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Oral Presentation

Written submission from the Port Hope Community Health Concerns Committee

In the Matter of the

Cameco Fuel Manufacturing Inc.

Application to Renew the Class IB Nuclear Fuel Facility Licence for Cameco Fuel Manufacturing Inc. in Port Hope, Ontario

Commission Public Hearing

November 23-24, 2022

Exposé oral

Mémoire du Port Hope Community Health Concerns Committee

À l'égard de

Cameco Fuel Manufacturing Inc.

Demande de renouvellement du permis d'exploitation de l'installation de combustible nucléaire de catégorie IB pour Cameco Fuel Manufacturing Inc. à Port Hope (Ontario)

Audience publique de la Commission

23 et 24 novembre 2022

Canada

Part 1 : Submission prepared by Dr. Gordon Edwards

Part 2: Submission prepared by Faye More

Health Implications of re-licencing the Cameco Fuel Manufacturing Plant

By Gordon Edwards, Ph.D.

a report commissioned by

The Port Hope Community Health Concerns Committee (PHCHCC)

Submitted to the Canadian Nuclear Safety Commission

For scheduled relicencing hearings

November 23 & 24 2022

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QUESTIONS FOR CNSC

The Port Hope Community Health Concerns Committee (PHCHCC) would appreciate receiving written responses to these questions:

QUESTION A. Does CNSC have the power to deny a given site to a proponent or licensee on the grounds that it is seen by the community as representing an unreasonable risk to the physical and mental health of that community, provided that the community's objections can be substantiated?

QUESTION B. In choosing a site for a nuclear facility, does CNSC have any power or incentive to insist that the proponent consider alternative sites in addition to the proponents's preferred site? In particular, is there any CNSC requirement for the proponent to choose a site that will keep the "population dose" as low as reasonably achievable, even if all the CNSC regulations are otherwise met?

QUESTION C: Does the CNSC hold to the Linear No Threshold model of radiation carcinogensis, implying there is no proven safe level of exposure to ionizing radiation?

QUESTION D: What is the exact procedure by which CNSC determines which risks are reasonable, and how is the public involved in that procedure?

QUESTION E: Is the reasonableness of a given risk determined in a science-based manner, and if so, what are the precise criteria that are used?

QUESTION F: Is the reasonableness of risk defined by the proponent? by CNSC staff? or by a unanimous or majority decision of the Commissioners?

Purpose of This Report

The present report was prepared for the Port Hope Community Health Concerns Committee (PHCHCC) – henceforth referred to as the Health Committee. The author is Gordon Edwards whose Curriculum Vitae is posted on line.

The Health Committee is opposed to the proposed re-licencing of the Cameco Fuel Manufacturing Plant (CFM) for a 20-year period. During those two decades, if it were allowed, the plant would continue to expose the citizens of Port Hope to ever-increasing levels of respirable uranium dust. Uranium belongs to a class of known carcinogens, as it is an alpha-emitting radioactive heavy metal. The members of the Health Committee find it repugnant that the citizens of Port Hope should continue to be exposed to the risk of inhaling radioactive particulates for another entire generation, and they want it stopped.

In short, the Health Committee is opposed to the continued operation of this plant at its current location for any longer than is absolutely necessary. The Canadian Nuclear Safety Commission (CNSC) has, as its primary mandate, to prevent unreasonable risk to the health and safety of persons and the environment. The Committee wishes to assure the CNSC that CFM does represent an unreasonable risk and must no longer be tolerated. The CNSC has no legal madate to act in the interests of industry and should not do so. The Committee is therefore reaching out to the CNSC to help its members rid their community of this wholly preventable risk.

The town of Port Hope has suffered from decades of radioactive and toxic contamination, a tragic situation that was neglected for far too long. At the present time a $1.2 billion “cleanup” is underway that promises to consolidate over one million cubic metres of radioactive and chemically toxic waste into a gigantic earthen mound situated just about three kilometres northwest of the town centre. The Committee believes that a thorough radioactive and toxic cleanup should also involve relocating the polluting industries and not just moving the waste materials..

This report is focussed on an examination of the scientific facts and regulatory practices related to the first two recommendations of the PHCHCC as articulated by Faye More, president of the Health Committee, in her written submission dated October 7 2022.:

> *1. Cameco's request for a 20 year license term for the nuclear facility CFM with a 24% production increase involving natural, depleted and enriched uranium must be rejected by the Commission as unreasonable, unjustified and unacceptable in a community setting with no buffer zone whatsoever.*
>
> *2. A two year license should be issued to Cameco Corporation for this facility with the condition that within this two year time period, Cameco will prepare and submit a plan to the CNSC, relevant government departments, the municipality and the public by December 31, 2024 to fully decommission all of its sites, including CFM, within the boundaries of Port Hope.*

QUESTION A. Does CNSC have the power to deny a given site to a proponent or licensee on the grounds that it is seen by the community as representing an unreasonable risk to the physical and mental health of that community, provided that the community's objections can be substantiated?

The Health Committee has been informed that CNSC has a "non-prescriptive" regulatory philosophy. According to some interpretations, it is said that such a philosophy allows the proponent to choose any site it wishes for a new facility, and the CNSC will grant a licence for such a facility on the chosen site as long as a safety case can be made by the proponent that will persuade the Commission that all of its relevant regulations can and will be met. Is this true?

1. Eliminating Carcinogens from Living Spaces

The members of the Health Committee believe that the siting of a massive and polluting nuclear facility such as CFM in the midst of a quiet residential and retirement community such as Port Hope is a historical accident that needs to be corrected. Committee

members aspire, quite simply, to live in a healthy community that is not constantly subjected to unnecessary, unavoidable, unrelenting exposure to known carcinogens. The Committee believes there is no justification for siting the CFM facility where it is now located. If it were a new facility, it would likely not be approved. Or would it?

QUESTION B. In choosing a site for a nuclear facility, does CNSC have any power or incentive to insist that the proponent consider alternative sites in addition to the proponents's preferred site? In particular, is there any CNSC requirement for the proponent to choose a site that will keep the "population dose" as low as reasonably achievable, even if all the CNSC regulations are otherwise met?

This aspiration of the Health Committee is in keeping with a general trend in our society, fully supported by medical science, to eliminate from our living environment all preventable exposures to carcinogenic materials.

For example, asbestos has been banned from automobile brake linings. Without such a ban, every time a car's brakes are applied many invisible respirable asbestos fibers may be released into the air, each one capable of scarring the lungs and possibly triggering a crippling case of mesothelioma in someone who breathes it in. The law does not seek to reduce or limit the asbestos content to an "acceptable" level, but to ban it altogether. There is no scientific evidence suggesting there is any safe level of asbestos inhalation.

As another example, cigarette smoking is banned in restaurants, theatres, airplanes, and many other public places. Scientific evidence has demonstrated convincingly that smoking causes lung cancer, despite decades of denial and disinformation from cigarette manufacturers. Scientific evidence has shown that second-hand smoke is carcinogenic too. Banning smoking in public places is a science-based public health policy. The object is not to determine a permissible level of cigarette smoking, or to establish a regulatory limit on how much second-hand smoke should be allowed, but to ban it altogether.

Science has established that the incidence of cancers caused by a particular carcinogen within an exposed population is roughly proportional to the average dose of the individuals in that population. Cut the dose in half, and half as many people will get cancer. The cancers are no different whether the dose was large or small. Reducing the exposure only reduces the number of cases, but not the severity of each case.

Proportionality implies that the only safe exposure is zero exposure. While it is impossible to test proporotionality down to the very lowest levels of exposure, there are good scientific reasons to act on the assumption that no safe level of exposure exists. It is also, evidently, the most prudent course of action in light of the precautionary principle.

A carcinogen can effect changes in an individual cell that allow that cell to reproduce abnormally, with damaged DNA instructions, sometimes developing into a diagnosable cancer years later. The disease is usually due to a single cell being damaged – as attestified by the monoclonal nature of cancerous tissues. That being the case, it does not matter so much if the dose to the whole body is great or small, what matters most is the nature of the damage done to that one individual cell. And that precise damage is largely a matter of chance, reflecting the observably stochastic nature of carcinogenesis.

