CMD 25-H2.59

Date: 2025-05-08

Written Submission from the Durham Nuclear Awareness, Slovenian Home Association, and the Canadian Environmental Law Association

Mémoire de Durham Nuclear Awareness, Slovenian Home Association et de l'Association canadienne du droit de l'environnement

In the matter of the

À l'égard d'

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Application to renew power reactor operating licence for the Darlington Nuclear Generating Station

Demande concernant le renouvellement du permis d'exploitation d'un réacteur de puissance pour la centrale nucléaire de Darlington

Commission Public Hearing
Part-2

Audience publique de la Commission
Partie-2

June 24-26, 2025

24-26 juin 2025

DURHAM NUCLEAR AWARENESS,
SLOVENIAN HOME ASSOCIATION &
THE CANADIAN ENVIRONMENTAL LAW ASSOCIATION

Comments on Ontario Power Generation's Application to renew power reactor operating licence for the Darlington Nuclear Generating Station for a 30-yeaar term

Hearing Reference: 2025-H-02

Prepared by:
Sara Libman, Legal Counsel

Expert Review by:
M.V. Ramana, Professor and Simons Chair in Disarmament, Global and Human Security
Dr. Ian Fairlie

May 8, 2025

May 8, 2025

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

Dear Sir or Madam:

Sent by email interventions@cnsc-ccsn.gc.ca

Re: Joint Submission of Durham Nuclear Awareness, Slovenian Home Association, and the Canadian Environmental Law Association, Regarding Ontario Power Generation's application for the renewal of the power reactor operating licence for the Darlington Nuclear Generating Station

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The Canadian Environmental Law Association ("CELA") has enclosed its comments, on behalf of Durham Nuclear Awareness, Slovenian Home Association, and CELA on Ontario Power Generation's application to renew the power reactor operating licence for the Darlington Nuclear Generating Station for a 30-year term, from December 1, 2025 to November 30, 2055.

Please find below our submission for your review.

By this letter, and pursuant to the CNSC's *Rules of Procedure*, CELA request status to participate as an intervenor in the public hearing and an opportunity to make a 30-minute oral presentation at the June 2025 hearing.

Sincerely,

CANADIAN ENVIRONMENTAL LAW ASSOCIATION

Sara Libman
Sara Libman
Legal Counsel, CELA

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SUMMARY OF RECOMMENDATIONS

Recommendation No. 1: Licence renewals should be subject to shorter licensing terms as it provides the opportunity for public hearings under section 40(1) of the NSCA, and enhances the openness and transparency of the CNSC, and its oversight of nuclear uses and technologies. These opportunities are critical to building the public's trust in the regulator and would be lost if there is only one chance for every generation of the public to participate in a hearing and engage in dialogue with the CNSC and the licencee about their concerns.

Recommendation No. 2: Given their limited scope and exclusion of oral intervention opportunities, Regulatory Oversight Reports and meetings are not sufficient alternatives to licensing hearings and should not be relied upon to remedy outstanding issues resulting from licensing hearings, nor used as a stand-in for public hearings.

Recommendation No. 3: The CNSC should disregard CNSC staff's recommendation for a 30-year licencing term.

Recommendation No. 4: Because CNSC Staff has not carried out and published a more thorough review of legislation and licencing procedures in other jurisdictions, and because some of the literature they have relied on are very old and do not reflect recent understandings of nuclear safety, international precedence and benchmarking do not justify longer term licences in Canada.

Recommendation No. 5: the Commission should apply the precautionary principle to the assessment of Darlington's ETE study, which would require the rejection of a 30-year licence term.

Recommendation No. 6: We encourage the CNSC to require Darlington to provide KI Pills by way of pre-distribution within a 50 km radius, and pre-stock to 100 km. In accordance with international best practice, the CNSC should extend KI Pill stockpiles to 100 km and ensure that places frequented by vulnerable groups, such as children and pregnant women, maintain sufficient stockpiles.

Recommendation No. 7: OPG should explain how the PA system at Darlington fell into disrepair and why it was not upgraded in a timely manner.

Recommendation No. 8: OPG should provide the public with details about how it intends on monitoring the functionality of emergency equipment, and how it is going to ensure that malfunctions of important equipment like the PA system will not occur in the future.

Recommendation No. 9: Licence Conditions Handbook section. 10.1 should be updated to read "licensee must provide emergency communications" and not "should", as currently drafted.

Recommendation No. 10: The CNSC should require ongoing public education for emergency preparedness and protective actions. The CNSC and OPG should collaborate with community groups and intervenors to develop a strategy to better inform the public on what to do in case of emergency.

