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Oral Presentation

Exposé oral

Written submission from Anna Tilman

Mémoire de Anna Tilman

In the Matter of the

À l'égard de

BWXT Nuclear Energy Canada Inc., Toronto and Peterborough Facilities

BWXT Nuclear Energy Canada Inc., installations de Toronto et Peterborough

Application for the renewal of the licence for Toronto and Peterborough facilities

Demande de renouvellement du permis pour les installations de Toronto et Peterborough

Commission Public Hearing

Audience publique de la Commission

March 2 to 6, 2020

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Submission to the Canadian Nuclear Safety Commission (CNSC)

with respect to

BWXT Nuclear Energy Canada Inc.'s Application for Renewal of its Class 1B Operating Licence for a 10-year period

January 30, 2020

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BWTX LICENCE RENEWAL APPLICATION REQUEST

INTRODUCTORY REMARKS

The current Nuclear Fuel Facility Operating Licence (FFOL-3620.01/2020) issued by the Canadian Nuclear Safety Commission (CNSC) to BWXT Nuclear Energy Canada Inc. (NEC) authorizes it to operate and modify its nuclear fuel facility to produce natural and depleted Uranium Dioxide (UO_2) pellets in Toronto at 1025 Lansdowne Avenue; and to produce and test fuel bundles in Peterborough at 1160 Monaghan Road. The Peterborough facility is also authorized to receive, repair, modify and return contaminated equipment from off-site nuclear facilities. Both facilities have been in operation since 1965.

Prior to the pellet plant operations at the Toronto facility, General Electric (GE) had operated an industrial facility at this site since 1905, in an area which at that time and for many years was an industrial area, close to a major railway line.

The Toronto facility is located in a mixed industrial commercial and residential area in west-central Toronto. The Peterborough facility is also located in a mixed industrial, commercial, and residential area in west-central Peterborough.

Over the years, the population in these areas has increased and become more dense, and the surrounding area has altered to become far more residential. Over the past decade or so, the Toronto area has experienced a large influx of new residents.

While years ago, there was a lack of awareness of what the plant was actually producing, that is no longer the case. The local community has been raising several concerns about the operations at the plant for well over a decade. Residents have expressed concerns over uranium emissions to air, deposition to soil, the potential health effects, especially on children, and the transportation of uranium dioxide powder and pellets through their community, as well as other issues related to health and safety.

The buildings in both these facilities are over 55 years old. They process and store highly dangerous materials. The Toronto facility consists of two buildings, one of which houses uranium dioxide pellet manufacturing (and some office space). The other is used for storing uranium dioxide as miscellaneous scrap awaiting reprocessing or shipment for disposal, compaction of waste, and decontamination activities. The Peterborough facility, which consists of 4 buildings, also houses processing facilities and stores contaminated material.

The production of fuel pellets and bundles requires a lot of transportation: powdered UO_2 is shipped from Cameco's Port Hope Conversion facility to the BWXT facility in Toronto. The pellets are shipped from Toronto to Peterborough which produces fuel bundles. Some of the pellets are also shipped to a facility in the U.S. The fuel bundles manufactured at the Peterborough facility are shipped to its customers (the Pickering and Darlington Nuclear Stations). The transportation of such hazardous goods is an ongoing concern to the local communities, and rightly so.

If an emergency should arise and there were a need to evacuate, given the location, residential intensification, traffic issues, etc., in Toronto, how effective could it be?

Is it rational or equitable to permit facilities such as BWXT to operate in these highly populated areas for decades and allow them to continue their operations and process even more UO_2 pellets than the current level for yet another decade?

Beyond the complex and dangerous processing operations that take place at these facilities in producing pellets and assembling them in bundles, the Peterborough facility is also authorized to receive, repair, modify and return contaminated equipment from off-site nuclear facilities and the Toronto facility is permitted to store uranium dioxide as miscellaneous scrap.

There is no question that these facilities emit hazardous substances continuously to air, water and soil and have done so for decades. For example, uranium dioxide is highly flammable, and can ignite upon coming into contact with air. Beryllium is a known carcinogen. Exposure to these dangerous substances is a major concern, both to workers at these facilities and to the local community.

The emissions from these facilities are not just a daily, monthly or yearly event, but are continuous and cumulative. To presume that there are no adverse effects on the environment or health of the residents and the workers who are in very close contact with toxic uranium-laden material and other toxic substances is unconscionable.

Additionally, the all too evident discrepancy between actual (monitored) emissions and these limits and the regulatory limits and guidelines for these facilities established by the CNSC, and guidelines is extremely disconcerting. It is very doubtful that such permissive limits can provide the necessary protection and safeguards for the workers and local communities, especially in the long term.

At this stage, the discussion about these two facilities should be about their closure and decommissioning, which will be enormous tasks in themselves. A 10-year licence renewal should definitely not be considered.

OVERVIEW OF BWXT'S LICENCE REQUEST

BWXT NEC's current 10-year licence was granted on January 1, 2011, and expires on December 31, 2020. It was amended on December 16, 2016 to reflect the transfer from GE-Hitachi to BWXT NEC.

BWXT NEC has submitted an application to the CNSC for a 10-year renewal of its licence which is based on its current possession and processing limits of Uranium:

- Possess up to a maximum of 700 Mg (700,000 kg) of Uranium at the Toronto facility in any form at any given time;
- Possess up to a maximum of 1500 Mg (1,500,000 kg) of Uranium at the Peterborough facility in any form at any given time; and
- Shall not process more than 150 Mg (150,000 kg) of Uranium at each facility in any form in any calendar month.