In 1977, Dr. David Bates – then Dean of the McGill Medical Faculty, susbequently Chairman of the 1980 British Columbia Royal Commission of Inquiry into Uranium Mining – wrote a report entitled “Policies and Poisons” for the Science Council of Canada. (Science Council Report #28, https://tinyurl.com/3zamxtht) He wrote, “The impact of collective exposure to the broad spectrum of toxic substances ***at or below the permissible levels at which each is viewed as safe*** demands serious consideration…. I feel that, in view of the preceding, we must develop ***a preventive rather than simply a reactive strategy*** as regards hazardous substances. For far too long the cost to human life and health of industrial technologies has either been hidden or generally ignored.“ [emphasis added]

QUESTION C: Does the CNSC hold to the Linear No Threshold model of radiation carcinogensis, implying there is no proven safe level of exposure to ionizing radiation?

Uranium is a Carcinogen

Uranium is an alpha-emitting radionuclide. Alpha-emitters are harmless outside the body but are especially harmful inside the body, when in close contact with radiosensitive tissue. Radon gas, radium, polonium, thorium and plutonium are all examples of alpha-emitters that are well-documented human carcinogens.

All alpha particles are identical in nature, regardless of the alpha-emitting material that is the source of those highly energetic ionizing projectiles. When an alpha particle comes to rest it is simply a helium nucleus, consisting of two protons and two neutrons bound tightly together. But when it is emitted from the nucleus of a radioactive atom it has enormous energy, measured in "millions of electron-volts", or MeV. An alpha particle given off by a uranium atom has an energy of about 4.2 MeV, and has a range of less than 30 microns in soft tissue. It can't do any biological harm unless it is very close to iiving tissue, without any obstruction.

The International Agency for Cancer Research (IARC), operating under the aegis of the World Health Organization (WHO), says this about alpha-emitting materials:

> "Internalized radionuclides that emit alpha-particles are *carcinogenic to humans (Group 1).* In making this overall evaluation, the Working Group took into consideration the following:
>
> "• Alpha-particles emitted by radionuclides, irrespective of their source, produce the same pattern of secondary ionizations, and the same pattern of localized damage to biological molecules, including DNA. These effects, observed *in vitro*, include DNA double-strand breaks, chromosomal aberrations, gene mutations, and cell transformation.
>
> "• All radionuclides that emit alpha-particles and that have been adequately studied, including radon-222 and its decay products, have been shown to cause cancer in humans and in experimental animals.
>
> "• Alpha-particles emitted by radionuclides, irrespective of their source, have been shown to cause chromosomal aberrations in circulating lymphocytes and gene mutations in humans *in vivo*.
>
> "• The evidence from studies in humans and experimental animals suggests that similar doses to the same tissues — for example lung cells or bone surfaces — from alpha-particles emitted during the decay of different radionuclides produce the same types of non-neoplastic effects and cancers."

IARC Monograph 100D-9 (2012) p.275
https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100D-9.pdf

This statement clarifies the basic scientific fact that all alpha-emitters are human carcinogens when they are internalized. This is because all alpha particles do the same kind of damage to living cells – random damage involving DNA molecules that in some cases results in cancer many years later. But some are much more potent carcinogens than others.

Given the very short range of alpha particles in soft tissue, the fundamental consideration becomes how close the alpha-emitting material is able to come to radiosensitive tissues. The dangers from some of the more infamous alpha emitters like radon, radium, polonium, plutonium and thorium, have been very well-documented – in large part because sizable populations have been exposed internally to these materials, through breathing (radon), ingesting (radium), smoking (polonium), medical injections (thorium), machining of nuclear weapons components (plutonium), or absorption through cuts and wounds (laboratory work). In many cases there have been methodologies in place to estimate with reasonable accuracy the exposures of the people involved, and good follow-up procedures to record the numbers of cancers that occur decades after those exposures have taken place.

Inhaling Uranium Dust

For uranium (and some other alpha emitters, like plutonium) the inhalation pathway is far more dangerous to human health than the ingestion pathway. This point was made clearly in 2010, when the Ontario Ministry of the Environment published its Rationale Document, in the context of setting a standard for human exposure to uranium in air. “For a given uranium intake, the inhalation pathway gives doses 200 times greater than ingestion.” (See https://www.ontariocanada.com/registry/view.do?postingId=2063)

In CMD 22-H12, CNSC staff gives a table (Table 9, page 54) showing atmospheric releases of uranium dust to the air from the CFM plant on an annual basis. The total amount of uranium dioxide released annually through the HEPA filters on the stacks ranges from 4 grams to 30 grams, while emissions through the bag filters on the building exhaust ventilation system are much greater, by factors of 30 to 272 times greater.

Because the HEPA filters are very efficient at removing the larger dust particles and preventing them from entering the atmosphere, stack emissions consist of particularly minute particulates, invisibly small.

Table 9: Total uranium discharged to the air from CFM in kilograms compared with applicable release limit (2012 – 2021)

	Release limit (kg/yr)[a]	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total uranium discharge through stacks (kg/year)	14	0.02	0.03	0.01	0.01	0.03	0.01	0.01	0.004	0.01	0.01
Total uranium discharge through building exhaust ventilation (kg/year)		0.57	0.48	0.40	0.45	0.70	0.57	1.25	1.09	0.92	0.89

[a] The current atmospheric release limit, effective March 01, 2022, is 10.5 kg U/yr, as discussed later in this section.

Each particulate emitted from the stack is so small in diameter that, if inhaled, it can travel to the deepest and most sensitive regions of the lung. Such a tiny radioactive speck, being made of highly insoluble uranium dioxide, can lodge in the lung for a very long time, delivering a large cumulative dose of alpha radiation to a tiny volume of lung tissue.

In addition, some of the smallest-diameter particulates (less than 0.5 microns in diameter) can cross the oxygen-blood barrier and enter the bloodstream, thereby spreading microscopic motes of radioactive material through the circulatory system, some of them being carried directly to the brain on their first pass through the aorta.

In CMD 22-H12, CNSC staff claims that “potential risks to human health are indistinguishable to health outcomes in the general public.” [p.10] Here, and elsewhere, CNSC staff implies that there is no evidence of any adverse health consequences in Port Hope despite these persistent radioactive emissions and exposures. In doing so, however, staff members are turning a blind eye to CNSC’s own published findings on the matter.

In the CNSC staff's "Synthesis Report" entitled "Understanding Health Studies and Risk Assessments Conducted in the Port Hope Community from the 1950s to the Present" it is noted that there is a statistically significant excess of both lung cancers [p.III] and circulatory illnesses, particularly heart attacks [p.IV], in Port Hope, compared with the Ontario population as a whole. The Synthesis Report also notes an unexplained excess of brain cancer in Port Hope [p.42, Table 9], although it is implied, somewhat naively, that the excess is not statistically significant.

These organs – the lungs, the heart, and the brain – are precisely the organs that would be expected to be most impacted by the continual and prolonged inhalation of radioactive aerosols. To quote the US Centre for Disease Control, "The definition of an aerosol, as used here, is a suspension of tiny particles or droplets in the air, such as dusts, mists, or fumes." (https://www.cdc.gov/niosh/topics/aerosols/default.html) .

Galaxies of Particulates

The ventilation exhaust emissions are much greater than the stack emissions, and the CNSC allowable limits are far greater still. Neverthekess, for the sake of argument, let's further examine the stack emissions from CFM. Simple arithmetic shows that each gram of uranium dioxide powder (density = 10.9 grams per cm^3) corresponds to about 175 billion particulates having an average diameter of one micron (one millionth of a gram). Since the mind has difficulty grasping such large numbers, suffice it to say that the number of uranium dioxide particulates emitted into the air from BWXT-Toronto – each year – is comparable to the number of stars in the Milky Way galaxy.

Since the average annual emission through the stacks is about 15 grams, the number of tiny airborne particulates is equivalent to the total number of stars in 15 gigantic galaxies. Over a period of 20 years, the number of such particulates would be equivalent to the stars in 300 galaxies! And each of those 32,500 billion particulates is, in principle, capable of causing a lung cancer if inhaled.

Particulates – Size Matters

This is an image of the tiny particulates of size PM2.5 (less than 2 1/2 microns in diameter) that are emitted by the triillions every year from the CFM Plant in Port Hope

[There are 174 billion one-micron particles per gram of UO2.]