Recommendation No. 11: OPG should discuss the 13 infractions that occurred during the current licence term in more detail—what the infractions were, when they occurred, why they took place, and what OPG has done to resolve them.

Recommendation No. 12: The Commission needs to hold licensees like OPG accountable with the disclosure of releases into the environment.

Recommendation No. 13: More information surrounding the tritium oxide release is requested, namely how it happened, i.e., what does OPG mean by the vague statement of "*this exceedance was attributed to an event at the Darlington NGS Tritium Removal Facility (TRF) due to issues with the tritium immobilization system?" Was this a preventable incident*? Are there refurbishment activities that need to occur at the TRF to protect the environment from tritium oxide releases?

Recommendation No. 14: More information about the seven ozone depleting substance releases is requested, and clarification as to whether they could have been prevented through proper maintenance and monitoring procedures that did not occur.

Recommendation No. 15: A 30-year term is an inappropriate request amidst the absence of disclosing details surrounding environmental releases.

Recommendation No. 16: The CNSC should review the licence renewal application with express consideration given to climate impacts and climate resiliency, including in the context of site suitability and impacts on safety and the environment.

Recommendation No. 17: The criteria by which climate change impacts and natural external events have been assessed and evaluated against the 25-year licence application must be clearly set out.

Recommendation No. 18: OPG's detailed climate analysis must be presented in a public forum as part of the CNSC's licensing process.

Recommendation No. 19: Without a permanent and safe disposal site in place for the long-term disposal of radioactive waste, the amount of radioactive waste being produced should be limited.

Recommendation No. 20: a shorter licence term is more appropriate to protect and encourage public participation and engagement with issues like radioactive waste storage.

Recommendation No. 21: The Commission should review this licensing renewal application with the DNNP included in the context of emergency planning and waste management issues.

Recommendation No. 22: The 30-year licence term should be denied to ensure there are more frequent engagement opportunities to assess how the two nuclear reactor sites are impacting each other.

Recommendation No. 23: The CNSC should deny a 30-year licence term and only permit a much shorter licence extension, thus allowing the public to have more frequent and deeper insight into the rate of failures of components at the Darlington Nuclear Generating Station and its safety.

Recommendations from Dr. Ian Fairlie's Expert Report

Recommendation No. 24: CNSC should not extend operating licences for Darlington NGS.

Recommendation No. 25: CNSC should apply the Ontario Government's ODWAC recommendation of 20 becquerels per litre (Bq/L) for drinking water

Recommendation No. 26: CNSC should implement its own 2010 design guide for groundwater for tritium of 100 Bq/L for tritium levels in wells near Darlington NPS.

Recommendation No. 27: Urine tests and non-invasive bioassay tests should be carried out on volunteers from the community to ascertain local HTO and OBT levels.

Recommendation No. 28: Residents within 10 km of the plant should be advised to avoid consuming locally-grown foods including honey from hives, wild foods such as mushrooms and berries and produce from their gardens.

Recommendation No. 29: In view of the discussion in Appendix C, local women intending to have a family, and families with babies and young children should consider moving elsewhere. It is recognised this recommendation may cause concern but it is better to be aware of the risks to babies and young children than remain ignorant of them.

Recommendation No. 30: Darlington employees, especially young workers and women workers, should be informed about the hazards of tritium.

I. INTRODUCTION

Durham Nuclear Awareness ("DNA") and Slovenian Home Association ("SHA") together with the Canadian Environmental Law Association ("CELA") and the expert reviews by Dr. M.V. Ramana,[1] and Dr. Ian Fairlie, submit this written report in response to the Canadian Nuclear Safety Commission's ("CNSC") Participant Funding Notice to review Ontario Power Generation's ("OPG") application and associated documents seeking to renew the power reactor operating licence for the Darlington Nuclear Generating Station ("DNGS") for a 30-year term, from December 1, 2025 to November 30, 2055.[2]

DNA, SHA, and CELA's (herein, "the intervenors") submission is the result of a review of OPG's documents which have been made available to the public, as well as the CNSC staff Commission Member Document (CMD) prepared in response to OPG's application. In addition to reviewing the documents submitted by OPG, this submission considers the CNSC's jurisdiction pursuant to the *Nuclear Safety and Control Act* (NSCA), which requires that in making a licensing decision, the CNSC ensure the adequate protection of the environmental and human health. In meeting this objective, per section 24(4) of the NSCA, the intervenors' findings and concerns are itemized below. Our recommendations are summarized above in the **SUMMARY OF RECOMMENDATIONS** section.

