making. Meaningful public participation is not possible without an informed public; therefore, easy access to relevant studies, data, records, etc., is critical.

Meaningful participation in decision-making is also critical to advancing environmental justice as it ensures that no population suffers disproportionate adverse environmental or human health effects. A core principle of environmental justice is the public's right to information, or "right to know", which stands for a basic human entitlement to information when there may be direct impacts to health and bodily integrity.[14]

The right to know is furthered through public information frameworks, inventories and databases which require for instance, the identity of chemicals or risks in one's environment to be disclosed, alongside their hazardous properties and potential health hazards. These public information mechanisms – enabled by a right to know – increase the transparency of licensee's operations and trust in decision-makers' authority. Having accessible, high-quality information also raises the expectation of more rigorous oversight.

While CARN appreciates the efforts of the Commission and CNSC Staff to respond to information requests and questions received leading up to this hearing, unfortunately, without being supported by a publicly accessible environmental data sharing system, whose data is sufficient and displayed in a timely way, the information sharing is of little value. Proactive disclosure of data is preferred to piecemeal, individual responses.

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[14] Richard M. Brown, 1982 "Canadian Occupational Health and Safety Legislation" (1982) 20:1 Osgoode Hall LJ)

Further barring the public's right to know in this context, has been BWXT's repeated denial of information on the basis that it is security sensitive or proprietary. CARN submits that disclosure in the public interest should serve as an override to claims of information being proprietary when the information has the potential to implicate the individual and collective health of citizens and the environment.

Among the disclosure requests denied by BWXT on the basis of being proprietary, include:

- BWXT Business Management System Manual
- BWXT Licenced Activity Quality Assurance Program
- BWXT Business Plan
- BWXT Preliminary Decommissioning Plans
- BWXT Public Information and Disclosure Program document

Despite our best efforts, our ability to weigh in the context of this licensing hearing has been diminished because the public has not been provided the same level of access to documents as that provided to the Commission, CNSC Staff and the proponent. While BWXT did provide short summaries of some of our requested documents, we maintain that the more detailed studies and data underlying these reports should be as equally accessible. This inequal distribution of procedural rights diminishes CARN's trust in the CNSC and the actions of the licensee, operating in our community.

In this regard, CARN endorses the intervention submitted by Swim Drink Fish Canada which recommends that "the CNSC should immediately initiate a comprehensive review of access to information or interrogatory processes for future Commission meetings and hearings in consultation with stakeholders."[15]

Recommendation No. 4: At a minimum, the CNSC should require all licensing documents be publicly disclosed to advance the public's right to know. This is critical, not only in advancing the right to know, but the public's trust in the regulator and the actions of the licensee.

Recommendation No. 5: CARN supports the recommendation by Swim Drink Fish Canada that the CNSC immediately initiate a comprehensive review of access to information or interrogatory processes for future Commission meetings and hearings in consultation with stakeholders.

[15] Swim Drink Fish Canada, "Submission of Swim Drink Fish Canada/Lake Ontario Waterkeeper" (27 January 2020)

ii. CNSC Public Information and Disclosure Guidance

The high level of concern about the risk accompanying BWXT's licence application for pelleting operations in Peterborough is partly rooted in the legacy of illness and contamination left by the GE facility. As a quick online search for related stories will reveal, there is already heightened community anxiety surrounding pelleting operations in Peterborough as well as the controversial nature of BWXT's Application more generally (e.g., Clayside, 2019; Ruiter, 2019).

The Commission must understand that the public interest in BWXT's Application is sufficiently high to warrant an open and transparent process for accessing all of the reports, analyses, and data that comprise it.

In contrast to CNSC's RegDoc 3.2.1 obligations, however, the reports, analyses, and data that comprise BWXT's licence application are presented in such a way that in-depth public and expert reviews are almost impossible. As section 2.1 of RegDoc 3.2.1 *Public Information and Disclosure* stipulates,

> The public information program and its disclosure protocol shall be commensurate with the public's perception of risk and the level of public interest in the licensed activities, which may be influenced by the complexity of the nuclear facility's lifecycle and activities, and the risks to public health and safety and the environment perceived to be associated with the facility and activities.

Furthermore, per section 2.2.4:

> The public information program shall provide open and transparent means and access for the public to obtain desired operational, environmental and safety information about the licensed facility or activities.

BWXT's licence application document contains scant information readily accessible to the public. Throughout the application BWXT refers to relevant studies that provide supplementary information to demonstrate its attention to various obligations. The vast majority of these studies, however, is inaccessible to the public through BWXT's public information website.

Below, is a list of additional information requests made by CARN which we did not anticipate being denied, as they were supplementary reports directly referenced in BWXT's licence application. These supplementary reports relate to critical Safety and Control Areas that comprise BWXT's licence application and the CNSC's environmental review. Access to these reports is needed for a fair and comprehensive review of BWXT's licence application; however, they are totally inaccessible to the public through BWXT's public information website:

- BMS Manual,
- Licenced Activity Quality Assurance Program (Footnote 7),
- Conduct of Operations (Footnote 9),
- Public Information and Disclosure Program document (Footnote 10),
- HAZOP Study, Toronto Facility (Footnote 18),
- Peterborough Facility Safety Analysis (Footnote 20),
- Radiation Protection Manual (Footnote 29).

Our request to BWXT for some of these reports was not granted. Consequently, we could not undertake a comprehensive review of BWXT's Application. For these reasons, CARN submits that BWXT has not met the CNSC's obligations for public information and disclosure and at best, BWXT's licence application is a superficial token of openness and transparency in this regard.

Recommendation No. 6: The CNSC must require BWXT to make all reports, analyses, and data associated with its licence application readily accessible to the public via its website or an internal process that the public can easily access.

iii. CNSC Environmental Risk Assessment Guidance

Additionally, given the results of the 2019 IEMP (discussed in Section C below), we also note that it is unfortunate that the Environmental Risk Assessment (ERA) for this licensing hearing only covers Beryllium discharges from 2012 to 2016. However, according to the CNSC's RegDoc 2.9.1 *Environmental Protection* "the ERA is subject to regular updates (at least every five years, and whenever a significant change occurs in either the facility or activity that could alter the nature (type or magnitude) of the interaction with the environment" (emphasis added).

Despite the proposed significant change in the operations in Peterborough, the ERA, which supports the licence renewal application, only contains data until 2016. There is no data included for the following years.

The requirement in Reg.Doc 2.9.1 to have an updated ERA when significant changes occur can thus hardly be claimed to be met in this instance. As ERA's are usually updated on a 5 year-schedule, an ERA with 3 to 8-year-old data can hardly be considered an "updated" ERA.

Unfortunately, the CNSC Staff Commission Member Document (CMD) provides no reason is provided as to why the ERA does not, at least, include data from 2017 and 2018. Indeed, it is difficult to understand how the outdated ERA data can be reconciled with the requirement in RegDoc 2.9.1. to update the ERA whenever a significant change occurs in the facility. The IEMP data from 2019 in particular further highlights the need for an ERA that is up to date.

Recommendation No. 7: Given the significant changes proposed, the ERA should be updated with data from 2017 and 2018, and, if possible, with data from 2019, before the Commission makes any decision regarding the requested licence renewal.

c) Environmental Monitoring Data Indicates Potential Risk to Human Health and the Environment

CARN submits that the most current IEMP data for the Peterborough site was released too late for members of the public to properly review the data and potentially submit comments to the Commission. The disclosure of this data had to be specifically requested, and access was only provided one week before the public intervention deadline. On this basis alone, a deferral of the hearing is merited so that all CMDs can be accordingly updated.

While CARN was granted a one-week extension, which allowed us more time to consider the 2019 IEMP data, the general public did not benefit from such an extension. Given the importance of this data to the surrounding community, and as this data is relied upon in section 4.0 of the CNSC *Environmental Protection Review Report* (p. 34-37), which forms part of the licencing materials, it is highly problematic that access was not provided sooner.

When reviewing the 2019 IEMP data, we note that soil samples from 10 locations were tested for beryllium in 2019, but only 7 of these locations had also tested in 2014 and 2018. When looking at these 7 locations, we see that 5 of them had increases in beryllium levels in 2019.

Of particular importance are the elevated Beryllium levels that were found in soil samples collected at the nearby Prince of Wales Public School (sample code GP05-S05). Soil samples taken at a depth of 0-5 cm showed a significant increase over the past couple of years, with concentrations moving significantly closer to the reference level of 4.0 mg/kg dry weight:

- 2014: 1.0 mg/kg dry weight
- 2018: 1.27 mg/kg dry weight
- 2019: 2.34 mg/kg dry weight

These elevated levels are cause for concern, in particular as they indicate a trend of increased emissions of beryllium and, that there may be hotspots with significantly higher levels of beryllium concentrations in the area around BWXT's facility in Peterborough.

Of concern is also the fact that the licencing materials contain no discussion of the exposure to children, including at the nearby school. As children are a particularly vulnerable group, and given the close proximity to the nearby school, there is a particular need for such consideration.

Additionally, and in light of these findings, it should be noted that the reliance solely on soil samples may lead to significantly underestimating children's exposure to beryllium. In a risk assessment study of metal contamination of children's playgrounds[16], it was found that dust deposited on facilities and toys used by children while playing, contained concentrations of Beryllium that were 6 times higher than the beryllium concentrations in soil samples taken in the same areas.[17]

This risk assessment study also concluded that atmospheric urban dusts were the main source of toxic and carcinogenic elements within the tested playground areas. These findings suggest that collecting dust samples from facilities and toys located in the outdoor areas of the Prince of Wales Public School would help provide a fuller picture of the actual exposure to Beryllium – and possibly other harmful substances – that children may be experiencing at this school.

Furthermore, the IEMP should be repeated in 2020, to determine if the increase is continuing. Sufficiently detailed monitoring of beryllium air emissions from BWXT's facility should also be put in place in order to better understand the source of these releases, including whether the source is continual emissions or if we are dealing with unintentional releases, sudden spikes in emissions or defective equipment.

It should also be explained why the CNSC does not believe the elevated levels constitute a health risk, as well as what steps will be taken to ensure that the current trend is reversed and to further investigate the extent of the contamination. In general, better public notification of such findings, in particular in the period before licencing hearings.

Recommendation No. 8: The significant changes observed at the Prince of Wales Public School over a short period of time should result in further testing at the school. This should include multiple samples, to map the extent and potential variations in the concentration of contamination on school grounds.

Recommendation No. 9: The CNSC should have proactively communicated the findings of the IEMP data to the public. In light of the IEMP's findings, the Commission should have deferred the hearing until such a time that there was sufficient time for public review.