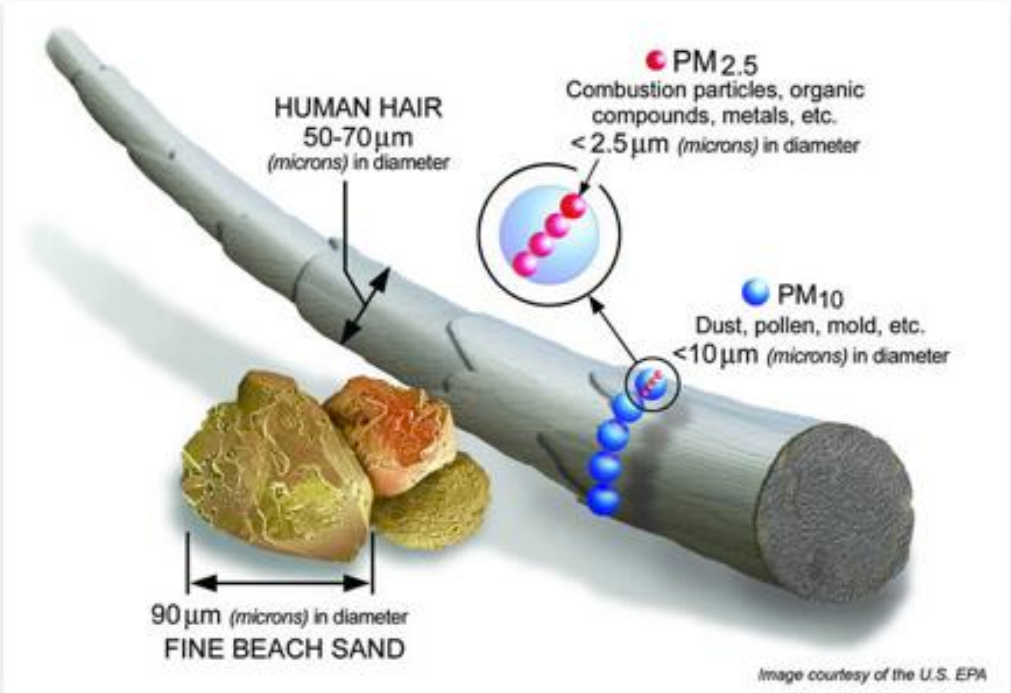
Relative Sizes

Diameter of Flour particulate 10 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



The size of uranium dioxide particulate emissions is indicated in red.

These particulates of uranium dioxide (shown in red) are much smaller than the finest human hair and can only be seen by using an electron microscope.

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*

The following photograph, taken through a microscope, shows the tracks made by the alpha particles given off by a particulate of plutonium lodged in the lung tissue of an experimental animal, irradiating a very tiny region of the lung . The tracks occurred over a 48 hour period.

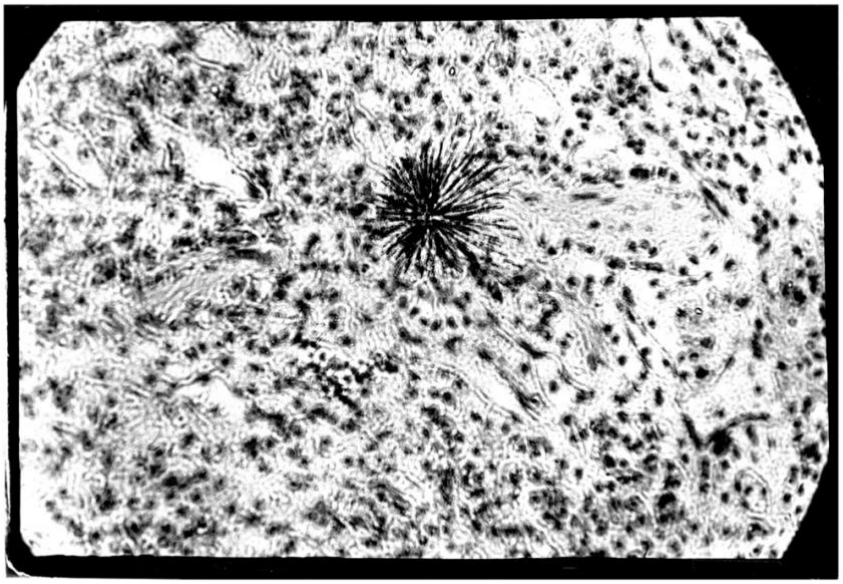


photo by Robert Del Tredici

The Principle of Justification

From the earliest days of nuclear regulation the "Linear No-Threshold" (LNT) model of radiation carcinogenesis has been adopted by regulators, including the CNSC. It is the most prudent science-based approach for the protection of workers and populations from the cancer-causing properties of ionizing radiation, which includes X-rays as well as alpha, beta, and gamma radiation from radioactive sources. "No Threshold" means no safe dose can be presumed. "Linear" means "proportional", which implies tthat the ideal exposure level (for zero risk) is "zero".

This led to the dictum that no planned exposures to ionizing radiation for workers or the public should be permitted without an explicit justfication. Such considerations led the International Commission on Radiological Protection (ICRP) to recommend as follows in their publicatioin ICRP 26 (1976). The first recommemndation has to do with justification.

> *"For the above reasons, the Commission recommends a system of dose limitation, the main features of which are as follows:*
>
> *"(a) no practice shall be adopted unless its introduction produces a positive net benefit;*
>
> *"(b) all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account; and*
>
> *"(c) the dose equivalent to individuals shall not exceed the limits recommended for the appropriate circumstances by the Commission."*
>
> *ICRP 26 (1977) p.3*
> *https://journals.sagepub.com/doi/pdf/10.1177/ANIB_1_3*

The same system of dose limitation was upheld and reinforced in ICRP 60 (1990). Moreover, the need for explicit formal justification in cases of new and existing ongoing radiation exposures was spelled out in more detail:

> *"The process of justification is required, not only when a new practice is being introduced, but also when existing practices are being reviewed in the light of new information about their efficacy or consequences. If such a review indicates that a practice could no longer be claimed to produce sufficient benefit to offset the total detriment, withdrawal of the practice should be considered. This option should be treated in the same way as the justification of a new practice, but it must be remembered that the disadvantages of withdrawing a well-established practice may be more obvious than the advantages of introducing a comparable new one*

and withdrawal of the practice may not result in the withdrawal of all the associated sources of exposure. Preventing the further extension of an existing practice that is no longer justified may sometimes be a reasonable compromise…."
https://www.icrp.org/publication.asp?id=ICRP%20Publication%2060

The German government has enshrined into law the need for a formal justification of any new radiation exposure to a previously unexposed population:

"In order to keep the risk of stochastic damage from ionising radiation as low as possible, three general principles have been set out in radiation protection for dealing with ionising radiation.

"These principles are based on recommendations from the International Commission on Radiological Protection (ICRP).

"The German Radiation Protection Act and the European Directive 2013/59/Euratom make these principles legally binding:

1. *Justification*
2. *Dose limitation*
3. *Optimisation*

"Every new application of ionising radiation or each new use of radioactive materials by man must be justified in advance. This legal requirement for justification also applies when, due to new activities, people are occupationally exposed to existing, mostly natural radiation at an increased level….

"The legal requirement for justification means that new activities are permitted only when they are associated with a reasonable benefit for the individual and for society. In this case, 'reasonable' means that the benefit outweighs any health detriment possibly caused by the activity."

Bundesamt für Strahlenschutz, Principles of Radiation Protection
https://www.bfs.de/EN/topics/ion/radiation-protection/introduction/principles/principles.html

The two recommendations of the Health Committee (cited on page 1 of this report) are completely consistent with the guidance of the ICRP and the 2013 Euratom Directive invoked by the German government agency Bundesamt für Strahlenschutz. Without explicit justification the CFM plant should not be licenced to continue and the process of relocating should begin without delay and with considerable pressure to act.

The European directive (https://eur-lex.europa.eu/eli/dir/2013/59/oj) is explicitly based on ICRP recommendations. It is important to note that Canada is not a member of Euratiom, but Canada does use ICRP guidance in setting radiation standards and dosimetric calculations.

Elimination as a Regulatory Goal

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.

Four years ago, the BWXT nuclear fuel fabrication plant was seeking a licence extension. At that time CNSC's Jenna Hartviksen sent an email to Jane Scott of Citizens Against Radioactive Neighbourhoods (CARN) on August 6, 2019. She wrote that the 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."

See complete email in Annex B

Ms. Hartviksen reports that CNSC safety programs are designed to "eliminate" the exposure of workers to uranium particulates if at all possible, or, if elimination is impossible, to "limit" the exposure. The same philosophy presumably should apply to the population. Public exposure to uranium dioxide particulates can be eliminated altogether only by moving the CFM out of Port Hope.

This is exactly what PHCHCC wants to achieve: public exposure to respirable particulates of uranium dioxide should be eliminated. CFM should be removed from residential areas altogether. Commissioners must to go against the advice of CNSC staff, which is to approve the licence as is, and vote to sharply limit the term of the licence to a maximum of two years with a view to allowing the licencee to make plans for moving to a new home, In the early 1980s the original uranium refinery operation at Port Hope was superceded by a new facility at Blind River. Now it is time for the CNSC to act and for the CFM facility to go.