II. INTEREST AND EXPERTISE OF THE INTERVENORS

A. Durham Nuclear Awareness

Durham Nuclear Awareness (DNA) is a citizens' group with a longstanding interest in the Darlington Nuclear Generating Station and the Pickering Nuclear Generating Station. DNA was first organized in 1986 in the wake of the Chernobyl disaster and born out of a need for people in Durham Region to come together, learn & empower themselves.

As a volunteer group of concerned citizens, DNA dedicates themselves to raising public awareness about nuclear issues facing Durham Region, and fostering greater public involvement in the nuclear decision-making process. DNA has appeared on numerous occasions before the CNSC and has a lengthy history lobbying for critical public health and safety measures, including improved emergency planning and baseline health studies, and setting standards for tritium in

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[1] M.V. Ramana is the Simons Chair in Disarmament, Global and Human Security and Professor at the School of Public Policy and Global Affairs, University of British Columbia, Vancouver, Canada.

[2] CNSC, "Notice of Public Hearing and Participant Funding" (March 18, 2024), online: https://api.cnsc-ccsn.gc.ca/dms/digital-medias/2025-H-02-Notice-of-Public-Hearing-and-PFP-OPG-Application-for-Licence-Renewal-for-Darlington-Nuclear-Generating-Station.pdf/object

drinking water. DNA continues to advocate for upgrades to nuclear emergency plans to ensure the protection of communities in the event of a nuclear accident.

B. Slovenian Home Association

Slovenian Home Association ("SHA") is a non-profit cultural organization dedicated to the preservation of Slovenian culture language, heritage and identity in Canada. Many Slovenians reside in the vicinity of the Pickering and Darlington nuclear plants and are concerned about the proposed plans to expand nuclear power generation within the region, particularly with OPG proposing novel reactor technology at the Darlington site. Much of these concerns stem from emergency planning for nuclear accidents.

SHA members are not aware of what to do in case of a nuclear alert from the Province of Ontario. Some questions posed to SHA by its members include: *Should they be prepared to evacuate or stay at home? Where is their closest evacuation center? How to protect themselves by staying at home?* Despite emergency planning being a heavy concern for its members, SHA not been made aware of any public information meetings where the details of the actions taken by the citizens, in case of a nuclear alert, were discussed. SHA would welcome an opportunity to distribute emergency preparedness instructions to its members and to organize and host a preparedness workshop on the topic of emergency preparedness.

C. Canadian Environmental Law Association

CELA is a non-profit, public interest law organization. CELA is funded by Legal Aid Ontario as a speciality legal clinic to provide equitable access to justice to those otherwise unable to afford representation for environmental injustices. For nearly 50 years, CELA has used legal tools to advance the public interest, through advocacy and law reform, in order to increase environmental protection and safeguard communities across Canada.

CELA has been involved in number of nuclear facility licensing and regulatory matters before the CNSC including federal environmental assessments. CELA also maintains an extensive library of public legal education materials related to Canada's nuclear sector on its website.[3]

D. Dr. M.V. Ramana

Expert review **Part VI** of this submission was provided by M. V. Ramana, Professor and Simons Chair in Disarmament, Global and Human Security at the School of Public Policy and Global

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[3] Canadian Environmental Law Association, online: www.cela.ca

Affairs (SPPGA), University of British Columbia. He has extensive experience with examining various aspects of the safety of nuclear reactors, and has published many articles on these topics in journals such as Journal of Risk Research, Science and Global Security, Regulation & Governance, and Bulletin of the Atomic Scientists.

E. Dr. Ian Fairlie

Expert review **Appendix A** of this submission was provided by Dr. Ian Fairlie, an independent scientist who has specialized on radioactivity in the environment with degrees in chemistry and radiation biology. One of Dr. Fairlie's areas of expertise is the dosimetric impacts of nuclear reactor emissions.

III. BACKGROUND/FACTS

A. Project

The Darlington Nuclear Generating Station (hereinafter, "Darlington" or "DNGS") is located on the north shore of Lake Ontario, in Clarington, Ontario. The facility lies 5 km outside the town of Bowmanville and 10 km southeast of Oshawa. The facility is owned and operated by Ontario Power Generation (OPG). Darlington consists of four CANDU pressurized heavy water nuclear reactors, as well as a tritium removal facility ("TRF").[4] The TRF extracts tritium from tritiated heavy water.[5]

In December 2015, the CNSC renewed the licence for Darlington for a period of 10 years, with the licence expiring on November 30, 2025.[6] In 2016, OPG commenced the Darlington Refurbishment Project, which requires each of the four reactors being taken out of service to complete the replacement of parts, rehabilitation of components, and system improvements and plant upgrades. Currently, refurbishment has been completed for Units 1-3, and Unit 4 is projected to be completed in Q4 2026.[7]

In May 2024, OPG submitted an application to renew the Darlington Power Reactor Licence ("PROL") for 30 years.[8]