The difference in allowable limits between the two facilities is in the amount permitted for possession of Uranium.

Other differences include:

- The production of Uranium Dioxide (UO_2) pellets is carried out only at the Toronto facility.
- The Peterborough facility is authorized to receive, repair, modify and return contaminated equipment from off-site nuclear facilities.

In its re-licensing application, BWXT is requesting the approval of a revised financial guarantee, and authorization to conduct pelleting operations at the Peterborough facility.

No changes have been requested to its operations or possession and processing limits at either facility. Nor is BWXT requesting changes to the footprint of the Peterborough facility. The requested to allow for the production of pellets at the Peterborough facility lies within the current licensed operating limits.

THE CHAIN OF NUCLEAR FUEL PRODUCTION

i) From UO_2 powder to pellets to fuel bundles

Cameco's Port Hope Uranium Conversion facility is the source of natural and depleted ceramic grade UO_2 powder for the manufacturing of pellets at BWXT. The UO_2 powder is transported by road from Port Hope to the Toronto facility in Type 1 industrial packages, in accordance with the *Packaging and Transportation of Nuclear Substances Regulations*.

Once received at the Toronto facility, the UO_2 powder is transferred to special containers to be mixed with a lubricating agent (zinc stearate). This mixture is then processed by pressing the UO_2 powder into "slugs" which are then granulated to a free-flowing powder. This powder is then pressed into solid cylindrical pellets. The solid pellets are sintered in a high temperature furnace under a hydrogen atmosphere, and ground to the required dimensions. Finally, the pellets are stacked, sorted and inspected for quality and contamination before being transported to the Peterborough facility.[1]

BWXT NEC also ships pellets to the U.S. (GE Nuclear Energy, Wilmington, N.C.) for use in Boiling Water (BWR) commercial power reactors.[2] There is no indication in either the CNSC staff report or in BWXT's re-licence application as to the quantity of pellets manufactured at the Toronto facility nor the quantity shipped to the plant in North Carolina, nor any information as to how long the shipments to the U.S. have been going on.

At the Peterborough Facility, fuel manufacturing operations involve inserting the fuel pellets into Zircalloy tubes, sealing, and welding the tubes, and machining the ends of these tubes to produce fuel elements which are then assembled into fuel bundles. Beryllium coated spacers are welded to the tubes to facilitate the assembly of the fuel bundles.

The completed bundles are inspected for quality, packaged, and transported in approved packaging to Ontario Power Generation's Pickering and Darlington nuclear generating stations.

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[1] CNSC CMD 20-H2 CNSC p. 3,4
[2] BWXT Application CMD 20-H2.1 p.7

BWXT manufactures the Zircalloy tubes in-house. This manufacturing involves sub-operations that coat the tubes with graphite. Beryllium coated spacers are welded to the tubes to facilitate the assembly of the fuel bundles.[3]

The Peterborough facility also includes a reactor services business which involves designing, commissioning, servicing and repairing nuclear reactor components associated with reactor maintenance, fuel loading, and reactor inspections/testing.

In addition, contaminated equipment from off-site nuclear facilities is periodically received at the Peterborough facility for repair and/or modification.

The activities at both facilities have remained the same throughout the current licence period with some modifications to increase automation and improve the control of air emissions.

ii) Comments/Questions

<u>Natural and depleted UO_2:</u>

With respect to the use of depleted UO_2, the Fuel Service Division of the Cameco facility states that "New UO_2 powder may be combined with reprocessed material before it is pre-compacted, granulated and blended using conventional powder processing techniques."[4]

While that may explain the reference throughout both BWXT and CNSC documents to natural and depleted uranium dioxide, there is no indication whether the reprocessed material used by Cameco is depleted uranium dioxide powder.

There is also no indication as to the relative amounts of depleted UO_2 compared to natural UO_2 used in the manufacturing of pellets.
This matter needs clarification.

<u>Production and Possession of Uranium:</u>

No information has been provided as to the quantities of UO_2 actually processed at either facility or the actual amounts possessed. Nor has any information been provided as to the quantity of UO_2 that would be used at the Peterborough facility for the proposed manufacturing of pellets.

- Why has the Peterborough facility been permitted to possess more than double the amount of Uranium than what is permitted for the Toronto facility?
- Can the company request an increase in the amounts of UO_2 possessed and/or processed during its licence period in order to maintain its proposed production?
- While the "footprint" of the Peterborough facility is not proposed to be changed, surely adjustments would have to be to the facility in order to produce pellets. This is not just a routine operation. Surely one would expect modifications to be made to this facility.

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[3] CNSC CMD 20-H2 p.4

[4] Reference: Cameco Fuel Services Division Technical Reports | Safety Report |March 2018 p.3

Why is this matter not clarified or addressed by either the CNSC staff or BWXT in its licence submission request?

Contaminated materials on site:

- With respect to the Toronto facility, what amount of UO_2 is contained in this miscellaneous scrap material? What is the destination of this material? How much (what portion) of this material is re-used, re-processed, or decontaminated? Where would this type of work be carried out?
- What is the nature (contents) of the contaminated equipment shipped to the Peterborough facility?