Recommendation No. 10: A discussion of the likely reason or reasons for the significant increases from 2018 to 2019 should be included in section 4.0 of the *Environmental Protection Review Report*. Only with a proper understanding of the reason for this increase, can it be determined if what is being observed indicates a trend that should be cause for concern. Without discussion of

[16] Kicińska A, Klimek A (2015) Risk assessment of heavy metals in children's playgrounds in the Rabka Zdrój health resort. Environ Protect Natur Resour 26:15–19.
[17] Ibid., p. 16.

these results and further testing, CARN cannot agree with CNSC's finding that the levels are in fact safe, while seeing such rapid increases.

Recommendation No. 11: A press release should be issued, bringing attention to the new IEMP data, prior to the public hearing. This press release should describe the increases in beryllium levels and explain what the reference level is.

Recommendation No. 12: Dust samples should be collected from the area around the school, including playgrounds and other installations that children may interact with on school premises and where dust might settle.

Recommendation No. 13: The licencing materials should explicitly address the potential impact on children at the school in particular.

Recommendation No. 14: IEMP data should be required for 2020. Sufficiently detailed monitoring of beryllium air emissions from BWXT's facility should also be put in place in order to better understand the source of these releases.

(d) An impact assessment would have provided a more thorough review of social, economic, health and environmental effects

CARN submits that given the significance of the licensing change being requested by BWXT, an impact assessment (IA) would have provided a more comprehensive and robust forum to consider resulting changes to environment, health, social and economic conditions.

We were dismayed to learn that this project does not trigger the *Impact Assessment Act* (IAA), which was proclaimed into force on August 28, 2019 and supersedes the *Canadian Environmental Assessment Act, 2012*. As Canada's federal environmental assessment statute, it outlines which federal undertakings require an impact assessment (formerly, environmental assessment). We note the following shortcomings to the CNSC's process which would have been remedied had an IA been undertaken.

First, the CNSC recognized during the 2018 Pickering relicensing hearings that they do not consider socioeconomic aspects in their review of projects.[18] As a community that continues to respond to and live with the legacy effects of industrial pollution, it is critical that the human – or societal element – of this licensing matter be considered. In CARN's view, the CNSC has overlooked the need for a social licence, or 'society's consent' in order to permit uranium pelleting in Peterborough. To achieve a social licence, the project must engender trust, advance transparency

[18] *See* Canadian Nuclear Safety Commission (2018) Transcript of Proceeding dated 28 June 2018.

and meaningful public engagement, and protect health, safety and the environment.[19] In CARN's view, none of these preconditions have been met.

Secondly, without an IA, there is no forum to address alternatives to the proposed licensing change. Considering 'alternatives to the project' and 'alternative means of carrying out the project' are required considerations under the *IAA* which are not before the Commission, in the narrow licensing process provided for in the *NSCA.*

Thirdly, it has been a longstanding concern of CARN and its members that this licensing change could occur, absent express consideration of the site where the facility is located. Despite an extensive review of international guidance, there is a paucity of guidance pertaining to the siting of *existing* nuclear facilities. Had an IA been conducted, there would have been a forum to discuss siting, population density and vicinity of vulnerable populations.[20]

Lastly, as a Peterborough-based citizens group, CARN also has a direct interest in BWXT's future plans for the facility, which includes its ultimate decommissioning. As the preliminary decommission plan was among the documents denied by the proponent, the timeline for decommissioning remains very unclear to us – and the public. Further, as indicated in the PDP summary provided by BWXT, a preferred decommissioning has already been selected namely:

> The preferred decommissioning strategy for the BWXT NEC Peterborough operations is to release the entire licensed property (including land and buildings) from regulatory control for reuse or demolition of the structures.[21]

Had this project undergone an IA review and not a CNSC hearing, a range of decommissioning plans would have been reviewed and alternatives, based on a range of social, economic, environmental and human factors, considered. Currently, the process adopted by the CNSC is piecemeal in that decommissioning is not discussed, to any great extent, until the proponent seeks a licence to decommission. In CARN's view, understanding the proposed change in operations in light of future plans – which includes decommissioning – is critical to this hearing and should be addressed by the Commission.

Recommendation No. 15: A greater range of nuclear projects and facilities should be designated for review under the federal *Impact Assessment Act* so that considerations of social, economic,

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[19] Hoedl S (2019) A Social Licence for Nuclear Technologies in Black-Branch J and Fleck D (eds.) Nuclear Non Proliferation in International Law – Volume IV, Asser Press, The Hague

[20] *For instance*, in 2011 the Joint Review Panel for the EA for the proposed Darlington New Build project had given CNSC staff direction in regard to population density near the proposed new-build NGS and requested information about that matter.

[21] BWXT NEC Inc, "Peterborough Operations Preliminary Decommissioning Plan Summary" (2020).

and principles of sustainability – which are outside the scope of the CNSC's narrow licensing process – can be addressed.

VI. ORDER REQUESTED

For the foregoing reasons provided in this intervention, we request the CNSC issue an order:

(1) Granting CELA, on behalf of CARN, the status of intervenor;

(2) Granting CELA, on behalf of CARN, the opportunity to make an oral presentation at the March 5-6, 2020 hearing in Peterborough;

(3) Striking BWXT's request for a flexible licence allowing it to produce uranium pellets in Peterborough from its licence application and the CNSC's proposed Licence and Licences Condition Handbook; and

(4) Denying BWXT's request for a 10-year licence.

Yours truly,

CANADIAN ENVIRONMENTAL LAW ASSOCIATION
On behalf of
CITIZENS AGAINST RADIOACTIVE NEIGHBOURHOODS

Kerrie Blaise
Legal Counsel

Morten Siersbaek
Legal Counsel

SUMMARY OF RECOMMENDATIONS

Recommendation No. 1: Matters of critical public interest and importance to safeguarding human health and the environment should not be delegated to licence conditions, only reviewable by the Commission and licensee at a later date.

Recommendation No. 2: Regulatory Oversight Reports and meetings are not sufficient alternatives to licensing hearings given their limited scope and exclusion of oral intervention opportunities. They should not be relied upon to remedy outstanding issues resulting from licensing hearings.

Recommendation No. 3: The Commission must ensure its decision-making aligns with the precautionary principle and only licence BWXT's activities to the extent that they are carried out in a way which ensures protection of the environment and human health and safety in accordance with the precautionary principle.

Recommendation No. 4: At a minimum, the CNSC should require all licensing documents be publicly disclosed to advance the public's right to know. This is critical, not only in advancing the right to know, but the public's trust in the regulator and the actions of the licensee.

Recommendation No. 5: CARN supports the recommendation by Swim Drink Fish Canada that the CNSC immediately initiate a comprehensive review of access to information or interrogatory processes for future Commission meetings and hearings in consultation with stakeholders.

Recommendation No. 6: The CNSC must require BWXT to make all reports, analyses, and data associated with its licence application readily accessible to the public via its website or an internal process that the public can easily access.

Recommendation No. 7: Given the significant changes proposed, the ERA should be updated with data from 2017 and 2018, and, if possible, with data from 2019, before the Commission makes any decision regarding the requested licence renewal.

Recommendation No. 8: The significant changes observed at the Prince of Wales Public School over a short period of time should result in further testing at the school. This should include multiple samples, to map the extent and potential variations in the concentration of contamination on school grounds.

Recommendation No. 9: The CNSC should have proactively communicated the findings of the IEMP data to the public. In light of the IEMP's findings, the Commission should have deferred the hearing until such a time that there was sufficient time for public review.

Recommendation No. 10: A discussion of the likely reason or reasons for the significant increases from 2018 to 2019 should be included in section 4.0 of the *Environmental Protection Review Report*. Only with a proper understanding of the reason for this increase, can it be determined if what is being observed indicates a trend that should be cause for concern. Without discussion of these results and further testing, CARN cannot agree with CNSC's finding that the levels are in fact safe, while seeing such rapid increases.

Recommendation No. 11: A press release should be issued, bringing attention to the new IEMP data, prior to the public hearing. This press release should describe the increases in beryllium levels and explain what the reference level is.

Recommendation No. 12: Dust samples should be collected from the area around the school, including playgrounds and other installations that children may interact with on school premises and where dust might settle.

Recommendation No. 13: The licencing materials should explicitly address the potential impact on children at the school in particular.

Recommendation No. 14: IEMP data should be required for 2020. Sufficiently detailed monitoring of beryllium air emissions from BWXT's facility should also be put in place in order to better understand the source of these releases.

Recommendation No. 15: A greater range of nuclear projects and facilities should be designated for review under the federal *Impact Assessment Act* so that considerations of social, economic, and principles of sustainability – which are outside the scope of the CNSC's narrow licensing process – can be addressed.

EXPERT REPORT 1:
Sustainability Analysis of BWXT Nuclear Energy Canada's 2018 Fuel Facility Operating Licence Renewal Application

By Tanya Markvart, PhD, on behalf of the Canadian Environmental Law Association

I. INTRODUCTION

This report presents our review of BWXT Nuclear Energy Canada's (BWXT) consideration of sustainability and associated concerns in its 2018 Fuel Facility Operating Licence Renewal Application. Our review rests on the following legislation, regulations, and best practices:

- The Nuclear Safety and Control Act (NSCA);
- Canadian Nuclear Safety Commission (CNSC) REGDOC-2.9.1;
- Best practices in sustainability-based planning and decision making.

In Section 2, we clarify the legislative basis for devoting attention to the principles of sustainability, precaution, and adaptive management in licence renewal applications for Class 1 nuclear facilities. We summarize best practices in sustainability-based decision making in the context of these applications, and we explain how BWXT's Application as a whole should have incorporated sustainability concerns throughout analysis.

Our review concentrates on BWXT's Application and associated Environmental Risk Assessment (ERA) for consolidated operations in Peterborough. In Section 3, we discuss the following findings of our review:

- BWXT's consideration of the principles of sustainability, precaution, and adaptive management in its Application as a whole and in its ERA for consolidated operations in Peterborough (sub-section 3.1),
- BWXT's investigation of potential hazards in its ERA for consolidated operations in Peterborough (sub-section 3.2), and

At the end of each sub-section we provide recommendations for CNSC Staff to consider in its EA and final decision on BWXT's Application.

II. Sustainability-Based Decision Making

Section 2 of CNSC REGDOC-2.9.1 provides guiding principles for protection of the environment. These principles form an overarching framework for analysis and decision making in the CNSC's

environmental assessment (EA) process under the NSCA. The CNSC must be satisfied that an applicant will make adequate provision for the protection of the environment and the health and safety of persons before a licence can be granted.