CNSC and the Principle of Justification

The International Atomic Energy Agency (IAEA) often provides guidance on regulatory matters to its member states, including Canada. From 3 to 13 September 2019 the IAEA's Integrated Regulatory Review Service (IRRS) examined Canada's system of nuclear regulation using a team of nuclear experts from more than a dozen countries. The ensuing IRRS report noted that Canada does not explicitly include the justification principle in its legal framework, the Nuclear Safety and Control Act (NSCA), under which the CNSC is created. The justification principel is also not found in CNSC regulatory documents.

The IRRS report notes that CNSC sees its own internal determination of what it considers "acceptable risks" as an exercise of the justification priinciple. This process however has no legal basis because there is no legal definition of the word "acceptable" or the word "reasonable". Acceptable to whom, one might ask? Reasonable from whose perspective?

https://www.iaea.org/sites/default/files/documents/review-missions/irrs_canada_2019_final_report.pdf

The IRRS team suggested that the Government of Canada consider incorporating the justification principle directly into its legal framework for the regulation of radioactive emissions and exposures. In its response to the IRRS report, the government of Canada states that it does not accept this suggestion.

> "Licensing under subsection 24(4) of the NSCA fundamentally involves assessing what risks are reasonable and therefore what risks are acceptable. This discretionary decision of reasonable vs. unreasonable risk is an exercise of justification and embodies the SF-1, Principle 4 [the justification principle]."

See http://nuclearsafety.gc.ca/eng/resources/international-cooperation/irrs/canada-response-irrs-2019.cfm#sec1-2

QUESTION D: What is the exact procedure by which CNSC determines which risks are reasonable, and how is the public involved in that procedure?

QUESTION E: Is the reasonableness of a given risk determined in a science-based manner, and if so, what are the precise criteria that are used?

QUESTION F: Is the reasonableness of risk defined by the proponent? by CNSC staff? or by a unanimous or majority decision of the Commissioners?

Canada, CNSC and the IAEA

From the IRRS Report *https://www.iaea.org/sites/default/files/documents/review-missions/irrs_canada_2019_final_report.pdf*

The IRRS team noted that the Justification principle in not explicitly addressed in Canada's Nuclear Satey and Control Act (NSCA), nor in the regulations of the CNSC. The team suggested that this gap be filled.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
Observation: The national policy and strategy for safety does not explicitly mention SF-1 Principle 4: Justification of facilities and activities	
(1)	BASIS: GSR Part 1, Requirement 1, states that "The government shall establish a national policy and strategy for safety, ...to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals."
(2)	BASIS: GSR Part 1 Requirement 1, para. 2.3 states that "In the national policy and strategy, account shall be taken of the following: (a) The fundamental safety objective and the fundamental safety principles established in the Fundamental Safety Principles [1]; ..."
S1	Suggestion: The Government should consider explicitly addressing SF-1, Principle 4 (Justification) in its legal framework.

The Canadian Government's Response – Suggestion not accepted

http://nuclearsafety.gc.ca/eng/resources/international-cooperation/irrs/canada-response-irrs-2019.cfm#sec1-2

Canada's response [to Suggestion S1]

Not accepted. According to Principle 4 of the IAEA's Safety Fundamentals No. SF-1, *Fundamental Safety Principles*, **"for facilities and activities to be considered justified, the benefits that they yield must outweigh the radiation risks to which they give rise."**

Parliament has given the CNSC the statutory authority to regulate the nuclear industry in Canada…. The Commission is guided in its decision making by its mandate, as provided for in the NSCA. This mandate is, in part, to regulate the development, production and use of nuclear energy in order to prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use. Licensing under subsection 24(4) of the NSCA fundamentally involves assessing what risks are reasonable and therefore what risks are acceptable. **This discretionary decision of reasonable vs. unreasonable risk is an exercise of justification and embodies the SF-1, Principle 4.**

. . . A proponent of a designated nuclear project is required to justify that the project is the best option – in terms of socio-economics, safety (including worker safety) and protection of the public and environment. It needs to do so by explaining the purpose and need for the project, and by assessing various alternatives to the project and alternative ways of carrying out the project. **This is a sound and rigorous assessment of the justification of a project.** The results of the assessment must be considered by the Commission prior to issuing a licence. [emphasis added]

Epidemiological evidence on uranium

The epidemiological evidence of lung cancer carcinogenesis in the case of uranium dust is somewhat scanty. This is in large part due to the fact that few populations have been exposed to uranium dust in a form that is (1) sufficiently fine to be inhaled into the deepest parts of the lung and (2) so insoluble that it can lodge in the lung tissue for a long time. The residence time is important because uranium has a very long half-life and so its alpha particles are emitted much more slowly than is the case with many other alpha-emitters. On the other hand, thorium (Th-232) has an even longer half-life than uranium and yet its carcinogenic characteristics have been convincingly demonstrated.

The 2012 IARC monograph 100D-9 refers to

> "… a pooled study of seven uranium miller cohorts, [in which] a significant excess of lung cancer mortality was observed in analyses using state mortality rates as a comparison (SMR, 1.51; 95%CI: 1.19–1.89). Potential confounding by smoking, silica exposure, or other occupational hazards complicated the interpretation of these results, and these studies lacked a direct measure of cumulative exposure to uranium."
>
> IARC 100D-9 p. 261
> https://monographs.iarc.fr/wp-content/uploads/2018/06/mono100D-9.pdf

Uranium millers are involved in the crushing of uranium ore, the chemical separation of uranium from its radioactive residues (which become the tailings), and the production of yellowcake powder that is shipped in drums to a uranium refinery. It is worth noting that the particulate sizes in the case of yellowcake are often larger, and the chemical form of uranium is often more soluble, than is the case with the uranium dioxide powder used in pelleting. The finer insoluble particulates from pelleting have easier access to the radiosensitive lung tissue and the residence time is likely to be considerably longer, as soluble forms of uranium are more easily cleared from the lungs.

The same IARC monograph also reports that

> "Uranium ore dust containing 44% elemental uranium induced bronchioalveolar carcinomas, bronchial carcinomas and squamous cell carcinomas in rats by inhalation. (Mitchel *et al.*, 1999)."IARC 100D-9 p. 264

and that

> "Overall, two epidemiological cohort studies of uranium enrichment workers reported significant positive associations between the radiation dose quantified by personal dosimeters and lung cancer (McGeoghegan & Binks, 2000b; Richardson & Wing, 2006). Lung cancer risk could be caused either by external exposure to γ-radiation, or by α-particles emitted by uranium particles inhaled into the lung, or both. In addition, an excess of lung cancer mortality was observed in cohorts of mortality among uranium millers. However, these associations are not consistent across all studies, and there is the potential for confounding of these associations by smoking as well as occupational hazards other than uranium."
>
> IARC 100D-9 pp. 263-264

Since the IARC 100D-9 monograph was published, there have been newer studies that document a significant increase In human cancers from exposure to uranium. Here is a passage from a European Study published in ***Epidemiology*** on May 17 2017, entitled "Risk of lung cancer mortality in nuclear workers from internal exposure to alpha particle-emitting radionuclides", by Grellier J, Atkinson W, Bérard P, et al. The study shows that Internal exposure to alpha particles emitted by radionuclides **(**particularly plutonium and uranium) is associated with an increased risk of lung cancer mortality. The results are consistent with estimates of risk from other types of radiation and compatible with current Radiation Protection recommendations.

> "Knowledge of the long-term health effects of ionizing radiation (i.e. radiation with enough energy to break chemical bonds such as those in DNA molecules) derives mainly from populations exposed to gamma and X-rays, particularly Japanese atomic bomb survivors, and populations receiving external doses due to occupational, medical and environmental exposures.
>
> "However, very little is known about the long-term effects of low level internal exposure to alpha particles. In contrast with neutrons, gamma or X-rays, alpha particles only travel a few centimetres in air and are unable to penetrate the skin. However, they can cause serious cellular damage if ingested or inhaled**.**
>
> The goal of the study was to estimate the risk of lung cancer in populations exposed to low doses of alpha particles through inhalation. The authors conducted a case-control study of lung cancer mortality among Belgian, French and UK cohorts of uranium and plutonium workers, for which they determined individual lung doses from alpha-emitters.