The market for UO_2 pellets:

Currently, and for the past licence period, pellets produced at the Toronto facility are sintered and packaged for shipment to the Peterborough facility for fuel assembly for CANDU reactors at the Pickering and Darlington nuclear stations. BWXT also ships pellets to the US for use in Boiling Water Reactors.[5] As indicated in its BWXT's Licence Renewal Request Document, this shipment goes to GE Nuclear Energy (Wilmington, North Carolina).

- There is no indication of the quantity of pellets shipped to the Pickering and Darlington stations.
- What portion of the pellets produced by the Toronto facility is shipped to the U.S.?
- Bruce Power, with 8 reactors, does not get its fuel bundles from this facility. The Pickering facility is due to shut down by 2024. This would definitely affect the market for pellets and fuel bundles for CANDUs. So where is the market? Why would an additional pellet facility (at Peterborough) be needed?
- Why is BWXT requesting to introduce pellet production at its Peterborough facility for this licence period, while maintaining production at the Toronto facility?

At this stage, we need to ask basic questions and get definitive answers:

- What will be the impact of the proposed pellet manufacturing activity at Peterborough?
- What testing has been done for contamination re soil, vegetation, water, etc. over the years? Is there any baseline data available for comparison?
- What emergency measures above all, evacuation of residents are in place, and have been tested. At what distance from the facility will such measures be carried out?
- Why, given their age, location, and nature of the work being done, is these facilities still allowed to continue to operate?
- When will these facilities be shut down and decommissioned?

[5] BWXT CMD 20-H2.1 p.7

REGULATORY LIMITS AND GUIDELINES

i) Derived Release Limits (DRLs)

DRLs are regulatory limits imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility. DRLs are the legal upper bounds for releases of radioactive substances to the environment. The DRL represents the quantity of a radionuclide that, if released from the specified facility, would result in the most exposed member of the public receiving a dose equal to the specified dose objective (i.e., regulatory public dose limit or specified dose constraint).

Calculations of DRLs by the CNSC are derived from exposure-pathway modelling from the source of release to a "representative person". DRLs translate dose constraints into site-specific levels.[6] In some cases, the dose constraints are 1 mSv/yr or 50 µSv per year.

The CNSC uses models, rather than monitoring actual emissions, as a basis for regulatory action. Dose estimates for air emissions are based upon assumptions about the behaviour of stack plumes, which are notoriously difficult to model.

There is a great disparity, in many cases orders of magnitude, between reported or monitored emissions of radionuclides to air and water and discharges in effluent, and the regulated limits and action levels established by CNSC for nuclear facilities. For the most part, nuclear facilities actually emit only a few percent of the ALs or regulated limits, such as DRLs. As a result, these limits do not restrict the amounts of radionuclides and other hazardous substances emitted into air, water, and soil.

The methods for calculating such limits (DRLs, AL's, etc.) do not and cannot take into account for the cumulative effects of doses that occur over a number of years, and thus ignore the accumulation of radionuclides in the environment and in individuals. As a result, they are not effective as regulatory tools.

Such limits do not minimize the risk of adverse health effects due to radiation exposure, but set a bar that at least recognizes that exposure to radiation is harmful.

Nuclear licensees and the CNSC typically report emissions as percentages of regulated limits. This can give the public the impression that because the percentages are low, the emissions are not significant.

ii) Action Levels (ALs)

The CNSC requires licensees to determine action levels (AL) to serve as an early warning system to indicate when releases from a regulated facility may be deviating from the norm. While ALs are typically lower (that is, more stringent) than release limits, there is no legal requirement for a facility to take action when these levels are approached or exceeded. It is only required that exceedances of ALs be reported to the CNSC.

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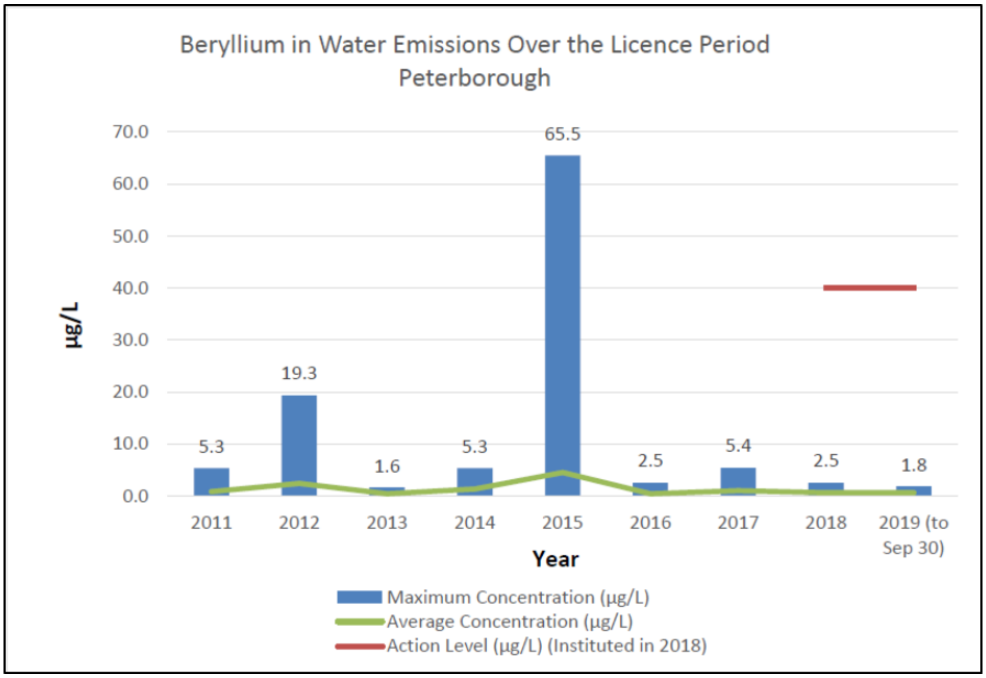
[6] The methodology for establishing DRLs comes from the Canadian Standards Association (CSA) standard CSA N288.1-08: *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities.*