Our review of BWXT's Application as a whole rests, in part, on the CNSC's guiding principle of sustainable development. In REGDOC-2.9.1, the guiding principle of sustainable development helps to clarify the CNSC's expectations of applicants and licensees. In this report, we explain how BWXT and the CNSC should apply the concept of sustainable development in analysis and decision making.

First, it is important to note that REGDOC-2.9.1 is insufficiently helpful on the key matter of how to apply the concept of sustainable development in analysis. Two key expansions and revisions are needed to clarify the obligations of the licensee and guide CNSC Staff in their evaluations and decisions:

- Elaboration of the main generic concerns that define sustainability, and the implications of these generic concerns for analysis; and
- Requirements for specifying generic sustainability concerns to recognize the particular context for each project for which an application is prepared.

Some clarification of the implications of incorporating sustainability matters in analysis has been provided in previous panel review processes under the Canadian Environmental Assessment Act. Of particular importance have been the following documents:

- Voisey's Bay Mine and Mill Environmental Assessment Panel, "Environmental Impact Statement Guidelines for the Review of the Voisey's Bay Mine and Mill Undertaking" (20 June 1997), and *Environmental Assessment Panel Report on the Proposed Voisey's Bay Mine and Mill Project* (March 1999);
- Mackenzie Gas Project Joint Review Panel, "Joint Review Panel Determination on Sufficiency," (18 July 2005), and the panel's final report, "Mackenzie Gas Joint Review Panel, *Foundations for a Sustainable Northern Future: Report of the Joint Review Panel for the Mackenzie Gas Project*, CEAA 2009";
- Kemess North Copper-Gold Mine Project Joint Review Panel, *Joint Review Panel Report* (September 17, 2007), especially pages 233-241 on the panel's sustainability framework and its application; and
- White's Point Quarry and Marine Terminal Project Joint Review Panel, "Environmental Impact Statement Guidelines" (March 2005) and *Joint Review Panel Report* (October 2007).

In addition, Markvart (2014, 2015), Gaudreau et al., (2013), Gibson and Markvart (2008), and Gibson et al., (2008) illustrate how the concept of sustainable development should be incorporated in assessments of energy projects. Gibson (2005, 2017) and other experts in the field of sustainability-based EA provide further elaboration, including on specification of sustainability criteria for case and context in particular applications (see also Pope et al., 2004; Morrison-Saunders & Pope, 2013; Dalal-Clayton and Sadler, 2014).

(a) Generic Sustainability Evaluation Criteria

The generic requirements of sustainability have been defined in many different ways (see Markvart, 2015). In this report, we use Gibson's (2005, 2017) generic sustainability assessment criteria, which are based on a synthesis of insights from the sustainability literature and applied sustainability experiences. Please see Appendix A for the full criteria.

Briefly, Gibson's generic sustainability criteria devote attention to:

- the capacity of natural systems to maintain their structure and functions and to support biological diversity and productivity;
- the capacity of social and economic systems to deliver opportunities and livelihood sufficiency;
- the capacity of human environments, including local and regional institutions, to respond to and manage externally induced change;
- the attainment and distribution of lasting and equitable social and economic benefits and openings to participate meaningfully in decision making;
- the rights of future generations to the sustainable use of renewable resources; and
- the protection and conservation of wildlife and the environment for present and future generations.

Gibson's sustainability criteria elucidate what the concept of sustainability means. They constitute a package in that it is necessary to fulfill all of the criteria in decision making for progress towards sustainability. The aim of sustainability-based decision making is to integrate and pursue the criteria jointly, aiming for mutually reinforcing gains.

(b) Specification of Generic Sustainability Evaluation Criteria

It is necessary to specify the generic sustainability evaluation criteria in order to recognize the particular concerns raised by context-specific factors. This specification step ensures proper sensitivity to the factors that may affect how the generic requirements for sustainability can be pursued over the long term. These factors may include community and/or organizational conditions and trends, resources, capacities and other assets, opportunities and barriers, stresses

and vulnerabilities. All of these vary more or less significantly among different cultures, ecosystems, jurisdictions and sectors, etc.

In Table 1 below we provide an example of how Gibson's generic sustainability criteria should be specified for the context of BWXT's Application. Note that the table may not be comprehensive of all concerns that BWXT should consider in its analyses.

Table 1. Specified Sustainability Evaluation Criteria for BWXT's Application

Sustainability Criteria	BWXT Application-Specific Sustainability Concerns
Socio-Ecological System Integrity Resource Maintenance and Efficiency	• Potential long term, cumulative impacts from radiological and non-radiological contaminants associated with operations in Toronto and Peterborough (air, water, soil) • Insufficiently low standards for cancer risk arising from radiological hazards, with greatest risks to women and young children • Occupational health and safety risks associated with plant operations • Higher radiation dose limits for workers vs. the general public • Community-scale exposure to routine and accidental releases of radiological contaminants • Energy supply diversity/resilience vs. reliance on nuclear energy generation for baseload supply
Livelihood Sufficiency and Opportunity Intragenerational Equity Intergenerational Equity	• Costs of health and environmental impacts of operations for individuals, families, and communities • Facility performance, reliability and maintenance costs • Costs to public of accidents, malfunctions, malevolent acts • Boom and bust effects of nuclear energy generation and associated undertakings (loss of jobs and livelihoods over the course of different phases of nuclear energy generation)
Socio-Ecological Civility and Democratic Governance	• Security and weapons proliferation • Long-term security of facilities • Capacity for long-term environmental management and monitoring • Capacity to manage, safely store, and pass along vital information to future generations • Capacity to deal with unplanned releases, catastrophic accidents, malfunctions • Capacity for emergency planning and response

	• Capacity to implement open, inclusive, transparent public decision-making processes • Capacity to provide easily accessible, relevant information to the public • Capacity to educate public on emergency planning
Precaution and Adaptation	• Need for comprehensive emergency planning • Diversity, redundancy and retrievability in design • Need for long-term precautionary management of facilities

Once the generic sustainability requirements have been recognized and the context-specific concerns have been identified, the next step is to consolidate them into one comprehensive set of criteria for application in planning and analysis.

(c) Application in Analysis and Planning

The sustainability objective and specified criteria should inform all steps in the planning process, including but not limited to the following:

- how interested stakeholders are to be engaged in the planning process, including how different perspectives can be accommodated;
- what planning options and components (technologies, programs, etc.) should be examined, and how alternative system options should be elaborated and subjected to comparative evaluation;
- what possible effects (direct, indirect, cumulative effects) deserve detailed attention;
- which effects are likely to be most significant, given sustainability objectives;
- what important opportunities or perils need attention;
- how anticipated positive effects could be enhanced and how adverse effects and risks could be mitigated;
- the strengths and limitations of each system component, including interconnections;
- what specifics are needed in the plan, and/or what arrangements are needed for subsidiary and subsequent deliberations and decisions to ensure proper consideration of purposes, alternatives, effects, mitigation and enhancement options, trade-offs, etc. in light of the sustainability objective and criteria;
- whether and under what terms and conditions the proposed plan should be approved;
- what monitoring and adaptive response requirements are imposed; and
- what preparations by various parties are necessary and desirable to ensure that negative effects are avoided or mitigated, that unanticipated effects are identified and addressed quickly, that subsidiary planning and project development proceeds appropriately, that the

plan is reviewed and revised regularly, that maximum mutually reinforcing gains are achieved and that significant adverse effects are avoided (see Gibson & Markvart, 2008).

In the context of the CNSC's EA of BWXT's Application as a whole, the CNSC should evaluate whether or not BWXT has applied a comprehensive sustainability framework throughout all Safety and Control Areas and associated studies.

III. FINDINGS

BWXT's ERA and its Application as a whole are fundamentally flawed in the following ways that are critical to the CNSC's EA and final decision:

- Consideration of the principles of sustainability, precaution, and adaptive management (see section 3.1), and
- Examination of potential release events associated with equipment, operational processes, and human activities (see section 3.2).

(a) Consideration of Sustainability, Precaution and Adaptive Management

The CNSC REGDOC-2.9.1 as well as the human health and EA obligations under the NSCA provide an opening for Applicants to devote explicit attention to the guiding principles of sustainability, precaution, and adaptive management.

BWXT's ERA and Application touch on some sustainability concerns in so far as the ERA focuses on the effects of consolidated operations on human health and ecological systems, and the Application summarizes the results of studies undertaken to ensure the health and safety of people and the environment. BWXT's ERA and Application, however, do not explicitly devote attention to the guiding principle of sustainability by incorporating the concept in a systematic way throughout analysis.

In addition, BWXT's ERA and Application do not explicitly devote attention to the concept of adaptive management, which is integral to sustainability and taking a precautionary approach. The concept of adaptive management has been widely adopted in energy and natural resource management sectors (see Walker & Salt, 2009) as an iterative approach to management in the face of

- scientific uncertainty and human error;
- technological innovations and/or advances in scientific understanding;
- new technical or scientific information regarding the design and operation of a project;
- changes in social and political opinion;

- changes in policy and regulatory frameworks, including safety standards; and
- unforeseen events (including natural disasters, malfunctions, accidents and malevolent acts).

Associated design concepts that may increase the level of adaptive management capacity in the context of BWXT NEC's ERA and Application as a whole include diversity and redundancy (see OECD, 2001, 2012).

Diversity and redundancy are major sources of adaptive management capacity. The diversity requirement seeks to ensure that decision makers evaluate and compare a range of different alternatives that could achieve the same objective. If the preferred option fails there should be sufficient knowledge about other options to make adaptation feasible. The concept of redundancy is central to enhancing the safety and reliability of complex technologies. An element of a system is redundant if there are backups to do its work if it fails.

It is important to note that BWXT's failure to respect the principles of sustainability, precaution, and adaptive management stems from the ERA's narrow methodological approach. As BWXT asserts, its ERA methods are in accordance with CSA standards for ERAs at Class I nuclear facilities (see CSA 288.6). BWXT, however, does not situate and interpret these standards broadly within the framework of CNSC's guiding principles. At a minimum, BWXT should have acknowledged and incorporated these principles in analyses in a systematic way in combination with such methods explained in CSA 288.6.

One obvious way in which BWXT could have incorporated the principles of sustainability, precaution, and adaptive management in its ERA is through an evaluation of associated monitoring and management alternatives. BWXT's ERA should have been carried out to identify potential risks and to enable risk management decisions to be made (see Manuilova, 2003).