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[4] Canadian Nuclear Safety Commission, "CMD 25-H2: A Licence Renewal – Ontario Power Generation Inc. Darlington Nuclear Generating Station," (26 March 2025) at p 4 **[CNSC Staff CMD]**

[5] CNSC Staff CMD at p 15

[6] Canadian Nuclear Safety Commission, "CNSC renews the Darlington Nuclear Reactor Operating Licence" (December 23, 2015), online: https://www.canada.ca/en/nuclear-safety-commission/news/2015/12/cnsc-renews-the-darlington-nuclear-power-reactor-operating-licence.html

[7] Ontario Power Generation, "Darlington Refurbishment" online: https://www.opg.com/projects-services/projects/nuclear/darlington-refurbishment/

[8] Ontario Power Generation, "Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025" (May 30, 2024) [**Licence Application**]

In February 2025, CNSC Staff submitted their Commission Member Document ("CMD") to the CNSC, recommending that the licence be renewed for a period of thirty years, from December 1, 2025 to November 30, 2055.[9]

B. Scope of Review

The intervenors received participant funding to review OPG's licence renewal application and related documentation, including OPG and CNSC Staff CMDs, with a focus on the environment and human health, public awareness and dissemination of information, emergency planning, and relevant international guidance, in order to make recommendations aimed at improving licence and licence condition handbook ("LCH") parameters specific to environmental protection, public awareness and human health. Our recommendations to the CNSC, including suggested licence conditions and licence condition revisions, are listed above in the **SUMMARY OF RECOMMENDATIONS** Section.

DNA, SHA, and CELA's findings and recommendations, below, aim to advance the object of the CNSC[10] and are directly relevant to the CNSC's licensing powers under section 24(4) of the NSCA to ensure the applicant will "make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed."[11]

IV. SUMMARY OF COMMENTS AND RECOMMENDATIONS

After reviewing submissions by CNSC staff and OPG, the intervenors submit that the CNSC should deny OPG's request to renew the Darlington PROL for a 30 year term.

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[9] CNSC Staff CMD at p ii

[10] The objects of the CNSC are set out in Section 9 of the NSCA as follows:

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

> (i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,
> (ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and
> (iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and

(b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph (a).

[11] NSCA at s 24(4)

Within the relevant documents associated with OPG's application, the intervenors identified several areas of concern that would contravene the aforementioned objective of the CNSC, namely: insufficient public participation opportunities; inadequate emergency planning and evacuation planning measures; inadequate consideration of environmental and climate change impacts; risks associated with operating a nuclear reactors for 30 year terms; and risks to human health associated with radioactive releases. Attached to this submission in **Appendix A** is an expert report by Dr. Fairlie which, *inter alia*, comments on the extremely large emissions of tritium (the radioactive isotope of hydrogen) from Darlington NGS. In our view, these constitute a serious health hazard to the local population and workers. The intervenors draw attention to this hazard and **recommend** the Commission address the matter.

These concerns are discussed below, along with a number of recommendations and requests for the CNSC to adopt in response to OPG's request to operate Darlington NGS for an unprecedented 30-year term.

Based on the findings within this submission, in the interest of protecting the environment and ensuring public health and safety, the intervenors submit that the Commission cannot, in good conscience, approve the renewal of the Darlington Power Reactor Licence for a 30-year term.

V. LEGAL ANALYSIS OF 30-YEAR LICENCE TERM

The intervenors submit that a 30-year licence for Darlington is patently unreasonable in the circumstances and should be denied for the following reasons, each detailed below:

- OPG's request for a 30-year licence term is contrary to the public interest and erodes public trust;
- A 30-year licence term is not compatible with existing emergency response and preparedness measures for Darlington;
- OPG's licence application fails to adequately consider environmental concerns and climate change modelling;
- A 30-year term raises concerns surrounding waste management; and
- OPG's application fails to discuss the implications of the Darlington New Nuclear Project being located at the same lands as the Darlington NGS.