As noted in the CNSC Discussion Paper, *Process for Establishing Release Limits and Action Levels at Nuclear Facilities*, the methodology for calculating and applying ALs for nuclear and hazardous substances across all licensed nuclear facilities has not always been consistent. The CNSC proposed that a standardized methodology for calculating and applying ALs for environmental protection be established, and be statistically based on predicted performance (for new facilities) or on actual operating performance.[7] To this date, it is not evident that the methodology has changed.

With respect to the facilities at BWXT, the two main substances and their emissions to air, water, and land that are monitored and reported on are Uranium and Beryllium.

The following graphs are examples that indicate the disparity between monitored results and Action Levels at the two facilities.

Fig.1 Beryllium Concentration in Water (µg/L) Emissions -2011 to 2019[8]



The Action Level is 40µg/L. For the year 2015, the maximum concentration is 65.6 µg/L while the average concentration is approximately 4µg/L. Can this be explained?

This graph also points out the impact of averaging emissions. Averages mask the necessary detail that would demonstrate anomalies.

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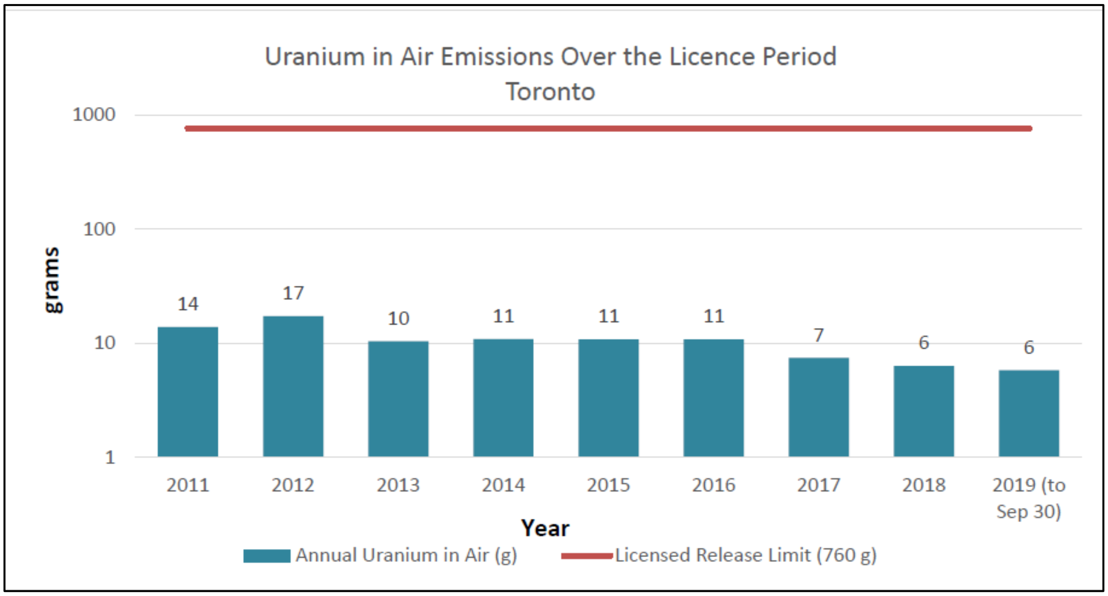
[7] Reference to CNSC Discussion paper: (DIS-12-02 CNSC, February 2012)http://nuclearsafety.gc.ca/eng/acts-and-regulations/consultation/history/dis-12-02.cfm

[8] BWXT CMD =H2.1 p. 37

Fig. 2 Toronto Uranium Emissions[9]



Note that the y-axis is a logarithmic scale in order to demonstrate the license limit of 760 g.

The following table provides another example of the difference between regulated licence limits and the actual results. It provides the licence limits for these two facilities and the Uranium concentrations of liquid effluent (kg/year) discharged to the sanitary sewers in Toronto and Peterborough.[10]

Parameter	Toronto	Peterborough
Licence Limit (FLOL)	**9,000**	**760**
2011	1.0	0.00010
2012	0.90	0.00010
2013	0.83	0.00020
2014	0.72	0.00014
2015	0.39	0.00006
2016	0.65	0.00013
2017	0.94	0.00003
2018	0.94	0.00001

Effluent releases are several orders of magnitude below the FLOLs during this period.
This raises the question as to the relevance of such limits, and of course, raises serious doubt as to their effectiveness.

In conclusion, if regulated limits do not provide any confidence that these facilities are being subject to the necessary scrutiny, how can the public be confident that the effluents pose no risk to the public?