BWXT's ERA, however, does not illustrate a direct connection to its monitoring and management regimes. Indeed, the question of how BWXT's ERA has informed its monitoring and management regimes remains unanswered. Again, this failure is partly rooted in the insufficiently narrow and simplistic methods employed in the ERA.

Moreover, BWXT's ERA does not sufficiently respond to widespread public concerns about the long-term, cumulative impacts and associated costs to present and future generations of uranium and beryllium releases to the environment. This omission is significant in light of the well documented, problematic legacy of the GE facility in which the consolidated operations may take place (see Canadian Broadcasting Corporation, 2019). We comment more on this in Section 3.2.

Finally, it is important to note that our review of BWXT's attention to the principles of sustainability, precaution, and adaptive management in its Application as a whole is severely limited by the inaccessibility of relevant documents. We requested many of the reports that BWXT refers to in its Application document, but we were not given access. On the basis of our review of BWXT's Application and ERA, we submit that BWXT does not give adequate respect to CNSC guiding principles in its Application as a whole.

RECOMMENDATIONS

i. The CNSC REGDOC-2.9.1 should be revised to elaborate on the core generic concerns that define sustainability, the implications of these concerns for analysis, and how they should be specified for the particular context surrounding the project for which an application is prepared.

ii. The CNSC must require Applicants to situate and interpret CSA 288.6 (Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills) broadly within the framework of CNSC REGDOC-2.9.1 guiding principles and recognize and apply these principles in analysis.

iii. The CNSC must require BWXT to provide a detailed explanation of how the CNSC guiding principles of sustainability, precaution, and adaptive management were applied in analysis.

iv. The CNSC must require BWXT to evaluate the long-term, cumulative impacts of uranium and beryllium releases to the environment (air, water, and soil), especially in the context of consolidated operations at the Peterborough facility.

v. The CNSC must require BWXT to provide specific details to the public about how its ERA for consolidated operations at the Peterborough facility informs its monitoring and management regimes.

BWXT's Application and ERA fail to clearly illustrate that BWXT will provide adequate provisions for the protection of the environment and the health and safety of persons. The CNSC, therefore, should not renew BWXT's licence, and it should deny BWXT the additional flexibility to conduct pelleting operations at both facilities during the proposed next licence period.

(b) Investigation of Potential Hazards in BWXT's ERA for Consolidated Operations in Peterborough

An in-depth investigation of potential hazards (or release events) associated with consolidated operations at the Peterborough facility is of paramount importance in BWXT's Application and the CNSC's EA. The context surrounding BWXT's Application includes a public perception of high risk due to the toxic legacy of the Peterborough facility (formerly known as GE-Hitachi Nuclear Energy Canada) within which the consolidated operations may occur:

"…a silent tragedy has ravaged a tight-knit community of Peterborough workers with hundreds of compensation claims filed for often horrific and sometimes terminal diseases — from brain to bowel to lung cancer. The cause, they believe, is prolonged exposure to a dizzying range of human carcinogens used at their former workplace, General Electric — where toxic substances sometimes registered at hundreds of times the levels now considered safe. One occupational disease expert calls the factory in its heyday a "cancer generator" (Mojtehedzad, 2016).

Understandably, concerns for public health and safety surrounding the proposed pelleting operations in the Peterborough facility are amplified due to the legacy of illness that has touched dozens of former GE workers. The costs to some individuals and families have been great, including long-term, life-changing financial, emotional and psychological impacts. BWXT's ERA and the CNSC's EA should be commensurate with these complexities in order to devote appropriate attention to these sensitive public concerns.

BWXT's ERA, however, does not devote appropriate attention to the potential hazards (i.e., due to equipment failure, accidents, human error, natural disasters, extreme weather, etc.) associated with consolidated operations in the Peterborough facility. The main issue is that the tiered, source-pathway-receptor methodological approach employed in the ERA is too broad and simplistic to capture release events associated with specific equipment, processes, and activities.

The NSCA and CNSC REGDOC-2.9.1 require Applicants to provide a detailed description of the structures, systems, and equipment at the subject nuclear facility, including their design and their design operating conditions. BWXT's ERA, however, is inappropriately focused on the scale of the facility, as opposed to the specific equipment, processes, and activities involved in consolidated operations.

It is beyond the scope of this review to list the relevant equipment, processes, and activities that BWXT should have described in detail for the public in its ERA. Notable flaws in the analysis include that BWXT's ERA for consolidated operations was completed before specific fuel pelletizing equipment and associated, environmental controls were selected. In addition, the exact

number of air emission sources from consolidated operations had not been determined at the time of completion.

Indeed, BWXT's ERA rests on the assumption of perfect operational performance. But release events happen. In January 2017, for example, BWXT reported a minor hydrogen fire at a furnace in its Toronto plant. In April 2017, BWXT reported an issue with its fire sprinkler equipment, and in August 2017 it reported an occupational exposure limit exceedance for beryllium related to the filters that two workers were using at the time of exposure (CNSC, 2017).

As we noted, BWXT's methodological approach is based on CSA standards for ERAs at Class I nuclear facilities (see CSA 288.6). These standards are not readily accessible to the public; therefore, it is beyond the scope of this review to comment on BWXT's interpretation of them for the purpose of the ERA. Nevertheless, it is fair to assert that these standards should not prevent BWXT from devoting attention to critical matters at the appropriate scale.

Finally, it is important to note that this failure in BWXT's ERA is especially significant because BWXT's ERA reports are among the only Application-related documents accessible to the public through BWXT's website. BWXT includes information regarding potential hazards in its activity- and facility-scale safety analyses for the Toronto and Peterborough facilities. Clearly, BWXT understands the activity-scale potential hazards associated with its operations. These safety analyses, however, are not readily accessible to the public.

In the light of insufficient access to pertinent information, BWXT's ERAs seem to be superficial tokens of public disclosure. We discuss BWXT's attention to CNSC RD 3.2.1 in more detail in Section 3.3.

RECOMMENDATIONS

i. BWXT's ERA was completed before specific fuel pelletizing equipment and associated, environmental controls were selected. In addition, the exact number of air emission sources from consolidated operations was not known at the time of completion. The CNSC must require BWXT to revise its ERA in order to provide accurate and complete information to the public.

ii. BWXT's ERA does not include an examination of potential hazards (or release events). BWXT includes information regarding potential hazards in its activity- and facility-scale safety analyses for the Toronto and Peterborough facilities. These safety analyses, however, are not readily accessible to the public. The CNSC must require BWXT to provide sufficient information to the public about the potential hazards (or release events)

associated with the equipment, processes, and activities involved in consolidated operations.

iii. The CNSC must require BWXT to explain how its investigation of the potential hazards associated with the equipment, processes, and activities involved in consolidated operations informs its monitoring and management regimes for the Peterborough facility.

These critical methodological failures heighten the public perception of risk surrounding consolidated operations in Peterborough, and they should compel BWXT to clearly illustrate by addressing these failures that it will provide adequate provisions for the protection of the environment and the health and safety of persons.

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APPENDIX A - Gibson's (2012, 2017) Generic Sustainability Assessment Criteria

Socio-ecological system integrity
Build human-ecological relations to establish and maintain the long term integrity of sociobiophysical systems and protect the irreplaceable life support functions upon which human as well as ecological well-being depends.

Livelihood sufficiency and opportunity
Ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity.

Intragenerational equity
Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc) between the rich and the poor.

Intergenerational equity
Favour present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably.

Resource maintenance and efficiency
Provide a larger base for ensuring sustainable livelihoods for all while reducing threats to the long term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit.

Socio-ecological civility and democratic governance
Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary and personal decision-making practices.

Precaution and adaptation
Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise, and manage for adaptation.

Immediate and long term integration
Apply all principles of sustainability at once, seeking mutually supportive benefits and multiple gains.

EXPERT REPORT 2:
Human Health Implications of BWXT Nuclear Energy Canada's 2018 Fuel Facility Operating Licence Renewal Application

By Dr. Gordon Edwards, on behalf of the Canadian Environmental Law Association

Health Implications of Pelleting Operations at the BWXT-Peterborough Plant

By Gordon Edwards, Ph.D.

a report commissioned by

The Canadian Environmental Law Association (CELA)

And

Citizens Against Radioactive Neighbourhoods (CARN)

to be submitted to the Canadian Nuclear Safety Commission (CNSC)

February 3 2020

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Background : The BWXT Licence Application

The present report was prepared for the Canadian Environmental Law Association (CELA) and the Peterborough-based community group, Citizens Against Radioactive Neighbourhoods (CARN). The report addresses potential health impacts of pelleting at the BWXT-Peterborough plant.

BWXT Nuclear Energy Canada Inc. operates two Class 1 nuclear facilities, one in Toronto and the other in Peterborough, under the terms of a ten-year licence from the Canadian Nuclear Safety Commission (CNSC) governing both plants. These facilities have been authorized for many years to work in tandem to produce CANDU fuel bundles for Ontario's nuclear reactors, and to pursue other licenced activities as well.

The BWXT-Peterborough plant receives finished ceramic uranium pellets from the Toronto plant and assembles those ceramic pellets into CANDU fuel bundles. Workers at the Peterborough plant stack the solid ceramic pellets into 30-centimeter long zirconium alloy rods, which are then sealed. More than two dozen of these parallel fuel rods are bound together into a cylindrically shaped CANDU fuel bundle, welded together into a solid unit with zirconium alloy spacers.

Small zirconium alloy appendages are brazed to the surfaces of the outer fuel rods using beryllium, a metal that is lighter than aluminum, tougher than steel, and transparent to neutrons. It is also one of the most toxic metals known. The appendages make it easier to slide the fuel bundles through the long horizontal fuel channels inside a CANDU reactor while maintaining some separation between the inner wall of the channel and the fuel rods themselves, and allowing coolant flow with less resistance. Bundles produced by BWXT are used at the Pickering and Darlington reactors.

Figure 1. CANDU fuel bundle showing brazed appendages

The pelleting operation that currently takes place at BWXT-Toronto involves an entire suite of materials and processes having almost nothing in common with the fuel bundle assembly that takes place at the BWXT- Peterborough plant. Very fine uranium dioxide powder from the Cameco conversion facility in Port Hope is shipped to BWXT-Toronto. There the uranium oxide powder is formed into a cylindrical shape under a pressure of 12 to 15 tons per square inch. The resulting “green pellets” are then sintered at a temperature of about 1650 to 1700 degrees C in a pure hydrogen atmosphere to prevent oxidation and to vaporize and remove the zinc stearate lubricant used in the pressing operation. The finished pellets are cylindrically shaped, approximately one centimeter high, with a diameter of comparable size. The ceramic pellets are then shipped to BWXT-Peterborough for fuel bundle assembly.