> Most subjects in the study had low doses from uranium and/or plutonium. However, a dose-related increased risk of lung cancer was still observed. 'This study is the first in which individual estimates of dose have been reconstructed to estimate the risk of lung cancer mortality among European nuclear workers exposed to these radionuclides' says Elisabeth Cardis, coordinator of the study."

https://www.isglobal.org/en/-/la-inhalacion-de-particulas-alfa-emitidas-por-uranio-y-plutonio-aumenta-el-riesgo-de-cancer-pulmonar-en-trabajadores-nucleares

This European study associates, for the first time, low to moderate doses of alpha-emitters with lung cancer risk. Elisabeth Cardis**,** coordinator of the study, is Research Professor in Radiation Epidemiology at ISGlobal. Until April 2008, she was the head of the Radiation Group at IARC in Lyon, where she coordinated studies of ionising and non-ionising radiation for over 20 years.

> *"METHODS:*
> "We conducted a case-control study, nested within Belgian, French, and UK cohorts of uranium and plutonium workers. Cases were workers who died from lung cancer; one to three controls were matched to each. Lung doses from alpha-emitters were assessed using bioassay data. We estimated excess odds ratio (OR) of lung cancer per gray (Gy) of lung dose.
>
> *"RESULTS:*
> "The study comprised 553 cases and 1,333 controls. Median positive total alpha lung dose was 2.42 mGy (mean: 8.13 mGy; maximum: 316 mGy); for plutonium the median was 1.27 mGy and for uranium 2.17 mGy. Excess OR/Gy (90% confidence interval)-adjusted for external radiation, socioeconomic status, and smoking-was 11 (2.6, 24) for total alpha dose, 50 (17, 106) for plutonium, and 5.3 (-1.9, 18) for uranium.
>
> *"CONCLUSIONS:*
> "We found strong evidence for associations between low doses from alpha-emitters and lung cancer risk. The excess OR/Gy was greater for plutonium than uranium, though confidence intervals overlap. Risk estimates were similar to those estimated previously in plutonium workers, and in uranium miners exposed to radon and its progeny. Expressed as risk/equivalent dose in sieverts (Sv), our estimates are somewhat larger than but consistent with those for atomic bomb survivors. See video abstract at, http://links.lww.com/EDE/B232 ."

The epidemiological evidence for lung cancer carcinogenesis from uranium inhalation is growing. There is reason to doubt that alpha radiation from uranium can and does trigger lung cancer. Consequently no unnecessary exposure to respirable uranium dust is justified.

Epilogue

This report has focussed on respirable uranium dust particulates that escape from the CFM facility into the Port Hope atmosphere on a daily basis, in the midst of a residential and retirement community with homes and schools quite close by. Men, women and children are exposed on a daily basis to the risk of inhaling uranium oxide particulates that are invisible, odorless, tasteless, undetectable, but potentially deadly.

There are many other issues with the CFM plant that have not been addressed due to lack of time and resources. Chief among these is the question of enrichment levels in the uranium feedstock. As the enrichment level increases, the risk to human health posed by each one of these respirable particulates also increases. Not only is the proposed licence extension poised to prolong these exposures for two more decades, while increasing the risk by up to 24 percent in terms of the sheer numbers of airborne particulates, but also to make those particulates increasingly more radioactive and thus more deadly as the demand for enriched fuel increases. All newly proposed nuclear power reactors in Canada require enriched uranium or plutonium as a fuel, with degrees of enrichment that range as high as 20 percent in some cases. Routine handling of enriched uranium poses a host of additional problems including the potential for criticality accidents, and extraordinary increases in security measures to prevent theft or diversion of feed material.

The Health Committee is troubled by what they see as an overtly pernissive and supportive attitude on the part of CNSC staff towards the industry, while senior staff seems to disregard, minimize, or contradict health concerns raised by intervenors.

A case in point is the alarmingly permissive CNSC "release linits" of 14 kg annually for atmospheric releases of uranium particulates into the atmosphere of this pretty little town (see Tabkle 6 on page xx of this report). Such a "permissible" release limit is already 350 times higher than the largest recorded release from the CFM stacks over the last 10 years, and 11 times higher than the largest recorded release from the ventilation exhaust over the last 10 years.

Whatever happened to the ALARA principle, that all radiation exposures (and, presumably, all radioactive releases) be kept "as low as reasonably achievable? Shouldn't the CNSC release limits approximate more closely to what has already been demonstrated to be "reasonably achievable"?

CNSC also has an obligation to "disseminate objective information" to the public on the nature of radiation risks. The Committee finds it discouraging to see CNSC publications, such as the "Synthesis Report" purporting to summarise a numnber of "Health Studies" carried out using data from Port Hope, making assertions such as the following:

> **"The environmental and epidemiological studies conducted in Port Hope support each other, and overwhelmingly lead to the conclusion that the low levels of radiological and non-radiological environmental exposures within the town, resulting from the radium and uranium industry, have not caused any adverse effects on human health.**
>
> **On this basis, the CNSC concludes that no adverse health effects have occurred or are likely to occur in Port Hope, as a result of the operations of the nuclear industry in the community**." [emphasis in original]
>
> From the Extended Executive Summary, page V

No epidemiological study can warrant such a conclusion, which is manifestly unscientific. It does no credit to the CNSC to nmake such claims, and in my professional opinion it is at odds with the legal madate of the CNSC to disseminate objectiive scientific and technical information.

It is unfortunate that the CNSC does not have a cadre of independent biomedical scientists on staff, as I believe that health professionals would never allow such an incorrect statement to appear in print under the name of the CNSC and carrying the authority of the CNSC.

In the body of the CNSC report more nuanced and cautious language is used:

> "Overall, the study found no unusual cancer trends to suggest cancer incidence was unusual within Port Hope. In most cases, a statistically significant excess cancer incidence was based on very small numbers of observed and expected cases and the confidence intervals were wide. Despite that the study covered an extended period of time (1971-1996), the Port Hope population is small so the study only has sufficient power to detect large variations in cancer incidence."
>
> [p. 44]

A Cautionary Tale

Forty-two years ago, in 1980, the British Columbia Royal Commission of Inquiry into Uranium Mining was chaired by Dr. Bates, an esteemed medical expert on lung cancer and a one-time Dean of the McGill Faculty of Medicine. In order to allow the British Columbia Medical Association (BCMA) to compile and report on the medical aspects of radiation exposures related to the uranium industry, two prominent doctors – Robert Woolard and Eric Young – were seconded by the BCMA to attend the public hearings of the Inquiry on a daily basis and to wrte a detailed account of the proceedings and of the scientific testimony presented there from the point of view of medical professionals,

The result was a 477-page book entitled "Health Dangers of Uranium Mining" published by the BCMA. The authors were shocked by the poor quality of health information and number of erroneous and misleading statements on health matters provided to the Royal Commission by representatives of the Atomic Energy Control Board (AECB was the precursor to CNSC). As a result, Chapter 22 of their book was entitled "Atomic Energy Control Board – Unfit to Regulate".

At one point in Chapter 22 of the BCMA publication the authors wrote:

> AECB states : *"If one had to choose a WLM value that had some special significance 840 WLM would be a more logical choice [than 120 WLM] because it marks the level above which lung cancer incidence appears to increase with increasing exposure; (i.e. although an excess of lung cancer is evident in each of the exposure categories, the excess appears to be independent of exposure below 840 WLM.)"*
>
> **Such a policy statement, based on antiquated data and inadequate literature review, would be irresponsible coming from the nuclear industry, let alone the regulatory agency of that industry. However, as will become clear, it is difficult to ascertain where one ends and the other begins**. [emphasis in original]
>
> www.ccnr.org/bcma.html

The BCMA was subjected to pressure from the AECB, the Canadian government, and the Canadian nuclear industry to distance istelf from the report. In response, the president of the BCMA issued the following Open Letter:

13 January 1984

TO WHOM IT MAY CONCERN:

As there appears to be some confusion among representatives of industry and government with respect to the British Columbia Medical Association's efforts as a major participant in the British Columbia Royal Commission of Inquiry, Health and Environmental Protection Uranium Mining, we wish to make the following comments:

1. Dr Eric R Young and Dr Robert F Woollard participated as interveners at the Inquiry as representatives of this Association.
2. Dr Young is presently the chairman of the environmental health committee of the BCMA and Dr Woollard is past-chairman.
3. During the Inquiry the BCMA was privileged to present statements of evidence of internationally-recognized authorities on various aspects of this issue.
4. The report entitled "The Health Dangers of Uranium Mining and Jurisdictional Questions" authored by Drs Young and Woollard is the summary argument of the BCMA presented in 1980 to the Royal Commission in response to its call for final arguments from participants in the inquiry. As such it has been supported by the BCMA Executive and Board of Directors.
5. This report has had significant peer review and there has been ample opportunity for public comment.
6. The substance of the report is reflective of BCMA policies in the area of environmental health as established over several years by consideration and debate at the general

assembly and Board of Directors and, as confirmation of this, the BCMA holds copyright on both printings of this BCMA publication.