[9] Ibid p. 38
[10] CNSC CMD20-H2 p. 20-21 Table 3.3

EVENT REPORTS

A number of reportable (unplanned) events have occurred at BWXT during its current licence period.[11] BWXT's licence application document cites 6 events, while the CNSC document cites 22 events. This discrepancy makes it awkward for a member of the public to track such events and even try to figure out why there is this glaring difference. For example: the CNSC provides the following table for the number of events that have occurred during the years 2011-2019.

Table 3: Number of reported events by BWXT (2010-2019) – CNSC Document

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total	0	1	1	2	3	4	5	3	3

On the other hand, BWXT's licence request submission cites 6 reportable events as follows:

1) In 2015, a sprinkler pipe burst in the unheated warehouse on the licensed site in Toronto. During an unusually cold month that winter, condensation build-up in the normally dry piping system froze and expanded enough to break open the piping, releasing the hold back pressure allowing the system to accidentally activate.

2) In 2017, a sprinkler head accidentally activated after it was re-installed too close to the Furnace 2 exit door flame after overhead renovation work completion at BWXT NEC's Toronto licensed facility. Corrective and preventive actions were implemented to address the situation.

3) In 2017 at the Toronto licensed facility, a small hydrogen gas leak on Furnace 5 occurred at a union coupling causing a 15 cm flame that lasted three-to-four minutes at the location of the leak and did not propagate to other materials. The flame was extinguished by shutting off the gas supply using the emergency stop button. Corrective and preventive actions were implemented across all furnaces.

4) In 2017 at the Peterborough Fuel Assembly Operation, incorrect Powdered Air Purifying Respirator (PAPR) respirator filters were discovered in use and in stores. As a result, an investigation was initiated and corrective actions implemented.

5) In August of 2018, the region of Toronto surrounding the BWXT NEC Toronto facility lost electrical power for a period of approximately 16 hours. The power outage coincided with a period of heavy rainfall at the plant location. Due to the protracted power outage BWXT NEC opted to manage the event under its Emergency Plan and activated its Emergency Organization, notified the CNSC, and BWXT NEC personnel managed surface water entering the basement of the building. Water was contained to the interior of Building 7 and was collected and processed in accordance with normal water treatment practices through the Building's Water Effluent Treatment System. All treated and released water met the normal release criteria.

[11] CMD H-2.1 p 16,17

6) In 2019, a personal air sample for an operator in the Beryllium area was above the Occupational Exposure Limit. Subsequent investigation showed that the ventilation system needed adjustment, and it was upgraded to increase the capture efficiency which was effective.

"CNSC staff issued a request to BWXT under subsection 12(2) of the GNSCR to review the licensee's operations for improvements taken, or to be taken, to minimize beryllium air concentrations in the affected work areas in the future. CNSC staff also conducted an unplanned, reactive inspection in response to the event, which confirmed that BWXT responded to the event as per requirements, and that the root causes and associated corrective actions taken were appropriate."[12]

Referring back to the CNSC Document, in which 22 events were indicated during BWXT's licence period, some information is provided on only one event and this event was not included in BWXT's re-licensing submission document.

This reportable event pertained to a beryllium occupational exposure limit exceedance that occurred in August 2017 and was reported by CNSC staff to the Commission in October 2017. [13] This event was the result of the discovery that BWXT personnel were using incorrect respirator cartridges/filters in the powered air purifying respirators while performing non-routine work at the Peterborough facility. BWXT submitted a final event report that included the root causes and the corrective actions taken to prevent a recurrence of this type of event.[14]

CNSC staff issued a request to BWXT to review the licensee's operations for improvements taken, or to be taken, to minimize beryllium air concentrations in the affected work areas in the future. CNSC staff also conducted an unplanned, reactive inspection which confirmed that BWXT had responded to the event as per requirements and that the root causes and associated corrective actions taken were appropriate.

Comments and Questions

- Firstly, what is the explanation for this vast difference in the number of reportable events between BWXT and CNSC staff?
- Secondly, why are these events not being succinctly described in the licence's document or/and CNSC's document?

The lack of information, or even missing information, demonstrates a clear lack of public disclosure to so-called events or accidents at these facilities. While some events may seem to be less important than others, it should not be the purview of the licensee or the licensor to disclose or not disclose this information clearly and publicly. This is one of the many reasons why the public are very concerned, and rightly so, about these operations, and very skeptical of the company and the regulator.

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[12] CNSC CMD H-2 p. 22

[13] Reported as an Event Initial Report (EIR) in CMD 17-M53 and in the *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities in Canada: 2017* [7]. CNSC doc: CMD H-2 Environmental Protection Review Report

[14] CMD 20 H-2: e-Doc 5963958 (Word) - 1 - 20 December 2019 e-Doc 6032464 (PDF) P. 21-22

RADIATION PROTECTION – NUCLEAR ENERGY WORKERS (NEWS)

i) Equivalent Dose Exposure – Extremities and Skin

The language of radiation dose limits is complex. While values such a 1 mSv/year as the protective dose for the public are generally used, and 50 mSv/year with a maximum of 100 mSv over 5 consecutive years for NEWs, these limits are denoted as effective dose levels, to distinguish them from what is referred to as the equivalent dose.