Figure 2. Uranium dioxide powder.

Figure 3. Sintered uranium dioxide fuel pellets

At present, pelleting is carried out at the BWXT-Toronto plant but not at the BWXT-Peterborough plant. BWXT Nuclear Energy Canada Incorporated (BWXT NEC) is currently asking the Canadian Nuclear Safety Commission (CNSC) to renew the licences for these two facilities, enabling BWXT to continue performing the same functions at the same two plants for the next ten years, but with an extra provision that would allow BWXT to begin pellet-making operations at the Peterborough plant at any time during the licence period if management so decides, for reasons that are not specified in the licence application or in any of the supporting documentation.

According to article 9 of the Nuclear Safety and Control Act, one of the four principle objects of the CNSC is to regulate the nuclear industry "in order to prevent unreasonable risk, to the environment and to the health and safety of persons…." The other three objects of the CNSC are "to prevent unreasonable risk to national security…", to "achieve conformity with measures of control and international obligations…", and "to disseminate objective scientific, technical and regulatory information…."

CNSC has no mandate to approve a project, no matter how convenient it may be for the licensee, if that project entails risk to the health and safety of persons or the environment that is judged to be "unreasonable". It follows that a fundamentally important consideration for any licencing hearing must be for the Commissioners to deliberate on whether the facility under consideration poses a reasonable risk, or an unreasonable risk, to the people most likely to be exposed to the emissions from the plant, and whether that risk is justified. The documentation in this case contains no detailed examination of health matters as it may affect those most likely to be impacted by a pelleting operation at BWXT-Peterborough, nor does it provide justification.

Recommendation 1: *CNSC Commissioners are urged not to approve the additional pelleting provision requested by BWXT NEC unless and until a detailed safety case is presented and subjected to public scrutiny regarding the potential health consequences of initiating a pelleting operation at BWXT-Peterborough, as well as the possible implications for emergency preparedness in the event of severe accidents.*

Canada. Nuclear Safety and Control Act.

9. The objects of the Commission are

(a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to

(i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,

(ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and

(iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and

(b) 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).

Exhibit 1: Nuclear Safety and Control Act, article 9, the objects of the Commission

Those most at risk at BWXT-Peterborough

Those most likely to be exposed to airborne emissions from the BWXT plant are elementary school children attending the Prince of Wales school just across the street from the plant. Commissioners must consider whether these children may be exposed to an unreasonable risk simply by going to school and playing in the playground.

Evidence recently made available from the Independent Environmental Monitoring Program (IEMP) – posted on the CNSC web site on January 22, 2020 – has indicated to several scientists at Trent University (see Annex A) that airborne beryllium emissions from the plant may have been slowly accumulating in the soil, even in the school's playground area, since 2014, when soil sampling began. The playground in question is one where children frequently play sports and engage in other outdoor activities, and it extends to a point that is within 50 metres of the plant across the street (Figure 4).

Figure 4. Prince of Wales elementary school playground with BWXT plant and stack in background. Photo by Robert Del Tredici, December 3, 2019.

If pelleting is to commence at BWXT- Peterborough there will be an anticipated increase in uranium emissions into both air and water – likely by a factor of three to five orders of magnitude (see tables 1 & 2 below). Is it reasonable or unreasonable that these children will begin routinely inhaling 1000 to 100,000 times more uranium dust from the plant?

It is unusual to see a Class 1 nuclear facility sited so close to an elementary school, where about 600 children attend classes from Kindergarten to Grade 8. Many of those kids will likely be spending nine years at the same school, entering Kindergarten at age 5 and progressing to grade 8 before graduating to high school. The student body will turn over (on average) by about 67 children per year, so in the course of a decade there could be a total of about 1200 young kids exposed to airborne BWXT emissions, each one for a period of time ranging from one to nine years. These exposures would occur simply as a result of attending school and playing in the playground.

It is reasonable to infer that, as uranium oxide particulate emissions inevitably increase due to pelleting, uranium depositions will also begin to accumulate in the soil of the playground, following the same pathway as the airborne beryllium may have travelled.

Under such circumstances, children at play will be more likely to inhale, not only minute amounts of beryllium, but also minute amounts of uranium dioxide particulate matter. Moreover, such insoluble particulate matter that has settled in the soil can easily become resuspended due to running, jumping, kicking, skipping or simply walking.

Let's examine the increases in airborne uranium dioxide emissions to be expected. Comparing reported uranium emissions from the two plants from 2014 to 2018 we see that the Toronto pelleting operation released from 5000 to 94,000 times more uranium into the water each year, and from 2700 to 3700 times more uranium into the air each year, than has been the case from the fuel bundle assembly operation in Peterborough.

grams of uranium into the air	2014	2015	2016	2017	2018
BWXT-Toronto	10.9	10.8	10.8	7.4	6.3
BWXT- Peterborough	0.003	0.003	0.004	0.002	0.002
Ratio : T/P	3633	3600	2700	3700	3150

Table 1. Source: BWXT 2018 Compliance Report, Figures 10 and 11

grams of uranium into the water	2014	2015	2016	2017	2018
BWXT-Toronto	720	300	650	940	940
BWXT- Peterborough	0.14	0.06	0.13	0.03	0.01
Ratio : T/P	5143	5000	5000	31,333	94,000

Table 2. Source: BWXT 2018 Compliance Report, Figures 13 and 14.

The atmospheric uranium emissions in question are in the form of a very fine particulate matter – tiny specks of uranium dioxide powder that are easily inhaled into the deepest parts of the lung. Uranium dioxide powder is much finer than refined flour. The diameter of a uranium dioxide particulate is typically less than 10 microns (micrometres) in diameter, with a median value of about 6 microns. This is much smaller than the width of even the finest human hair. The size of uranium dioxide particulates that escape into the atmosphere through a HEPA filter are even smaller in size, generally less than two microns in diameter, and often smaller than one micron in diameter. Particles in this category are so small that they can only be detected with an electron microscope.

Relative sizes	
Diameter of Flour particulate	110 to 570 microns
Diameter of Human Hair	17 to 181 microns
Diameter of Uranium Oxide particulate	1 to 10 microns
Diameter of Particulate escaping HEPA filter	0.5 to 2 microns

Table 3. Relative sizes in microns

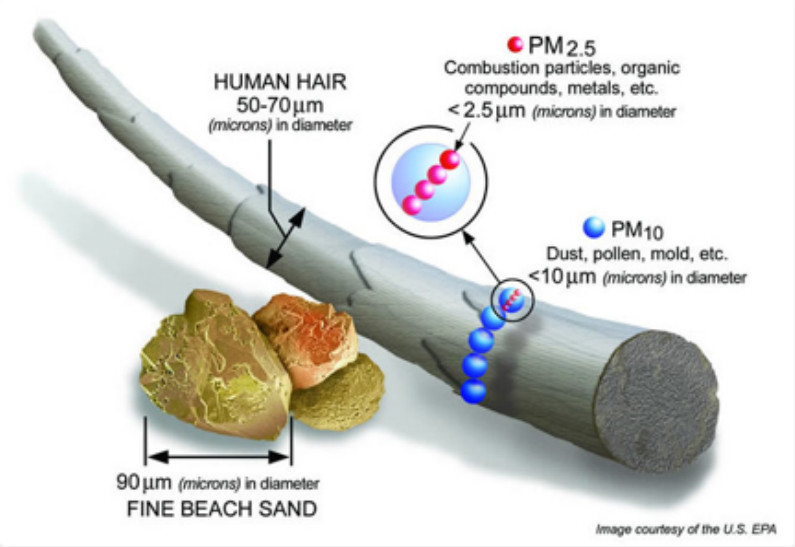

Figure 5. Particulates with diameter 2.5 microns compared to a human hair. https://blissair.com/what-is-pm-2-5.htm

A single gram of uranium oxide is equivalent to almost 175 billions of such one-micron particulates (density = 10.9 g per cm^3). Since the mind has difficulty grasping such large numbers, suffice it to say that the number of uranium oxide particulates emitted into the air from BWXT-Toronto – each year – is comparable to or greater than the number of stars in the Milky Way galaxy. If BWXT-Peterborough follows suit and begins pelleting, the schoolchildren at Prince of Wales Elementary School will have ample opportunity to inhale a few of these myriad tiny uranium oxide particulates into their lungs.

Elimination versus Control of Risk

CNSC's Jenna Hartviksen wrote to Jane Scott of CARN on August 6, 2019, saying that technical staff at CNSC had provided the following information for public dissemination:

> "About a few micrometers in diameter, these dust particulates may be inhaled if they become airborne. Inhalation of uranium dust may result in internal dose to lung tissue from the alpha particles, as well as chemical toxicity if it is absorbed in the bloodstream and transported to sensitive tissues, notably the kidneys.
>
> "It is precisely for this reason that the CNSC mandates stringent worker health and safety programs at BWXT to eliminate or limit exposure to uranium particulates inside the facility. This includes, but is not limited to, the use of engineering controls, work processes, and personal protective equipment."

Ms. Hartviksen reports that CNSC safety programs are designed to "eliminate" the exposure of workers to uranium particulates if possible, or, if elimination is impossible, to "limit" the exposure. The same philosophy presumably applies to the public. If public exposure to uranium dioxide particulates can be eliminated altogether, that is the ideal outcome. If such exposure cannot be eliminated, then it must be limited. Given the unusual circumstance of a Class 1 nuclear facility sitting on the doorstep of an elementary school, and the mandate of CNSC to protect health, Commissioners may choose to go beyond the advice of CNSC staff, which is to approve the licence as is.

Much attention has been devoted in recent years to the health dangers of particulate matter, especially $PM_{2.5}$ – particulate matter smaller than 2.5 microns in diameter. Such particulates are especially dangerous because they can be inhaled into the deepest and most sensitive parts of the lung, where they may lodge for an extended period of time. On a Government of Canada web site, for example, we read the following:

> "Outdoor $PM_{2.5}$, as measured at area monitoring stations, has been shown in a large number of studies to be strongly associated with cardiovascular and respiratory mortality and morbidity endpoints (Health Canada and Environment Canada 1999; WHO 2005; US EPA 2009). There is no recognized threshold of health effects for outdoor $PM_{2.5}$ regardless of where exposure occurs (i.e., indoors or outdoors), and there is evidence that adverse health effects occur at current levels of exposure."