Extensive feedback has confirmed the report's value as an aid in promoting public participation in this important area of environmental health and has vindicated the medical association's expressed interest to raise the level of debate on this issue.

Yours sincerely

G D McPherson, MD
BCMA President

This cautionary tale is offered to the Commissioners in order to underscore the point that biomedical scientists and medical practitioners often have very different views on human health issues and on cancer-causing agents than engineers, physicists, chemists, geologists and statisticians, including epidemiologists. Since the mandate of the Commission is to protect the health and safety of persons and the environment, it is difficult for many in the Health Committee to understand why such expertise is largely lacking in the CNSC staff.

7 October, 2022

Canadian Nuclear Safety Commission

280 Slater Street, Ottawa, ON

Dear Chair Velshi and Commissioners:

Re: Intervention re Cameco Fuel Manufacturing Inc.
Port Hope, Ontario

The Port Hope Community Health Concerns Committee (PHCHCC) is submitting the following comments and recommendations to the Commission on the above noted matter which build on important content in previous PHCHCC interventions to the CNSC in 2011 and 2021 related to the operations of this facility.

> **"For a given uranium intake the inhalation pathway gives doses 200 times greater than ingestion"**
>
> *Ontario MOE Rationale Document, Draft Uranium in Air Standard, 2010*

Recommendations:

1. Cameco's request for a 20 year license term for the nuclear facility CFM with a 24% production increase involving natural, depleted and enriched uranium must be rejected by the Commission as unreasonable, unjustified and unacceptable in a community setting with no buffer zone whatsoever.

2. A two year license should be issued to Cameco Corporation for this facility with the condition that within this two year time period, Cameco will prepare and submit a plan to the CNSC, relevant government departments, the municipality and the public by December 31, 2024 to fully decommission all of its sites, including CFM, within the boundaries of Port Hope.

3. Decommissioning, including removal of all wastes and full restoration of all occupied and impacted lands to future unfettered use, to be completed by December, 2028. The 2017 decision by Chair Binder to accept $23M financial guarantee for decommissioning costs should be immediately updated.

Construction of a new designated Nuclear Facility at the current Cameco operating locations in Port Hope would simply not be permitted under current environmental legislation and community standards because of the many risks they present.

The ongoing licensing of Cameco facilities by CNSC means the regulator continues to grandfather and perpetuate what was a historical mistake in Port Hope starting 90 years ago, and is unacceptable operating circumstances for this industry in today's world. It should be acknowledged as such by the regulator and government and a responsible decision made now to bring its presence here to an end.

Many of the unresolved concerns raised by citizens over the years will only be properly addressed by the relocation of this industry away from our town, with a suitable buffer zone meeting all current laws and regulations for such industry.

Ongoing Concerns to be Resolved:

1. ***Cameco Continues Fight Against WSIB Claim of Former Employee Dan Rudka:*** One of our board members, Dan Rudka, is a former nuclear energy worker at Zircatec Precision Industries, now CFM. Dan sustained serious injuries as a result of poisoning by inhaling insoluble uranium particles including the isotope 236U (the isotopic signature of recycled nuclear reactor fuel contaminating uranium in Port Hope) and possibly other toxic materials in the workplace over a very short period of employment in 1993/94. Dan was a participant in PHCHCC's urine bioassay testing which identified the presence of uranium in his body many years after he had been working there.

   Dan has detailed his experiences in the hope that he would one day receive justice. Over the many years, and in ill health which required a double lung transplant, he has made many requests for help - in interventions to CNSC, to his former employer, union, an array of health officials, and currently to Ontario's Workplace Safety and Insurance Board, all to no avail thus far. He is a brave, persistent fighter and will have another appeal scheduled with the WSIB soon with Cameco opposing him, once again. The Commissioners should ask why - why is Cameco fighting repeatedly, denying harm caused to one of its employees. The civil standard of preponderance of evidence should have settled Dan's case in his favour long ago. CNSC should intervene on Dan's behalf for Cameco to take responsibility and support a favourable WSIB decision.

2. ***No buffer zone:*** As the pictures in Cameco's presentations show, there are no buffer zones for any of the three licensed Cameco sites within the town. They operate in neighbourhoods, near schools, parks, Lake Ontario shores, outdoor recreational facilities, homes and families. They completely dominate our waterfront, presenting health, safety and security risks. Operations severely restrict safe use and enjoyment of the waterfront and other public areas with toxic emissions to air and water.

3. ***Radioactive waste remediation*** The community is dealing with Phase 2 of a federally funded multi-year, $1.2+ million cleanup of historic and current radioactive wastes from this industry present since the 1930's. The federally funded and regulated cleanup underway by Canadian Nuclear Laboratories is subjecting the people to increased uranium particulate and other contaminants in air for years and will still leave us with contaminated soils above background levels due to the cleanup scope and criteria. A proposal by CNL to CNSC to weaken the criteria for arsenic and leave more behind for future generations is unacceptable and now a subject of current debate. It is contradictory and counter-productive to continue the Cameco operations which contribute measurable contaminants to our air, water, soil, vegetation on a daily basis and present daily risks to the public consistently through inhalation.

4. ***Power lies elsewhere***: The public, including the municipal government, plays no meaningful role in regulating this industry although there is much busywork made to distract us from that fact. Decisions are always made out of our town, in Saskatchewan, at Cameco headquarters, and Ottawa, at the CNSC and Natural Resources Canada. There will be ever decreasing public involvement with 20 year licenses from the previous two, five and ten year terms. Public participation at mid-terms is negligible - not invited or very limited with no speaking permitted despite earlier promises to the contrary. Based on history we know that operational changes can and undoubtedly will be authorized in meetings and by letter between the regulator and Cameco with no public awareness or participation over the proposed 20 year license period.

5. ***No independent environmental monitoring***: There is no regular independent monitoring of Cameco's emissions' impacts on the local environment and public reporting by bodies such as the Ontario Ministry of the Environment as in the past when detailed phytotoxicology testing was conducted and reports issued annually . Cameco essentially monitors and reports on itself. Further, the uranium emissions from this aging facility are more than 60% fugitive and not monitorable.

6. ***No neutron radiation monitoring and reporting***: In the past Cameco and CNSC agreed in re-licensing documents with the findings of citizens in 2006 that neutron radiation is emitted from UF6 cylinders but decided that it will not be included in exposure calculations and therefore, is not counted in doses received by employees or the public. This is unacceptable practice and appears to be the As Low As Reasonably Achievable (ALARA) principle applied to save the industry money it would have to invest for proper neutron detection equipment.

Dose calculations for nuclear workers have been admitted to be wrong by federal officials some years ago which underscores the guesswork involved at the best of times especially for internal doses and impacts at the cellular/organ level. Since calculations for employee compensation are based on dose assumptions, they have not been fairly or accurately treated by the current methods. Question - How is neutron radiation exposure to employees and public being managed, monitored and reported today by Cameco?

7. ***Health effects***: Despite the health risks from exposures to contaminants all around us and an ongoing cleanup, as well as data from previous health studies showing inhaled, insoluble uranium in a small sample of both workers and the public, along with local elevated rates of cancers, neurological, cardiovascular and respiratory diseases in earlier Health Canada reports (1997, 2000,2002), the CNSC claims that no further health studies or ongoing health monitoring are necessary for the people who live here. This position is indefensible in the face of existing study evidence and the daily exposures. Eliminating a major risk, Cameco, from our midst is one way to try to prevent further damage. Independent health monitoring of those at special risk and regular updating of cancer, morbidity and mortality outcome studies should be ongoing.

8. ***Assessment of health risks***: In all of the government and industry documents we have seen over the years related to Cameco operations and the cleanup, the health risks to the people of Port Hope are deemed acceptable and minimized. This is done based on faulty industry-serving risk assessments based on faulty assumptions including average dose estimates. These conclusions are promoted license after license without considering the combined effect of all of the operations together which is our reality, rather than in “license silos”. There are also CNL/PHAI cleanup impacts plus the synergistic and cumulative effects of the many toxins emitted. They dismiss the very real risks and elevated rates of certain diseases locally without any proper scientific evidence and are used to justify no health investigations or monitoring. Absence of evidence is not evidence of absence.

9. ***Transportation of hazardous material:*** Hazardous material such as fluoride, hydrogen fluoride and uranium travel in and out of our community in various forms. Trucks travel regularly through the streets of Port Hope on their way to the highways with cylinders of Cameco’s UO2 and UF6 products that emit gamma and neutron radiation .