The equivalent dose accounts only for the types of radiation absorbed (alpha, beta, gamma), whereas the effective dose uses the equivalent dose weighted to take into account estimates of the susceptibilities of different organs and tissues. The factors assigned to the various tissues and organs are not precisely determined, but are estimates of the relative susceptibility of the different organs to radiation damage. For example, the doses range from 0.12 for gonads, 0.12 for lung, colon, stomach, bone marrow; 0.05 for bladder, breast , liver, thyroid to 0.01 for skin and bone surfaces.[15]

The CNSC uses both effective and equivalent doses as regulatory limits. While the effective dose is primarily used in assessing worker and public dose, the CNSC uses a maximum equivalent extremity and skin dose limit of 500 Sv/year at uranium processing facilities, including Cameco's Fuel manufacturing facility and BWXT (formerly GE Hitachi) facilities (Toronto and Peterborough).

BWXT NEC has established facility-specific CNSC approved Action Levels (ALs) for various radiological and environmental parameters. An Action Level is defined as "a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program, and triggers a requirement for specific action to be taken."[16]

Although Action Levels are set below regulatory limits, exceeding an Action Level is a CNSC reportable event. BWXT NEC must notify the Commission within 24 hours of becoming aware that an Action Level has been exceeded.

At BWXT's facilities, the two areas most likely to be exposed to radiation and most sensitive to it are extremities (hand, arm, etc.) and skin, particularly at the Toronto facility.

The highest maximum extremity dose recorded to date is 357.29 mSv for a worker at the GE Hitachi Toronto facility in 2012. In describing this incident in its staff report, CNSC stated that

> "A worker at the GEH-C Toronto facility exceeded the annual extremity dose action level of 350 mSv, receiving an annual extremity dose of 357 mSv, which represents 71 percent of the regulatory annual equivalent dose limit of 500 mSv and well within levels known to cause health effects."

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[15] For example, if an individual's stomach and bladder are exposed to radiation of 100 mSv (equivalent dose) each, the effective dose is 100 x 0.12 + 100 x 0.05 = 17 mSv.

[16] CMD H2.1 p. 23-24

Unfortunately, that comment does little to alleviate concerns about receiving such a high dose of radiation.

From 2008-2012, the maximum dose levels ranged from 139 mSv to the 357.29 mSv at the Toronto facility. It is not known what these levels were prior to that period.

ii) Action Levels

The current Action Levels for Skin and Extremity doses for NEWs at the two BWXT facilities are as follows:[17]

i) Peterborough

	Period	Action Level (mSv)
Skin Dose	1 year	100
Extremity dose	1 year	200

ii) Toronto

	Period	Action level (mSv)
Skin Dose	1 year	350
Extremity dose	1 year	350

The greater Action Levels at the Toronto facility are presumably due to its production of pellets.

Both of these Action Levels are inordinately and unacceptably high, as is the regulatory annual limit of 500 mSv. In reality, they are allowable or permissible levels, if they were significantly lowered, the type of work involved could possibly not be done.

- If the Commission approves BWXT's request for the Peterborough facility to produce pellets, would the Action Levels for that facility change to be aligned with the Toronto facility?
- Are the dose limits and action levels set for production purposes for health protection?
- Will workers be required to have additional protection against radiation, and/or reduced working time to avoid this exposure?
- Is there an inherent assumption by CNSC staff that extremities (and/or skin) are the only tissues of concern? If so, this requires explanation.
- What safeguards are used to protect against and/or prevent such exposure?
- Are workers being fully informed of the heightened risks involved in the production of pellets?
- What follow-up, if any, is provided for the workers exposed at such levels? Are workers obliged to continue to work on pellet production etc., especially if their exposure levels have already been elevated?

These concerns contribute to the need to reject BWXT's proposal to allow pellet production at the Peterborough facility. They should also lead to a thorough investigation of such exposures at the Toronto facility as well as a review of both the Regulated Limits and Action Levels, as neither would appear to be protective.

[17] CMD-H2.1 p. 24

HEALTH EFFECTS – URANIUM

i) Overview

Uranium has special properties, not only as a highly toxic heavy metal, but also as a naturally-occurring radioactive substance. As it decays, uranium constantly generates several other radioactive elements (referred to as daughters, or progeny) such as thorium, polonium, radium and radon, and finally becomes a stable isotope of lead, all of which are highly toxic. Uranium, the parent radionuclide, is always accompanied by its highly toxic progeny. It is never alone in nature, or in any processing, or in the production of nuclear energy.

Throughout the decay chain, alpha and beta particles are constantly emitted, as well as gamma rays. Such radiation at low levels poses well-known risks to human health (cancers, genetic mutations, mental retardation, etc.) and to ecosystems. Because uranium and its decay products always occur together, it is essential to consider their cumulative effects.

ii) Environmental Transport and the Ultimate Fate of Uranium

Refining and processing of uranium and uranium compounds, such as Uranium Dioxide (UO_2), results in releases of uranium dust (particulate matter containing uranium) into the air, water and soil. This dust is much finer than natural uranium dust. It is easily inhalable and readily transported to vulnerable tissues of the body, including the brain and lungs. Because these particulates are so small, they move about randomly in the air and can also be transported far from their source. Once deposited on land, this dust can be re-suspended in the atmosphere by wind.

Inevitably, uranium dust deposited onto soil and surface water will leach into groundwater. It can migrate large distances in surface water. It can also be deposited directly onto vegetation and absorbed through foliage or be taken up by plant root systems and thereby gain entry into the human food chain.