Health Canada. Guidance for fine particulate matter (PM2.5) in residential indoor air.
https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-fine-particulate-matter-pm2-5-residential-indoor-air.html

Children are particularly sensitive to the health effects of breathing such fine particulate matter for a variety of reasons. A recent article (2017) published in Particle and Fibre Toxicology points out that:

> "Exposure to airborne particles has a major impact on global health. The probability of these particles to deposit in the respiratory tract during breathing is essential for their toxic effects…. Exposure to airborne particles may pose different risks to different sub-populations, and children have been identified as one of the most sensitive groups…. The study included in total 67 non-smoking participants, aged 7–67 years…. Seven of the participants were 7–12 years old…. The real difference in deposition rate, and thus in deposited dose, is expected to be higher due to the generally higher activity level, and thus breathing volume, of children…."

Deposition efficiency of inhaled particles related to breathing patterns and lung function: an experimental study in healthy children and adults
https://particleandfibretoxicology.biomedcentral.com/articles/10.1186/s12989-017-0190-8#auth-3

***Recommendation 2**. The Commissioners are urged not to approve the special pelleting provision in the BWXT licencing application, thereby preventing and eliminating all future routine exposures of hundreds of schoolchildren at Prince of Wales elementary school to elevated levels of respirable particulates of uranium dioxide dust in the $PM_{2.5}$ category as a result of pelleting at BWXT-Peterborough.*

Radiological risks and public information

In a guest editorial that appeared in the Peterborough Examiner on December 13 2019 John MacQuarrie, President of BWXT NEC, wrote:

> "Naturally occurring radiation is all around us and inside us all of the time. It comes from cosmic and earth-based sources, like radon gas in the air we breathe, and small amounts of uranium and other radioactive elements in the water we drink, and from radioactive elements in the ground, and in our food. Credible studies have consistently shown that low levels of radiation, such as from these natural sources, do not negatively impact health or the environment."
>
> *John MacQuarrie, guest columnist, Peterborough Examiner, Dec 13 2019*
> https://www.thepeterboroughexaminer.com/opinion-story/9774832-guest-column-bwxt-has-a-track-record-of-safe-operations/

MacQuarrie's statement is incorrect. Naturally-occurring radon gas in homes has been identified by many countries, including Canada, as a major public health concern. Radon has been identified as the leading cause of lung cancer among non-smokers, and the US EPA has estimated that about 20,000 American citizens die annually from breathing radon in their homes.

> **"Radon** is the number one cause of lung cancer among non-smokers, according to EPA estimates. Overall, radon is the second leading cause of lung cancer. Radon is responsible for about 21,000 lung cancer deaths every year. About 2,900 of these deaths occur among people who have never smoked."
>
> *Exposure to Radon Causes Lung Cancer in Non-smokers and Smokers Alike*
> *US Environmental protection Agency, https://www.epa.gov/radon/health-risk-radon*

MacQuarrie suggests that he bases his remarks on a thorough scientific knowledge of the subject by saying "Credible studies have consistently shown that low levels of radiation, such as from these natural sources, do not negatively impact health or the environment."

Many people would likely interpret MacQuarrie's statement to mean that there is no danger at all associated with radioactive materials from natural sources, and that this opinion is a well-established and unchallenged scientific fact.

Reading such one-sided and misleading public statements like this from the President of a company seeking a ten-year licence from the CNSC does not inspire confidence. Regrettably, CNSC staff did not see fit to offer any public correction or commentary on MacQuarrie's article, despite the statutory obligation of CNSC to "disseminate objective scientific … information".

In fact, it is well documented that radon, radium and polonium are three naturally-occurring radioactive materials that are all exceptionally dangerous. They are elementary substances found in nature, formed as a result of the radioactive disintegration of uranium atoms. They are called "uranium progeny".

Radium has been described by the British Columbia Medical Association as "a superb carcinogen" (The Health Hazards of Uranium Mining, BCMA, 1980). In the 20th century scores of people died from radium-induced bone cancer, fatal blood diseases, and head cancers, many of them young women. Some radium-induced deaths were quite sensational such as the 1927 demise of Eben Myers, a prominent steel tycoon who regularly drank "radium water" as a tonic. Marie Curie and her daughter Irene both died from fatal anemias caused by prolonged contact with radium.

Polonium – another disintegration byproduct of uranium – is 250 billion times more toxic than hydrogen cyanide according to the Los Alamos National Laboratory. (See https://periodic.lanl.gov/84.shtml .) A small amount of polonium-210 dissolved in tea was used to murder ex-Russian agent Alexander Litvinenko

in London, England, in 2006. The American Health Physics Society, whose members include industry experts in radiation health monitoring, estimates that a large fraction of the deaths attributed to cigarette smoking are due to minute traces of radioactive lead-210 and radioactive polonium-210 in the tobacco.

These three materials – radon, radium and polonium – are not only "radioactive progeny" of uranium, but they share with uranium the fact that they are "alpha emitters". Alpha emitters are harnless outside the body but are far more biologically damaging than other forms of atomic radiation once in close contact with living cells.

In order to understand the nature of the potential radiological hazard associated with the inhalation of uranium dioxide particulates from the BWXT pelleting operation, it is important to understand what an alpha-emitter is.

Physical Facts about Alpha Radiation

Some elementary background is necessary. Every atom has an extremely tiny compact core called a nucleus. The nucleus contains most of the mass of the atom. An atomic nucleus is surrounded by a number of orbiting electrons.

The forces that hold the nucleus together are millions of times more powerful than those holding the electrons in orbit. Because of this, nuclear energy – energy that is released directly from the nucleus of an atom – is millions of times greater than any form of chemical energy. Most chemical reactions involve re-arranging the orbital electrons of different atoms in order to combine those atoms into molecules, without altering the nucleus of any one of the constituent atoms.

Most atoms normally encountered in the natural world have a nucleus that is stable, eternal, never-changing. A radioactive atom (radionuclide) is one whose nucleus is unstable. Such a nucleus will suddenly and violently disintegrate, usually giving off an energetic charged particle – an alpha particle or a beta particle – in some cases accompanied with or followed by the emission of a gamma ray. Most radioactive elements are either alpha-emitters or beta-emitters; radon, radium, polonium, uranium, and plutonium are alpha emitters.

A beta particle is a very high-speed electron that originates from within the nucleus, not from the ranks of orbiting electrons outside the nucleus. An alpha particle is a much heavier projectile that is also thrown out from inside the nucleus with great force. It is identical to the nucleus of an ordinary helium atom, with two protons and two neutrons bound together, but it travels extremely fast and thereby acts as kind of subatomic cannonball. An alpha particle is 8000 times more massive than a beta particle and has twice the electrical charge. Accordingly, in living tissue, alpha particles are far more damaging than beta particles, breaking thousands of chemical bonds before coming to rest.

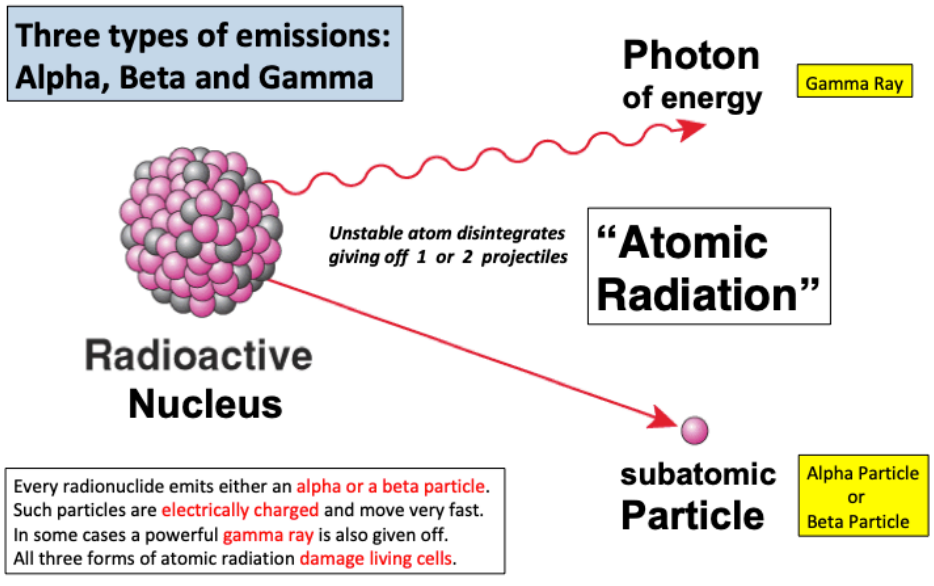

Figure 6. Three types of radioactive emissions: Alpha, Beta and Gamma.

A gamma ray is a photon of pure energy (with zero rest-mass) travelling at the speed of light. It is similar to an x-ray but more penetrating and more powerful. There are two important facts to bear in mind. 1. Gamma rays are much easier to detect with instruments than either beta particles or alpha particles. 2. Beta-emitters and alpha-emitters are primarily internal hazards, whereas gamma-emitters are both internal and external hazards.

An alpha particle in living tissue has little penetrating power, despite its exceptionally high energy and speed; it comes to rest within a very short distance: 20 to 70 microns. That range represents a thickness of one, two or three cells. The precise range of an alpha particle depends on its energy, measured in millions of electron-volts (MeV). An alpha particle with an energy of 5 MeV has a range of about 30 microns in soft tissue; alphas from uranium are about 4.2 MeV. All alpha particles can be stopped by an ordinary sheet of paper.