10. ***Inadequate emergency measures****:* Cameco and Port Hope are not listed as part of the Ontario Provincial Nuclear Emergency Response Plan despite both Cameco operations designated nuclear facilities by CNSC. It is unacceptable and mystifying that the significant resources quickly brought to help in a nuclear emergency by many Ontario ministries at nuclear reactor sites will not happen here automatically. Our Committee raised the concern years ago that the provincial umbrella of nuclear response should include our community. We made

a submission during public consultation when the Plan was updated in 2017 however Port Hope is still not included as it does not host a nuclear reactor.

11. ***Unidentified industry materials***: Despite acknowledging at previous hearings that 236U is present in some of the material at Cameco due to use of some recycled materials such as depleted uranium contaminated with high level transuranics, CNSC and Cameco were not testing the isotopic content of the uranium used at Cameco, or found in the products and wastes. It is also not part of the urinalysis testing of employees. Further, CNSC licenses depleted, natural and enriched uranium at the two Cameco operations in Port Hope all of which have impacts including on the issues of emissions, particulate, storage, security, criticality and dose, both external and internal when inhaled.

Further Considerations

1. **Dangerous Transportation of Radioactive Materials on Roadways, Lake Ontario and the St. Lawrence Seaway**

Excerpt from PHCHCC intervention to CNSC 2010 re Bruce Nuclear Transportation of Radioactive Steam Generators to Sweden

"The Port Hope Community Health Concerns Committee has previously brought to your attention in CNSC hearing interventions, our deep concern regarding the regular transport of uranium hexafluoride (UF6) cylinders through our town streets. We brought to the attention of the CNSC and Cameco, that these cylinders were tested independently in a public area and measurable levels of neutron and gamma radiation were recorded. This fact is known and confirmed by CNSC and Cameco, by testing and science, yet the trucks are still permitted to travel from the Cameco plant down the only road out from the west beach area and through our town streets. The trucks and cylinders pass beside unsuspecting children on bicycles, pedestrians and motorists in town until they go onto the main highways and continue to mingle with the public all the way to their destinations. This is a completely unacceptable situation and should be unacceptable to you as the regulator of radioactive material and public exposures. There is buck passing of responsibility but no actual accountability or change to protect the public.

Further, Commissioners should be aware that excerpts from documents released under Access to Information by Transport Canada confirm that in 2005, 156 cylinders of radioactive Uranium Hexafluoride (UF6) (approved for depleted, natural and enriched UF6) from Cameco Corporation in Port Hope, Ontario were to be transported to Oshawa, loaded at Oshawa harbour onto a vessel and transported to Rotterdam through Lake Ontario and the St. Lawrence Seaway. Documents indicate that this happens several times a year. Dockings at Port Hope apparently also occur on occasion. In these documents Transport Canada states that shipments of radioactive

dangerous goods are routine and standard on the Great Lakes St. Lawrence Seaway system.

Many questions arise from review of these documents. For example, it was concerning to read that the European Union requires special blanketing of the cylinders as a protective measure apparently to prevent overheating of the UF6, but Canada does not. Why not? Is the blanketing also a measure to help reduce radiation exposures and of so, should these not be applied immediately in Port Hope. What other measures are possible to protect the public?

Also, nowhere in the documents was there mention of the high levels of neutron radiation emitted from full UF6 cylinders. The full nature of this material and its potential hazards are critical for a crew to understand, particularly with this quantity on a long voyage and this was disturbingly missing from the material we reviewed."

2. U.S. Radiation Exposure Compensation Act

U.S. Energy Employees Occupational Illness Compensation Act

The United States Dept. of Justice recognizes in law diseases caused by ionizing radiation and compensates energy employees, military personnel and community down-winders. Why not Canada?

: "Ionizing radiation is invisible, high frequency radiation that can damage the DNA or genes inside the body" – *US Dept. of Health and Human Services*

…"There is no level below which we can say an exposure poses no risk…radiation is a carcinogen. It may also cause other adverse health effects, including genetic defects in children of exposed parents or mental retardation in the children of mothers exposed during pregnancy" - *US Environmental Protection Agency.*

As of 2019 the US government had paid more than $17 billion in compensation to military personnel, community downwinders, and nuclear energy employees for a long list of cancers and other diseases under its legislation in point #4 and below:

Excerpt from the September 2001 United States General Accounting Office Report to Congress: Radiation Exposure Compensation – Analysis of Justice's Program Administration GAO-01-1043 Radiation Exposure Compensation

"RECA (*Radiation Exposure Compensation Act*) establishes a procedure to make partial restitution to individuals who contracted serious diseases, such as certain types of cancers, presumably resulting from their exposure to radiation from above-ground nuclear tests or as a result of their employment in uranium mines. The law established three claimant categories—uranium mine employees (those who worked in underground uranium mines in certain specified states), downwinders (those who were downwind from aboveground nuclear weapons tests conducted at the Nevada test sites), and onsite participants (those who actually participated onsite in aboveground nuclear weapons tests)...."

In addition to RECA, The Energy Employees Occupational Illness Compensation Program (EEOICPA) provides benefits to employees (or their survivors) of the Department of Energy (DOE) and its contractors/subcontractors, who became ill as a result of exposure to radiation and/or other toxic substances authorized by the Energy Employees Occupational Illness Compensation Program Act (EEOICPA or Act). It includes two separate benefit programs: Part B and Part E. **Part B** of the EEOICPA provides eligible employees or survivors with lump-sum compensation up to $150,000, and pays medical expenses for accepted conditions. Part B also provides for payment of medical benefits and a smaller lump-sum amount of $50,000 to individuals who were determined to be eligible for compensation under Section 5 of the Radiation Exposure Compensation Act (RECA).**Part E** provides eligible employees or survivors with compensation payments up to a maximum amount of $250,000, plus medical expenses for accepted conditions. The amount of benefits paid up to the $250,000 is based on the level of impairment and/or years of qualifying wage loss related to the covered illness.

(Benefits.Gov)

Radiation Disasters and Children

- **Excerpt from: American Academy of Paediatrics, November, 2008**

Radiation Biology

Radiation exposure can be divided into external, internal, whole body, or partial body. Internal irradiation can occur after inhalation of a radioactive gas or ingestion of contaminated food (including produce, grains, and milk from goats or cows that have been grazing on contaminated fields). Radiation effects can be direct, interacting with target tissues; or indirect, producing free radicals or other harmful molecules. The cellular effects of radiation are highly variable, correlating directly with the cell's typical rate of division and inversely with the extent of cell

differentiation. The sensitivity of tissues to radiation, from most to least, is: lymphoid, gastrointestinal, reproductive dermal, bone marrow, nervous system. Ionizing radiation produces chromosome breaks in a variety of somatic cells; these breaks can persist for decades after exposure and may account for increased rates of cancer after irradiation. Other significant modulators of cellular injury after radiation exposure include dose, type of radiation, and age of the exposed person."

Vulnerabilities in Children: Children have a number of vulnerabilities that place them at greater risk of harm after radiation exposure. Because they have a relatively greater minute ventilation compared with adults, children are likely to have greater exposure to radioactive gases (eg, those emitted from a nuclear power plant disaster). Nuclear fallout quickly settles to the ground, resulting in a higher concentration of radioactive material in the space where children most commonly live and breathe. Studies of airborne pollutants are needed to test the long-held belief that the short stature of children brings them into greater contact than adults with fallout as it settles to earth. Radioactive iodine is transmitted to human breast milk, contaminating this valuable source of nutrition to infants. Cow milk, a staple in the diet of most children, can also be quickly contaminated if radioactive material settles onto grazing areas. In utero exposure to radiation also has important clinical effects, depending on the dose and form of the radiation; transmission of radionuclides across the placenta may occur, depending on the agent. After exposures to external radiation, fetal doses of 0.60 Sv (60 rem) have produced small head size and mental retardation (in Japanese atomic bomb survivors), when exposures occurred between 8 and 25 weeks of gestational age.2 A dose-response effect was found in the occurrence of small head size without mental retardation, which occurred in foetuses exposed to _0.2 Sv (_20 rem) between weeks 4 and 17 of gestation. Radiation-induced cancers occur more often in children than in adults exposed to the same dose. Finally, children also have mental health vulnerabilities after any type of disaster, with a greater risk of long-term behavioral disturbances.