The very long half-life of uranium assures its presence in air, land and soil for a very long time. For that reason, uranium causes harm for just as long as stable heavy metals that are developmental and neurological toxins, such as mercury, thallium and lead.[18]

iii) Toxicity of Uranium

Uranium poses a hazard through various routes of exposure: inhalation, ingestion and dermal contact. It is both radiologically and chemically toxic. If inhaled or ingested, its radioactivity poses increased risks of lung cancer and bone cancer. It may also affect reproduction and the developing foetus, and increase the risk of leukemia and soft tissue cancers.

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[18] The half-life of uranium-238 is about 4.47 billion years and that of uranium-235 is 704 million years. The only known uranium compound to degrade in the atmosphere is Uranium hexafluoride (UF) which rapidly hydrolyzes to uranyl fluoride (particulate) and hydrofluoric gas in air.

Uranium has been identified as a renal toxic metal, exerting its toxic effects by accumulation in the renal proximal tubules of the kidney, potentially resulting in kidney dysfunction, cellular necrosis and atrophy of the tubular wall.[19]

When inhaled, uranium is completely absorbed in the body. Insoluble uranium is scavenged into thoracic lymph nodes and can cause lymphoma or other radiation-related illnesses.

Children, the fertilized ovum, the foetus, newborn, women (especially if pregnant), the immune-compromised, and the elderly are especially vulnerable to the health effects of uranium and its radioactive progeny.

There is no threshold below which ionizing radiation from uranium does no harm, particularly for the most sensitive populations (women, children, and the foetus).[20] Any ionizing radiation can damage genes. Exposures at low doses may affect the ability of cells to repair themselves before being hit with a second dose of radiation. Each time a dose of radiation is received, the ability to repair is further damaged.

Additional factors and health issues resulting from exposure to uranium include:

- Uranium binds tightly to DNA, leading to genotoxic, carcinogenic, mutagenic and teratogenic effects to human health and to ecosystems.
- Effects of uranium exposure may be synergistic, increasing the harmful effects of toxic chemicals and other heavy metals.
- If the dose of radiation is reduced, it is presumed that the effects on the kidney are reduced. But this is not the case with cancer.
- While harmful effects on lungs and kidney are the primary focus of its toxicity, other organs of the body are also affected.
- The immune system may be suppressed.
- The daughter isotopes of U238/235 (e.g. Polonium, Radon) are primarily alpha emitters, and many times more biologically damaging than Uranium itself when ingested.

Health Canada has stated in Documents on Uranium in Drinking Water, (2017 and 2019), that "The epidemiological evidence does not convincingly demonstrate an increased risk of cancer following uranium exposure (IARC, 1999, Lane et al., 2011)." [21]

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[19] Ontario Air Standards for Uranium and Uranium Compounds, June 2011 (Chapter 5.1 etc. p.15)

[20] References: Rosalie Bertell: problems associated with low-level radiation underestimated (mutations in children) http://iicph.org/docs; J.W... Gofman: *Radiation-Induced Cancer from Low-dose* (Committee for Nuclear Responsibility PO Box 11207, San Francisco CA 94101and others). J.Gould and B.Goldman on low-level radiation *Deadly Deceit,* (Four Walls Eight Windows Press Box 548, Village Station New York NY 10015)

[21] Health Canada: Uranium in Drinking Water - Document for Public Consultation 2017 p. 38, 39 https://www.canada.ca/content/dam/hc-sc/documents/programs/consultation-uranium-drinking-water/consultation-uranium-drinking-water-eng.pdf; and Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Uranium May 2019 www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html

The International Agency for Research on Cancer (IARC) and the U. S. Environmental Protection Agency (US EPA) and other such agencies, have not classified uranium with regard to its carcinogenicity due to "insufficient evidence and the inability to isolate confounding factors".[22]

The International Commission on Radiological Protection *(*ICRP*)* has applied models that do not take into account exposures at the cellular level. Its models are based on kidney burden, and ignore the neurological and pulmonary effects of inhaled uranium.

However, since uranium is radioactive, occupational agencies assume it to be a confirmed or potential carcinogen based on the fact that in general, the US EPA considers all emitters of ionizing radiation to be Class A carcinogens as well as mutagens and teratogens.
Not classifying uranium and its compounds as carcinogens is a complete abdication of the responsibility of government bodies to protect human health and the environment. Instead, the nuclear industry is being sheltered and subsidized, and hides behind excuses like "confounding factors" and "insufficient evidence". It is an absolute scientific certainty that radioactive atoms can cause cancer when they are ingested into the body.

BERYLLIUM – TOXICITY

Beryllium is a health and safety issue for workers. Exposure to beryllium in the workplace can lead to a sensitization immune response and can over time develop "chronic beryllium disease" (CBD), a chronic life-threatening allergic disease. The toxicity of finely divided beryllium (dust or powder, mainly encountered in industrial settings where beryllium is produced or machined) is very well-documented. The International Agency for Research on Cancer (IARC) lists beryllium and beryllium compounds as Category 1 carcinogens.[23]

Inhalation of dust or fumes contaminated with beryllium, whether it is large amounts over a short time or small amounts over a long time, can lead to CBD. Symptoms of the disease can take up to five years to develop. Its use and prevention necessitates appropriate dust control equipment and industrial controls at all times.

Workers handling finished beryllium pieces are routinely advised to handle them with gloves, both as a precaution and because many if not most applications of beryllium cannot tolerate residue from skin contact.