A. OPG's request for a 30-Year Licence is contrary to the public interest and erodes public trust

The intervenors are highly concerned by OPG's request for a 30-year licence for Darlington, and submit it is contrary to the public interest mandate of the CNSC for a number of interrelated reasons, including that it shields licensee activities from the public oversight and participation mechanism provided in sections 40(1) of the NSCA; it would mean relying on more discretionary forms of public engagement like CNSC meetings which are *not* subject to the licensing framework of the NSCA; and it would be contrary to international guidance and precedents.

i. Public oversight and participation

OPG's request for a 30-year licensing term follows a growing trend amongst nuclear facility proponents in Canada pursuing licensing terms longer than 10-years. For instance, in 2022, New Brunswick Power Corporation ("NB Power") sought to renew the licence for the Point Lepreau Nuclear Generating Station {"Point Lepreau") for a period of 25 years; and in 2023, Cameco Corporation requested uranium mine and mill licensing terms of 20 years for its Rabbit Lake Operation, and its Key Lake and McArthur River Operations. Initially, Cameco Corporation had applied for an *indefinite* licence term for its operations, back scaled back to requesting 20 year terms following public backlash.[12]

After the public hearings for these facilities, the CNSC granted the following:

- Rabbit Lake Mine & Mill Operation: 20 year licence term;[13]
- Key Lake Uranium Mill Operation: 20 year licence term;[14]
- McArthur River Uranium Mill Operation: 20 year licence term;[15] and
- Point Lepreau NGS: 10 year licence term.[16]

CELA had intervened in the public hearing processes for all four of these licence applications, specifically expressing concerns about longer licencing terms being contrary to the public interest. We submit that the granting of the 20-year licence terms for Rabbit Lake, Key Lake, and McArthur River should not be used as a precedent in this hearing, as these facilities are associated with the mining and milling of uranium ore, and are not nuclear generating stations.

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[12] As seen in CNSC, "Record of Decision In the Matter of Cameco Corporation, Application to Renew the Uranium Mill Licence for the Key Lake Operation, Saskatchewan" DEC 23-H6 (October 24, 2023) at para 4, https://api.cnsc-ccsn.gc.ca/dms/digital-medias/Decision-Cameco-Key-Lake-Licence-Renewal-DEC23-H6-e.pdf/object **[Key Lake Record of Decision]**

[13] CNSC, "Record of Decision In the Matter of Cameco Corporation, Application to Renew the Uranium Mine and Mill Licence for the Rabbit Lake Operation, Saskatchewan" DEC 23-H7 (October 24, 2023) at para 11, https://api.cnsc-ccsn.gc.ca/dms/digital-medias/Decision-Cameco-Rabbit-Lake-Licence-Renewal-DEC23-H7-e.pdf/object

[14] Key Lake Record of Decision at para 11

[15] CNSC, "Record of Decision In the Matter of Cameco Corporation, Application to Renew the Uranium Mine Licence for the McArthur River Operation, Saskatchewan" DEC 23-H6 (October 24, 2023) at para 11, https://api.cnsc-ccsn.gc.ca/dms/digital-medias/Decision-Cameco-McArthur-River-Licence-Renewal-DEC23-H6-e.pdf/object

[16] CNSC, "Summary Record of Decision In the Matter of New Brunswick Power Corporation, Application to Renew the Power Reactor Operating Licence of the Point Lepreau Nuclear Generating Station" DEC 22-H2 (June 21, 2022) at para 10, https://api.cnsc-ccsn.gc.ca/dms/digital-medias/SummaryDecision-PLNGS-May-e.pdf/object [**Point Lepreau Record of Decision**]

In the case of the Point Lepreau Nuclear Generating Station, the Commission opted to not grant the requested 25-year term, and instead granted a licence term of 10-years, explaining:

> Regarding licence length, the Commission acknowledges the strong public interest in this hearing and the importance of providing regular opportunities for members of the public and Indigenous Nations and communities to voice their perspectives and concerns directly to the decision maker. Therefore, the Commission finds that a 10-year licence, with a comprehensive update to the Commission at the mid-point of the licence term, is appropriate at this time.[17]

The same reasoning should naturally apply to the case of the Darlington Nuclear Generating Station. The intervenors oppose OPG's request for a 30-year term for Darlington because such a long licence period will remove the 'regular opportunities" for stakeholders to "voice their perspectives and concerns directly to the decision maker." Approving OPG's renewal request would remove the opportunity for a public hearing under section 40(1) of the NSCA[18] for *three* decades, shielding OPG's activities at Darlington from public hearings until 2055.

We have previously made submissions before the CNSC emphasizing that we do not support the CNSC's transition to longer licences, as they significantly reduce public scrutiny of licensee operations, access to information, and effectively eliminate meaningful public participation.[19] We reiterate that there are good reasons to evaluate nuclear projects and their impacts even more frequently in the future.

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[17] Point Lepreau Record of Decision at para 11, *emphasis added*.