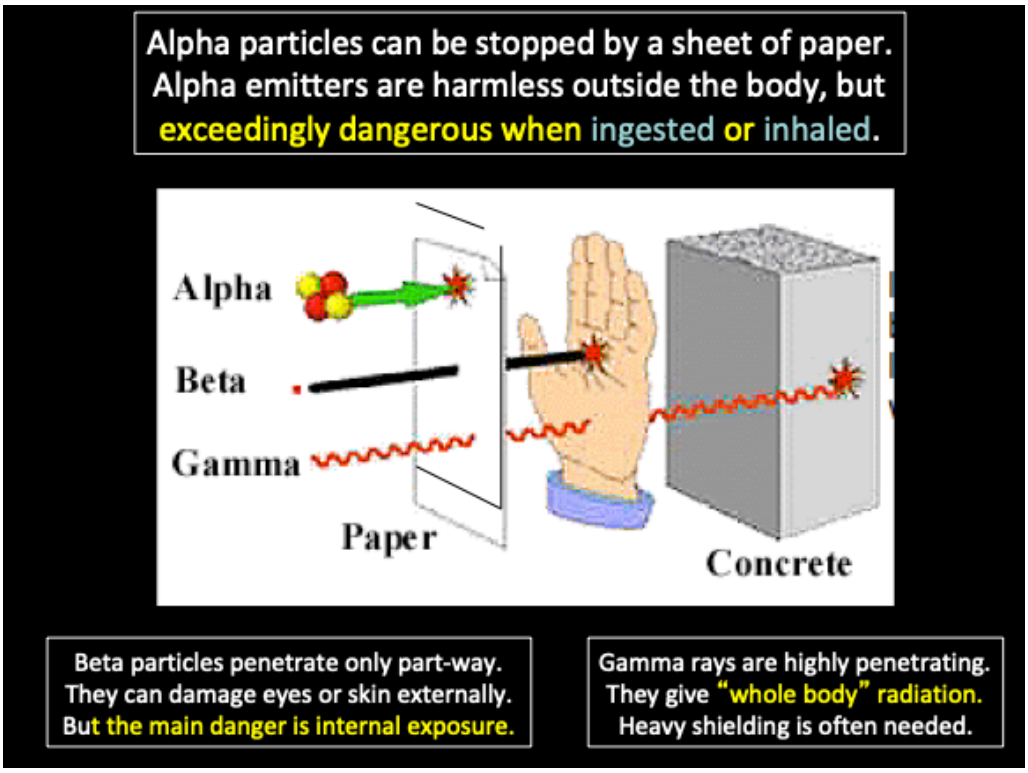

Figure 7. Alpha particles have very little penetrating power

For a given radioactive material, one becquerel indicates one radioactive disintegration per second. The half-life of a radioactive material is the time required for half of the atoms to disintegrate. For an alpha-emitter, the number of becquerels indicates the number of alpha particles that are emitted each second.

Access to Radiosensitive Tissues

Alpha emitters are extremely effective cancer-causing agents when they are in close contact with living cells. Indeed, per unit of energy deposited in tissue, alpha particles are regarded by the CNSC and other regulatory bodies to be twenty times more damaging than beta particles or gamma rays delivering the same amount of energy. The reason for this is only partly understood, but it is related to the fact that an alpha particle leaves behind an extremely dense track of broken and damaged molecules, far greater than is the case for a beta particle or a photon of gamma energy.

Nevertheless, alpha-emitting materials are generally harmless outside the body because the alpha particles they give off cannot penetrate through the dead layer of cells on the skin. This harmlessness disappears when there is a mechanism by which a particular alpha emitter can enter the body and come into contact with radiosensitive cells inside.

For radium, the most effective pathway into the body is ingestion. Drinking radium water or licking the tips of paint brushes with tiny amounts of radium-based paint on them, or contaminating hands and fingernails with minute amounts of radium, some portion of which ends up dissolved by saliva and incorporated into the body – these mechanisms contribute enough radium to the

skeletal frame of its hundreds of victims to promote extreme osteoporosis and bone cancer, while damaging the blood-forming organs in the bone marrow so as to cause acute life-threatening cases of anemia.

For radon gas, the obvious mechanism is inhalation, especially after the radioactive gas has time to accumulate a number of its pernicious radioactive byproducts called “radon progeny” – notably the alpha-emitting elements polonium-218 and polonium-214. When the toxic mix of radon gas and its progeny is inhaled, a massive dose of alpha radiation is delivered to the delicate lung tissue, causing many radiogenic lung cancers

Adding polonium-210 to a cup of tea provides an ingestion pathway that turns the tea into a murder weapon. Inhaling polonium-210 along with the smoke from a burning cigarette guarantees that the alpha-emitting material is deposited in the deepest parts of the lung. Some polonium-210 even crosses the blood-air barrier to introduce the alpha-emitting material into the bloodstream. Some researchers hypothesize that minute amounts of polonium-210 found in the arterial plaque of smokers during autopsies may play an important role in causing the otherwise unexplained elevated incidence of cardiovascular diseases among smokers.

In the case of uranium, it is less obvious how a large dose of alpha radiation can be delivered to radiosensitive tissues inside the body. Because of the extremely long half-life of uranium, alpha particles are emitted at a very slow drawn-out rate, compared with other alpha emitters having shorter half-lives. Uranium is less likely to be absorbed through the gut and is often in a chemical or physical form that prevents entry into the deepest parts of the lung or facilitates fairly rapid clearance from the body – soluble compounds, for example.

However, the minute highly insoluble uranium dioxide particulates that are continuously emitted into the air from the BWXT pelleting operation enables inhalation to act as an extraordinarily effective means for pulling one particular alpha emitter – uranium – into the most radiosensitive pulmonary regions.

Due to the extremely small diameters of the almost perfectly spherical BWXT particulates, specks of uranium oxide dust are able to lodge in the lung tissue. And, because of their insoluble nature, the particulates, once lodged, can remain in place for a very long time – many years or even a lifetime – providing a "body burden" to the individual who inhaled the dust. The internal bombardment of the lung tissues with alpha particles will continue as long as the particulate is lodged.

> "The distribution and retention of uranium in the body after inhalation of an aerosol depends critically on the aerodynamic size of the particulates and on their solubility in biological fluids. Inhalation of insoluble compounds is associated with uranium retention in lung tissue…"
>
> *US National Academy of Sciences, BEIR-IV, Health Risks of Radon and Other Internally-deposited Alpha-emitters, p.14*

There are hundreds of children currently attending Prince of Wales Elementary School. They have no choice but to be there day after day, possibly for years, right across the street from the plant that will be emitting enormous numbers of these invisible specks of insoluble radioactive dust into the air, if the CNSC approves the requested licence condition that would allow BWXT management to implement the pelleting operation in Peterborough at will.

Due to an unfortunate incident in 2009 during the Bruce Power refurbishment, over 500 local tradesmen inhaled alpha-emitting dust over a period of several weeks, but at least they were paid for the job. These hundreds of children enjoy no benefits whatsoever from their unnecessary exposure to alpha-emitting dust.

Ionizing Radiation and Calculation of Absorbed Dose

The biological damage done by alpha particles is caused by random breaking or damaging of thousands of chemical bonds that hold molecules together as the alpha particle blazes its way through the surrounding medium before coming to rest. When a molecular bond is broken or damaged, the fragments left behind are electrically charged objects called “ions”.

Scientific measurements have demonstrated that a single alpha particle travelling through air will create over 10,000 different “ion pairs”. Similarly, when an alpha particle traverses through soft bodily tissues, thousands of ion pairs are created and many organic molecules are damaged, including DNA molecules.

Damage to a DNA molecule can result in a cell with altered genetic instructions that is nevertheless still able to reproduce. Such a crippled cell may become the precursor of a cancer many years or decades later, giving rise to a growing colony of clones that constitutes a malignant growth, a cancer that threatens to destroy the host.

Cancer induction happens only rarely, as most radiation-damaged cells are killed or unable to reproduce; thus not every exposed individual will develop cancer. Radiogenic cancer induction is a stochastic or random event, affecting only a probabilistically-determined fraction of those individuals exposed. Larger doses result in greater probability, lesser doses correspond to reduced probability. However, no exposed individual is immune from suffering such a fate: cancer is always a possible end-point from exposure to internally emitted alpha particles.

All types of atomic radiation – including alpha particles, beta particles and gamma rays – are forms of "ionizing radiation" because they all create ion pairs and break molecular bonds. X-rays are included in this category also, for it too is an ionizing agent.

Extensive scientific evidence has shown that exposure of a sizable population to a sufficient amount of ionizing radiation will produce an excess of cancers as a result of DNA damage. These extra cancers are said to be "radiogenic".

However there is a delay of several years before radiogenic cancers begin to be seen. This delay is called the "latency period"; it depends on the type of cancer as well as other factors.

In the case of lung cancer, the "latency period" following exposure to ionizing radiation, before radiogenic cancers begin to be seen, is about twenty years. Once that minimum latency period has expired, new radiogenic cancers continue to appear year after year even if all the individuals were exposed to the same degree of ionizing radiation at more or less the same time. The British Columbia Medical Association describes the situation for atomic workers:

> "Risk of lung cancer from radiation, although beginning after several years of employment, continues many years past termination of employment; thus a gradually flowering crop of cancers grows larger each year."
>
> *Health Dangers of Uranium Mining, BCMA, 1980*

To get a handle on the likelihood of cancer induction, we use a scientifically defined unit called the "gray". It provides a measure of how much ionization is taking place in given amount of living tissue. Specifically, it corresponds to the

total amount of ionizing energy (measured in joules) divided by the mass of living tissue that absorbs all of that ionizing energy (measured in kilograms).

In the context of the proposed BWXT-Peterborough pelleting operation, any affected individual will have to have inhaled one or more specks of uranium dioxide particulate into his or her lungs. Being insoluble, such a particulate will lodge in place for months or years.

For purposes of discussion we calculate the absorbed dose due to a uranium dioxide particulate residing in lung tissue for one year for two separate cases
(1) for a one-micron diameter particulate
(2) for a two-micron diameter particulate.

Some of the details of the calculation are indicated in Table 5 below. To obtain a conservative result (one which tends to underestimate rather than overestimate the true value) we assume that the range of an alpha particle emitted by the particulate is 30 microns (it is somewhat less than that because the energy of an alpha particle given off by uranium is less than 5 MeV).

For a one-micron particulate residing in place for one year, the absorbed dose to the surrounding small volume of tissue (radius 30 microns) is 22.5 milligrays (mGy), and for a two-micron particulate it is 142 milligrays (mGy).

Alpha exposures normally are considered to be 20 times as biologically effective as the equivalent exposures from beta or gamma radiation, so the quantities calculated here and cited above correspond to 450 mGy of beta/gamma exposure for a one-micron speck and 2,840 mGy of beta/gamma exposure for a two-micron speck.

These are very large doses of absorbed radiation, albeit confined to extremely small regions of the lung. If they were whole-body doses they would be unacceptable, way beyond the regulatory limits even for atomic workers. The comparison however is not helpful – for interpreting the biological consequences of internal irradiation is still a very arcane and controversial subject.

The maximum annual exposure to whole-body radiation for an atomic worker in Canada is 50 millisieverts (equivalent to 50 milligrays of gamma radiation), and for a member of the public it is 1 millisievert (equivalet to 1 milligray of gamma radiation).

Nevertheless, it is undeniable that some portions of the lung are heavily irradiated. There is no reason to doubt that such alpha exposures are capable of triggering the creation of one or more precancerous cell, leading to a full-blown lung cancer decades later. This statement is consistent with the prevailing view of the monoclonal origin of cancer, that a single cell can be and usually is progenitor of such a malignancy. But even so, many that are exposed will never contract cancer as a result of that exposure; it depends on the DNA damage.