In addition to causing CBD, because beryllium is chemically similar to magnesium it can displace it from enzymes, causing them to malfunction. Its ionic form (Be^{2+}) is a highly charged and small ion which can easily gain access into many tissues and cells where it specifically targets cell nuclei, inhibiting many enzymes including those used for synthesizing DNA. Its toxicity is exacerbated by the fact that the body has no means to control beryllium levels. Once inside the body the beryllium cannot be removed.

[22] Ibid p.27
[23] https://en.wikipedia.org/wiki/List_of_IARC_Group_1_Agents_-_Carcinogenic_to_humans

BWXT manufactures the zircalloy tubes in-house at the Peterborough facility. This manufacturing involves sub-operations that coat the tubes with graphite. Beryllium-coated spacers are welded to the tubes to facilitate the assembly of the fuel bundles.

According to the CNSC document, CMD 20-H2, p.6, “Releases of non-nuclear hazardous substances, like beryllium, from the facility into the environment is controlled, in accordance with the requirements prescribed in the Certificates of Approval for air emissions issued by the Ministry of the Environment, Conservation and Parks and CNSC regulatory requirements.”[24]

The CNSC document cited above (p. 39) also notes that:

> A potential chemical hazard related to the Peterborough facility operation is worker exposure to beryllium. Engineered controls (room ventilation), safe work procedures, protective clothing and the use of full-face respirators as PPE control this hazard. To ensure worker safety, the room where the operations takes place is monitored through area monitors and personal air monitors. CNSC staff verify through compliance activities that the above procedures and controls are in place and ensure worker safety for routine work in the facility.
>
> For non-routine work, or high-risk activities, such as cleaning, maintenance and spillage handling, when airborne beryllium levels are expected to be above the occupational exposure level, work is performed under a work permit system. This includes the identification of hazards, appropriate training and the use of PPE like Powered Air Purifying Respirators with cartridges/filters specific for the type of hazard present.

CNSC staff are satisfied with the BWXT’s past performance in the Conventional Health and Safety SCA and that BWXT continues to meet regulatory expectations.

However, there have been issues related to worker exposure to beryllium at the Peterborough facility. For example;[25]

> One event arising out of the conduct of licensed activity was the beryllium occupational exposure limit exceedances reported in August 2017 by BWXT. This reportable event was the result of the discovery that BWXT personnel were using incorrect respirator cartridges/filters in the powered air purifying respirators while performing non-routine work at the Peterborough facility.
>
> CNSC staff reported this event to the Commission in October 2017 as an EIR in CMD 17-M53 and in the *Regulatory Oversight Report for Uranium and Nuclear Substance Processing Facilities in Canada: 2017* [7]. BWXT submitted a final event report that included the root causes and the corrective actions taken to prevent a recurrence of this type of event. CNSC staff conducted a compliance inspection in response to the beryllium occupational exposure limit exceedance event reported.

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[24] CMD 20-H2 p.6, p. 39

[25] CMD H-2 Beryllium - Event reports and other issues re exposure p. 14, 17-18 ,20,39,41

This raises questions as to how well informed the workers are (whether full or part-time) on their exposure to beryllium. The type of diseases related to such exposure may be latent, and thus not necessarily attributed to beryllium when they occur.

As noted in BWXT's submission, there have been releases of Beryllium to water well beyond the "action level" set by the CNSC, and a notable increase in emissions to air for the year 2015. There is no explanation for such releases, or exceedances.[26]

The US Occupational Safety and Health Administration (OSHA) has designated a permissible exposure limit (PEL) in the workplace at a time-weighted average (TWA) of 2 $\mu g/m^3$ and a constant exposure limit of 5 $\mu g/m^3$ over 30 minutes, with a maximum peak limit of 25 $\mu g/m^3$. The National Institute for Occupational Safety and Health (NIOSH) has set a recommended exposure limit (REL) of constant 500 ng/m^3. The IDLH (immediately dangerous to life and health) value is 4 mg/m^3.

What are the comparable values in Canada?

CONCLUDING REMARKS, RECOMMENDATIONS

The two BWXT facilities have been operating for over five decades. Both facilities are in mixed commercial and residential areas. The Toronto facility is in a highly populated area.

It is strongly recommended that the Commission reject BWXT's 10-year licence request, in particular the request to manufacture pellets at the Peterborough facility. It is definitely not in the public interest, or in the interest of the affected communities, in Toronto and Peterborough, whose water, land, air, and terrestrial habitat would be put at risk.

The company has not made any case for the need to manufacture pellets at its Peterborough plant. There is no indication of a thriving market for more pellets.

There are many gaps in BWXT's re-licensing submission that we have tried to identify in our submission. These gaps and uncertainties raise questions which require clarification, but the clarification is not to be found. The CNSC regulations do not give comfort or confidence that these facilities are not harming the health and environment of the area in which they are located or the health of the workers.

Closure will involve dangers and be very difficult. The sites will have to be "cleaned up", which will take years. Delaying closure is only increasing the level of contamination, and the risks of exposure to hazardous substances to workers and the communities.

In all conscience, the wisest path for CNSC to follow is to reject BWXT's 10-year licence request, including the manufacturing of pellets at Peterborough, and grant the company a licence for a much shorter period to prepare for the closure of both facilities. Within that period, BWXT must be required to prepare a full and detailed decommissioning plan, including costs. The plan must be subject to expert review, with public input and a full public review.

More than enough damage has been done over a very long period. Closure is the only way to prevent more harm.

[26] BWXT Submission CMD H-2.1 p. 37