[18] **40 (1)** Subject to subsection (2), the Commission shall provide an opportunity to be heard in accordance with the prescribed rules of procedure to

(a) the applicant, before refusing to issue a licence under section 24;

(a.1) the applicant, before refusing to authorize its transfer under section 24;

(b) the licensee, before renewing, suspending, amending, revoking or replacing a licence, or refusing to renew, suspend, amend, revoke or replace a licence, under section 25;

(c) any person named in or subject to the order, before confirming, amending, revoking or replacing an order of an inspector under subsection 35(3);

(d) any person named in or subject to the order, before confirming, amending, revoking or replacing an order of a designated officer under subsection 37(6);

(e) the applicant, before confirming a decision not to issue a licence or authorize its transfer — and the licensee, before confirming a decision not to renew, amend, revoke or replace a licence or authorize its transfer — under paragraph 43(4)(a); (f) the licensee, before confirming, varying or cancelling a term or condition of a licence under paragraph 43(4)(b);

(g) the licensee, before taking any measure under any of paragraphs 43(4)(c) to (f);

(h) any person named in or subject to the order, before taking any measure under any of paragraphs 43(4)(g) to (j); and

(i) any person named in or subject to the order, before making any other order under this Act.

[19] *See for example*: Coalition for Responsible Energy Development in New Brunswick and CELA Submission to CNSC for Renewal of Point Lepreau Nuclear Generation Station Power Reactor Operating Licence (2022), online: https://cela.ca/wp- content/uploads/2022/03/Submission-Point-Lepreau-Nuclear-Generating-Station.pdf **[Point Lepreau Intervention]**

First, the International Atomic Energy Agency ("IAEA") publication, *Stakeholder Engagement in Nuclear Programmes,* notes that "increased public participation in decisions can promote a greater degree of understanding of the issues and can help to develop appreciation of the actual risks and benefits of nuclear technologies, such as those found in nuclear energy, compared with the risks and benefits of other energy sources."[20]

Second, because of their complex and hazardous nature, nuclear power plants and related facilities pose substantial risks to human health, safety and the environment. Our understanding of these dangers is continuously evolving; fifteen years ago, few would have expected three nuclear reactors at a single site melt down one after the other. But that was what happened at the Fukushima Daiichi site in Japan in March 2011.

Formal licensing processes allow for the compulsory re-evaluation of the risks stemming from nuclear plants. Applications for licence renewal should, therefore, not just attract the highest level of procedural protections, but also build in rights for public intervention, including notice, awareness of the impacts, and regular opportunities to respond, interrogate industry claims, and offer independent expert advice. The intervenors submit that a 30-year licence would significantly reduce the level of procedural protections and rights for the public to participate in a public hearing process per section 40(1) of the *NSCA*.

We note that a 30-year licence term would minimize public scrutiny of licence operations and access to information because of the duration of time between hearings and the accompanying lack of meaningful ways for the public to engage with the Commission and licensee. Shorter licences and more frequent hearings, which are responsive to the operations being undertaken by licensees, would better serve the public interest.

Third, by limiting meaningful public participation and access to information for a full generation, a 30-year licence term would also diminish public trust in the CNSC and the licencee. IAEA guidance on stakeholder involvement explains that

> Inclusive stakeholder engagement contributes to building trust and, when adopted early, enables anyone interested in being part of the process to share their views. It also provides the basis to explain where to find information, and how to submit comments and questions, and to convey how all input is addressed."[21]

Essentially, public confidence in the use of nuclear material and technology can be enhanced by an authorization process that reflects a high degree of *openness* and *transparency* on the part of

[20] International Atomic Energy Agency, "Stakeholder Engagement in Nuclear Programmes" (2021), online: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1967_web.pdf at p 7 **[IAEA Stakeholder Guidance]**
[21] IAEA Stakeholder Guidance at p 9

the authorities.[22] This is lost if there is only one chance for every generation of the public to meaningfully engage in dialogue with the CNSC and the licencee about their concerns.

Even CNSC Staff acknowledge that there is a risk of eroding public trust with the issuance of longer licencing terms:

> With the recommendation of a longer licencing term, CNSC staff acknowledge there is a risk of eroded trust and relationships with Indigenous Nations and communities and the public, the same concern as was seen with the re-licensing of the Point Lepreau Nuclear Power Plant in 2022 and Cameco's McArthur River/Key Lake uranium mine and mill in 2023 where staff supported 20-year terms.[23]

Despite this risk, CNSC Staff are still supportive of stifling public engagement in favour of granting OPG the desired 30-year licence term. By supporting a longer licence, the public and community groups are limited in being provided opportunities to raise issues of timely and urgent importance. For example, having a shorter licence term would enable the public to weigh in more frequently on the advisability and timing for shutting down and decommissioning Darlington. An early shutdown carries the attendant benefit of ending the production of radioactive waste which is expensive to store and which has no proven-safe method of disposal.