Particulate Diameter	Particulate Volume	Mass of Uranium	Ionizing Energy	Mass of Tissue	Absorbed dose	Beta dose equivalent
	cm cubed	grams	ergs	grams	milligrays	milligrays
1 micron	5.2 E-13	4.7 E-12	2.54 E-5	1.13 E-7	22.5 mGy	450 mGy
2 microns	4.2 E12	2.98 E-11	1.61 E-4	1.13 E-7	142 mGy	2,840 mGy

Table 4. Calculation of absorbed dose assuming an alpha range of 30 microns in soft tissue

Because of the extremely long half-life of uranium and the fact that the alpha particles given off by uranium are not as energetic as those from other well-known alpha-emitters, it is clear that the number of ionizations will be correspondingly less and so the number of cancers caused will also be less.

Statistics may be too coarse an instrument to reveal the truth. There are relatively few people exposed to breathing insoluble uranium dioxide particles.

It would be a fallacy to conclude that people are not being killed simply because the number of extra deaths are not statistically significant. For example, even a mass murderer is unlikely to alter the mortality statistics for a population – even while people are being murdered. Similarly, it may be that people are suffering from radiogenic lung cancer caused by uranium exposure, but not in large enough numbers to register as a statistically significant increment.

The situation is complicated by many additional factors – the long latency period for lung cancer, requiring decades of follow-up time; the almost impossible job of estimating exposures accurately; and the extra radio-sensitivity as well as the unusual breathing patterns of children. Science and ethics both suggest that there is no room for complacency on these matters.

The Need for Justification

The fundamental principle underlying radiation protection is that all unnecessary exposures to ionizing radiation should be eliminated or prevented, and where that is not possible, exposures should be limited and kept as low as reasonably achievable (ALARA). Meeting regulatory standards is no substitute for the option of eliminating exposures altogether.

> "For practical reasons, the ICRP adopted in the 1950s a linear no threshold (LNT) dose-response relationship, a model indicating that there will be some risk even at low doses, that has served as a base for radiation protection regulations. While the debate over the effects of low level radiation is still contentious and unsettled, the sole application of

> permissible limits to the inferred risks is, until presently, considered not enough, and a system based on the general principles of justification, optimization and dose limits is required to protect individuals, society as a whole and the environment."
>
> *ICRP, General Principles of Radiation Protection*
> *https://link.springer.com/chapter/10.1007/978-3-319-42671-6_11*

The potential exposure of young children attending Prince of Wales Elementary School to significant increases in the amounts of respirable uranium dioxide dust can be prevented simply by not granting prior approval to the commencement of pelleting across the street at the BWXT-Peterborough plant.

The precautionary principle indicates that we should not presume to take chances when there is the possibility of an unacceptable outcome for some individuals and no justification for approving the project that spawns that outcome.

Indeed, no justification of any kind has been offered for commencing pelleting at BWXT-Peterborough. The only mainstream customer for unenriched uranium fuel pellets produced by BWXT appears to be, at present, Ontario Power Generation, to provide fuel for use in OPG's Pickering and Darlington reactors.

The six operating Pickering reactors will be shut down permanently in the foreseeable future, perhaps by 2024 or 2025, leaving only the four Darlington reactors in operation. That drops the number of CANDU reactors in question from ten down to four. During refurbishment of the four reactors at the Darlington nuclear plant, that power station will also have a temporarily reduced demand for new fuel bundles. The CANDU market will be sharply reduced.

Since all Small Modular Nuclear Reactors (SMRs) use enriched fuel, there are no prospects for new business for BWXT on that score. In short there is no perceptible need for a second pelleting operation.

CNSC is being asked to approve a licence condition simply to suit the convenience of BWXT management, while possibly subjecting Peterborough schoolchildren to unnecessary and preventable radioactive exposures that may produce a lifetime body burden of alpha-emitting materials in their lungs.

One of the principles of radiation protection is that all unnecessary exposures to ionizing radiation should be prevented. It is not sufficient to meet arbitrarily imposed standards of radiation exposure. Any exposure to additional levels of ionizing radiation requires a detailed justification designed to demonstrate that the advantages to those being exposed, or to society at large, clearly outweigh any risks that may be involved. Failing such justification the additional exposure should not be allowed to take place.

It is entirely within the competence of BWXT to rent or build additional structures to house a second pelleting operation, removed from built-up residential areas and far away from playgrounds and schools that are used by small children.

Accordingly we reiterate the main recommendation of this report:

***Recommendation**. The Commissioners are urged not to approve the special pelleting provision in the BWXT licencing application, thereby preventing and eliminating all future routine exposures of hundreds of schoolchildren at Prince of Wales elementary school to elevated levels of respirable particulates of uranium dioxide dust in the $PM_{2.5}$ category as a result of pelleting at BWXT-Peterborough.*

Siting a Nuclear Facility on the Doorstep of an Elementary School

It is not clear whether existing CNSC regulations would preclude the siting of a brand new Class 1 Nuclear Facility right on the doorstep of an elementary school, given that hundreds of schoolchildren might be subjected routinely to small but unnecessary and entirely preventable exposures to radioactive contaminants and other toxic effluents from such a facility.

In fact, the Commissioners are not legally bound to grant a licence, even if staff unanimously recommends it, when the Commissioners themselves remain unconvinced that granting such a licence may be inconsistent with the primary legal obligation to prevent unreasonable risk to persons and to the environment.

This question is not merely academic, but apropos to the case at hand. BWXT is, in a very offhand way, proposing to locate a brand new Class 1 nuclear facility right across the street from the Prince of Wales Elementary School. It will of course be co-located with the existing facility, but entirely different in the details of its operation – requiring a large tank of liquified hydrogen gas, drums of fine uranium dioxide powder delivered and stored on site, sharply increased emissions of uranium oxide dust into the air and water, powerful pellet-forming presses, and ovens for baking ceramics in a hydrogen gas atmosphere. None of these characteristics is evident at BWXT currently. There is virtually no overlap between the materials and processes presently utilized at BWXT- Peterborough for the assembly of fuel bundles, and the entire suite of other materials and processes needed for pelleting.

The pelleting operation will significantly increase the potential for onsite emergencies to occur at the BWXT-Peterborough because of fire and explosion possibilities associated with materials that do not now exist at this site.

Hydrogen is a highly flammable gas, much more combustible than gasoline. Under adverse circumstance it is capable of producing violent explosions when mixed with air in a wide variety of concentrations. Uranium dioxide powder is also combustible and can spontaneously catch fire in certain instances. As the US Nuclear Regulatory Commission warned:

> The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the potential for fires involving uranium dioxide (UO2) powder at various stages of transfer and conversion….
>
> It has been common experience that unstable uranium oxide feed material (comprised mostly of UO2, with a few other oxide forms present) in granulated form and in contact with oxygen undergoes exothermic oxidation reactions. In some cases, the heat generated by the reactions ignites combustible elements of the transfer passages or other powder handling equipment ….
>
> Information Notice No. 92-14: Uranium Oxide Fires at Fuel Cycle Facilities
> https://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1992/in92014.html

And, referring to one particular incident of a uranium dioxide powder fire:

> All of the combustible elements in the containment between the hammermill and the slugger press (e.g., the Viton hose and the Neoprene boot, as well as the Lexan parts of the containment housing) were consumed by the fire. The primary HEPA filters were extensively damaged. The secondary filters, however, were intact….
>
> Information Notice No. 92-14: Uranium Oxide Fires at Fuel Cycle Facilities
> https://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1992/in92014.html

Due to the presence of an elementary school across the street, emergency planning may be seriously compromised. The students no doubt know how to vacate the school premises in the event of a fire drill, but is this the best thing for

them to do if the air if filled with fine uranium dioxide dust resulting from burst drums of uranium powder or inoperative HEPA filters?

The school authorities may not have the necessary equipment nor the training needed to escort some 600 children away from the vicinity of the plant in a rapid and orderly fashion. Mothers and other relatives and friends are likely to converge on the school property to locate and rescue their children, thereby heading directly towards the site of the accident instead of away from it as prudence would normally dictate.

Indeed, since many of the mothers of these young children will still be of child-bearing age, there may be several cases of pregnant women visiting the school on a nearly daily basis and becoming exposed to the fine respirable uranium oxide particulates from the pelleting operation, not only at the school grounds but in laundering the clothes of their school-age children that may contain such particulates lodged in the fibres of the cloth. Uranium oxide powder will be readily resuspended in the air at home by simply shaking out the children's clothes prior to laundering.

Conclusion

According to the Nuclear Safety and Control Act, the CNSC was formed for the purpose of serving Canadians and the Government of Canada, and not for the purpose of acting for the convenience of the industry. Do not approve the licence condition that would allow pelleting at Peterborough. Any other decision would be, in effect, granting BWXT a licence to pollute.

~ fin ~

Annex A: Letter to the editor of the Peterborough Examiner, Jan 28 2020

28 January 2020

Dear Editor,

We are a group of scientists who reside in the neighborhoods around BWXT, and we would like to draw your attention to the results of the Independent Environmental Monitoring Program conducted by the Canadian Nuclear Safety Commission and published on their website on January 22, 2020.

We are concerned because concentrations of the heavy metal beryllium (Be), which is used in the BWXT production process, have steadily and significantly increased in soil samples taken in the vicinity of BWXT since recording began in 2014. The clear increase of Be in soil samples is likely being driven by significant increases in air concentrations, which is particularly worrying because beryllium can be toxic if inhaled. More worryingly, the highest values of beryllium in 2019 were found in the samples in the Prince of Wales school playground. Although none of these samples have reached the threshold at which intervention is mandated, the increase alone mandates intervention and further evaluation to ascertain the source.

BWXT responsibly monitors the outputs of the production process to detect pollutants such as beryllium and has indicated that their outputs are at or near zero. This statement is inconsistent with the publicly available results of CNSC's environmental monitoring program that shows, clearly and unambiguously, that beryllium concentrations are increasing.

Given the accumulation of Be in soils, it seems inappropriate to discuss an unrestricted licence renewal (or extension) before establishing the source of this contaminant. The only reasonable course of action is to request that, prior to any licensing agreement, the cause of this increase in Be be identified so that it can be stopped.

Yours sincerely,

Julian Aherne, PhD
James Conolly, PhD
Gary Burness, PhD
Peter Lafleur, PhD
Erica Nol, PhD
Mark Parnis, PhD