3. **Canadian Employees and Community Residents Inhale Radioactive Emissions from Nuclear Facilities - Port Hope Radio-Biological Test Results, November 2007 (UMRC-PHCHCC joint project)**

From 2005 to 2007 the PHCHCC fundraised over $11,000 to pay for the laboratory costs for this project which is the first time radioactive materials have been identified and measured in the bodies of Port Hope civilians. The scientific and medical expertise of the Uranium Medical Research Centre was donated. The November, 2007 report of the Uranium Medical Research Centre on radio-biological testing of 9 Port Hope subjects including 4 former Port Hope nuclear industry workers and 2 controls from outside the area was peer-reviewed at the European Association of Nuclear Medicine in Denmark, October 2007. It is published in the proceedings of the conference.

The study stated the following findings:

1. Chronic, long-term uranium contamination. Workers bodies releasing industrial and Depleted Uranium 23, 17 and 11 years since exposure.
2. Unexplained contamination by a man-made isotope 236U (Uranium 236) – a waste and spent fuel product of nuclear reactors.
3. Enriched levels of the 234U isotope in both retired workers and civilian Port Hope subjects, including a child.
4. A worker releasing Depleted Uranium >23 years since exposure – patient history refers to Eldorado Nuclear extruding DU metal rods for US weapons in 1980's.
5. One adult subject's uranium elevations 8 X's over average concentrations of the study's controls.
6. A child with uranium elevations ≈3 X's the controls' average concentrations of Uranium.
7. Exposure history, types of uranium and medical problems indicate contamination by inhalation.
8. Signatures of the uranium isotopes suggest exposure to recycled and blended uranium.
9. No health, radiological or industry reports identify the radioactive materials found to be in the bodies of the study subjects.
10. CNSC approved radiation protection standards (civilian and worker) do not include exposure to the toxic materials identified.
11. Control subjects <u>do not show</u> the contaminants or characteristics of the Port Hope subjects.

4. **Elevated Disease Trends for Port Hope (1998, 2000, 2002) Not Recognized by CNSC, Comprehensive Health Studies Never Done as Promised**

<u>Port Hope Harbour Area of Concern: Health Data and Statistics for the Population of the Region (1986-1992), Great Lakes Health Effects Program, Health Canada. November 1998</u>

CNSC and Health Canada's position is that this is another study that does not show any health effects in Port Hope from past or present exposure to radiation. This is not an accurate description of the study findings. The data in this report showed selected causes of death 1986-92 significantly higher than Ontario in the Port Hope area included: genetic, neurological, multiple sclerosis, Parkinson's disease, cardiovascular and respiratory diseases, and eleven cancers. Environmental contaminants were one of the possible causes described in the report.

Cancer Incidence Study (Health Canada/CNSC, 2000), Cancer and General Mortality Study (Health Canada/CNSC, 2002

Why does the Government of Canada recognize only leukemia, lung, breast and thyroid as sentinel cancers associated with ionizing radiation when analyzing Port Hope disease data and yet the U.S. Veteran's Administration and the U.S. Dept. of Justice recognize almost ten times as many to be associated with radiation exposure and provide compensation to Atomic Veterans, nuclear workers and community down-winders exposed to radiation?

The elevated disease rates for Port Hope contained in these two high level reports, have been consistently dismissed or ignored by Health Canada and the CNSC from the time the reports were publicly released. In his paper released in Port Hope in November, 2007, Dr. Jack Cornett, Health Canada, said about the findings of these two studies "that the cancer patterns in the Port Hope community were no different from similar communities in Ontario and patterns for Port Hope did not differ from other Ontario communities".

This is not factually correct. Independent analysis of the two federal reports and the data contained was done in February 2004 by Dr. Eric Mintz, epidemiologist. His two reports identify significant elevated disease rates for Port Hope when compared to the Ontario provincial average. These data were contained in tables at the backs of the federal reports and the same data were used in the text of the federal analysis.

Dr. Mintz reviewed these reports for the Atomic Energy Control Board (for the 2000 report he did so as a peer reviewer under contract with the AECB; for the 2002 report the CNSC declined to provide funding to him for peer review so the Committee made independent arrangements)/Canadian Nuclear Safety Commission and our Committee, said, among other important comments, that "the patterns of several cancer rates…are consistent with environmental contamination" and "…along with the brain cancer, colon cancer and some of the rare cancer results, the available evidence points to there being problems in Port Hope; the elevated cardiovascular death rate overall, and the dramatic increase in the death rate from 1986-1996 for women was a surprise finding that merited followup".

U.S. veterans' administration for Atomic Veterans	**Health Canada/CNSC**
- conditions recognized by statute or regulation as associated with radiation exposure	-conditions associated with radiation in port hope cancer and mortality studies "sentinel cancers" (2000,2002)

1. leukemia, lymphoid (except chronic lymphatic leukemia)	1. leukemia
2. leukemia, myeloid	2. lung cancer
3. leukemia, monocytic	3, breast cancer
4. leukemia, hairy cell	4. thyroid cancer
5. leukemia, other	
6. leukemia, unspecified cell type	
7. thyroid cancer	
8. breast cancer	
9. lung cancer (trachea, bronchus and lung)	
10. bone cancer	
11. liver cancer, primary	
12. skin cancer	
13. esophageal cancer	
14. stomach cancer	
15. colon cancer	
16. pancreatic cancer	
17. kidney cancer	
18. urinary bladder cancer	
19. salivary gland cancer	
20. multiple myeloma	

21. posterior subcapsular cataracts	
22. non-malignant thyroid nodular disease	
23. ovarian cancer	
24. parathyroid adenoma	
25. malignant tumours, brain and central nervous system	
26, lymphomas other than hodgkins disease	
27. cancer, rectum	
28. cancer, small intestine	
29. cancer, pharynx	
30. cancer, bile duct	
31. cancer, gall bladder	
32. cancer, renal pelves, ureters, urethra	
33. cancer, prostate	
34. brochio-alveolar carcinoma	
35. benign neoplasms, brain and central nervous system	
36. other malignancies not listed in the preceding diagnoses	

Independent analysis in February 2004 by Dr. Eric Mintz, Epidemiologist, of the limited data in the two Health Canada/CNSC reports cited above, identifies significant trends for Port Hope (below):

Condition	Dr. Mintz Analysis of Health Canada Data on PH
1. deaths -overall	13% elevation in Port Hope 1986-1997
2. cancer deaths-childhood	48% more than expected
3. leukemia -childhood	41% more than expected
4. lung cancer	elevated for men and women in different time periods; female rates significantly elevated 1986-1996
5. brain cancer -adult	elevated for men and women; women more than twice the expected rate 1986-1997 and significantly elevated entire study period
6. brain cancer-childhood	50% elevation entire study period; 4 times expected rate 1971-1985
7. Non-Hodgkins Lymphoma – childhood	statistically significantly elevated entire study period
8. nasal/sinus cancer	significantly elevated for men; over 5 times expected rate 1971-1985
9. esophageal cancer	twice expected rate for men 1971-1985; women have 50% excess entire study period
10. lip	more than twice expected rate for men 1986- 1996
11. bone	More than twice the expected rate for men 1986-1996
12. colorectal cancer	38% elevation for women 1986-1996
13. circulatory disease	15% excess deaths (300) over 42 year period – more than 7 per year. Female death rate rose

	dramatically 1986-1996 with 100 more deaths than expected.

5. **Earthquakes in the Vicinity of Lakes Erie and Ontario - -Natural Resources Canada - Earthquakes Canada web site (1995-2007)**

1995-05-25 M=3.0 MN felt 11 km NE of Fort Erie, ON

1997-09-24 M=2.5 MN felt 19 km SE of Belleville, ON

1999-11-26 M=3.8 MN felt 23 km SE of Scarborough, ON

1998-12-25 M=3.6 MN felt 25 km SE of Cobourg, ON

1998-09-25 M=5.4 MN felt 95 km NE of Cleveland , OH

1998-06-09 M=3.4 MN 22 km NW of Plattsburgh, NY

2000-05-24 M=3.1 MN felt 12 km SE of Scarborough, ON

2001-01-25 M=4.4 MN felt 94 km NE of Cleveland , OH

2002-11-07 M=3.0 MN felt 19 km SW of Belleville, ON

2003-11-29 M=2.6 MN felt 20 km SW of Belleville, ON

2004-08-04 M=3.8 MN felt 32 km SW of Cobourg, ON

2006-01-05 M=2.8 MN felt 43 km NE of Cleveland , OH

This geographic area of the Great Lakes basin has regular seismic activity and is not suitable for high risk nuclear facilities.

Submitted for consideration of Commissioners,

Yours truly

Faye More
Chair, on behalf of the Port Hope Community Health Concerns Committee

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