Recommendation No. 1: Licence renewals should be subject to shorter licensing terms as it provides the opportunity for public hearings under section 40(1) of the NSCA, and enhances the openness and transparency of the CNSC, and its oversight of nuclear uses and technologies. These opportunities are critical to building the public's trust in the regulator and would be lost if there is only one chance for every generation of the public to participate in a hearing and engage in dialogue with the CNSC and the licencee about their concerns.

ii. Regulatory framework and oversight

The intervenors submit that the CNSC Staff's recommendation that the Commission renew the Darlington PROL for a period of 30 years from December 1, 2025 to November 30, 2055, is contrary to the public interest because CNSC Staff erred in finding discretionary forms of public engagement,[24] such as regulatory oversight meetings, are sufficient stand-ins for public hearings under the NSCA. We do not accept CNSC Staff's position that a 30-year licence term is justified based on improvements to the regulatory framework and oversight practices of the CNSC.

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[22] IAEA Stakeholder Guidance, p 9
[23] CNSC Staff CMD at p 18
[24] See CNSC Staff CMD at p 16-19

First, the intervenors do not agree that the annual Regulatory Oversight Report for Nuclear Power Generating Sites is an appropriate alternative to more regular, site-specific licensing hearings. As the intervenors have mentioned in other licensing hearings,[25] a public hearing before the CNSC provides greater procedural rights and protections than other CNSC forums, such as the annual Regulatory Oversight Reports ("ROR") and meetings. We reiterate that unlike licence renewal hearings, the procedural rights for the public under section 24(4) of the NSCA do not apply to RORs.

It has been CELA's experience that the intent of RORs is not to change or amend licences or licence conditions, but rather to receive updates on licensee activity. Further, the public is excluded from oral interventions which provide for interrogations and dialogue with the proponent and Commission members. In December 2023, the Commission Meeting discussing the 2022 Nuclear Power Generating Sites ROR also included a discussion of the Pickering Nuclear Generating Station's Mid-Term Update. Because of the mid-term update for Pickering, intervenors were entitled to provide oral submissions at the Commission meeting. However, interventions remained limited in this respect with participant funding being provide to comment on both the ROR *and* the mid-term update, meaning that intervenors were left with a narrow scope of review for both documents. As such, the ROR is ill suited to resolving the concerns being made by the intervenors in the context if this licence renewal.

Second, the intervenors do not accept CNSC Staff's position that the Safety and Control Area ("SCA") framework, which evaluates how well licensees meet regulatory requirements and expectations based on a set of fourteen distinct SCAs, ensures comprehensive and consistent oversight of licenced activities. We submit there are several gaps in the SCA framework which often result in less than comprehensive oversight of licenced activities and limit CNSC staff's assessment of those activities. Indeed, DNA, SHA and CELA are concerned that the CNSC often has a legal obligation to consider issues that may be broader than those encompassed in the 14 SCAs. For example, the Waste Management SCA only "covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility."[26] Therefore, issues of off-site waste storage or disposal are not covered under the SCA framework, even though the CNSC may be required to consider them in order to meet its licensing duty regarding protection of the environment and human health as set out in section 24(4)(b) of the NSCA.

Third, the intervenors do not accept CNSC Staff's position that regulatory control measures—such as status reports, event initial reports, periodic safety reviews and environmental risk assessments—justify the use of longer licensing terms. For example, CNSC Staff note that

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[25] See for example, Point Lepreau submission at p 17

[26] Canadian Environmental Safety Commission, "Safety and Control Areas" (Date modified: 2023-03-06), online: https://www.cnsc-ccsn.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas/

Darlington is required to conduct a Probabilistic Safety Analysis, Environmental Risk Assessment, and Preliminary Decommissioning Plan every 5 years, and a Periodic Safety Review every 10 years.[27] Contrary to CNSC Staff's suggestion, the 5-to-10-year frequency of these submissions provide yet another reason to not exceed this timeframe for licensing, so that the public can have the opportunity to review and comment on the most recent iterations of these licensing basis documents.

Fourth, the intervenors do not accept the CNSC Staff's position that the Commission's power "to amend, suspend or revoke a licence at any time, in response to any concerns raised by the Indigenous Nations and Communities, the public or other interested parties"[28] constitutes as a reason to lengthen the licence term. While concerns can be raised at any point directly to CSNC staff and the Commission through written communication concerning a licensee, this does not guarantee open and transparent engagement with the public. A complaint about an activity at Darlington may warrant a licence amendment; however, licence amendments are not always subject to public hearings. And when these hearings are held, they are often in writing and are often not funded. As a result, meaningful engagement and comments from the public are not included in the process to amend the licence.

As a result of the above noted deficiencies, the intervenors submit that the CNSC should disregard CNSC Staff's recommendation for a 30-year licensing term.

Recommendation No. 2: Given their limited scope and exclusion of oral intervention opportunities, Regulatory Oversight Reports and meetings are not sufficient alternatives to licensing hearings and should not be relied upon to remedy outstanding issues resulting from licensing hearings, nor used as a stand-in for public hearings.

Recommendation No. 3: The CNSC should disregard CNSC staff's recommendation for a 30-year licencing term.

iii. International precedents

The intervenors submit that it would be contrary to the public interest to accept CNSC staff's recommendation for a 30-year licencing term based on international precedents. In making their recommendation, CNSC staff note they have "considered international precedence and benchmarking regarding licence terms."[29] In the CNSC Staff CMD, Table 3 "Licencee Periods and Periodic Safety Review requirements for nuclear power reactors" shows a range of licence

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[27] CNSC Staff CMD, p 15-16
[28] CNSC Staff CMD, p 18
[29] CNSC Staff CMD, p14

periods from different countries, ranging from 10 years to "plant lifetime".[30] However, in their brief analysis of international licence periods, CNSC staff have not provided sufficient information about what factors are considered by nuclear regulators in other jurisdictions during the licence application and renewal process.

Indeed, the intervenors submit that nuclear licencing procedures in other jurisdictions are quite prescriptive compared to Canada's highly subjective approach. For example, the U.S. Nuclear Regulatory Commission ("NRC") sets very detailed regulatory requirements that a nuclear facility and operator must meet to be licensed. The license renewal process requires that both a technical review of safety issues and an environmental review be performed for each application, and NRC regulations - 10 CFR Part 51 and 10 CFR Part 54 - contain very detailed requirements for each of these reviews, outlining their scope, content and technical basis.[31]

Comparatively, the CNSCs licencing scheme is so heavily reliant on guidance principles and non-binding language that it is very difficult for an observer to tell what is sufficient under the Act and regulations. The few mandatory/prescriptive provisions in the NSCA and accompanying regulations generally *only* require the license applicant to address several topics or areas of concern but offer nearly no concrete provisions for how they should be addressed or what would constitute sufficient planning and analysis under them.[32] Further, while REGDOCs give license applicants and the general public some insight into what the CNSC would like to see in an application, the use of non-binding language (e.g. "should" or "may" instead of "shall" or "must") in these documents makes it difficult to discern the threshold of information the CNSC would consider to be sufficient to address a listed area of concern.[33]

CNSC Staff also justify their recommendation for a 30-year licence period based on a claim that "the duration of a licence is largely a legal/administrative matter and has no bearing on safety performance" but the reference for this claim is a document from 2000,[34] well before the multiple reactor meltdown at the Fukushima Daiichi nuclear plant and the lessons for nuclear safety from those severe accidents. In fact, Japan's Nuclear & Industrial Safety Agency had granted a 10-year

[30] CNSC Staff CMD, p 14

[31] United States Nuclear Regulatory Commission, Part 51, online: https://www.nrc.gov/reading-rm/doc-collections/cfr/part051/index.html; Part 54, online: https://www.nrc.gov/reading-rm/doc-collections/cfr/part054/index.html

[32] *See for example*: NSCA at s 24(4); *General Nuclear Safety and Control Regulations*, SOR/2000-202 at ss 3(1), 5.

[33] *See for example*: REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*; REGDOC 1.1.1, *Site Evaluation and Site Preparation for New Reactor Facilities*; CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*; REGDOC 2.4.1, *Deterministic Safety Analysis*; REGDOC 1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant, Version 1.1*; REGDOC 1.2.2, *Licence Application Guide: Class 1B Processing Facilities*; REGDOC 2.3.3., *Periodic Safety Reviews.*

[34] CNSC Staff CMD, p 15

licence extension for Fukushima Daiichi 1 in February 2011, which had been operating for forty years at that point.

Taking this into consideration, CNSC Staff's recommendation for a 30-year licence based on international precedent *cannot* be relied upon by the CNSC as a basis for granting the licence.

Recommendation No. 4: Because CNSC Staff has not carried out and published a more thorough review of legislation and licencing procedures in other jurisdictions, and because some of the literature they have relied on are very old and do not reflect recent understandings of nuclear safety, international precedence and benchmarking do not justify longer term licences in Canada.

B. A 30-Year Licence is not compatible with existing emergency response and preparedness measures for Darlington

Emergency response planning and preparedness is multi-faceted and requires cooperation between the regulator, provincial authorities, and the licensee. The intervenors urge the Commission to exercise its stringent oversight role as to whether emergency planning and preparedness has been proven prior to exercising its discretion with regards to the Darlington NGS licence renewal.

i. Jurisdiction and authority

The intervenors submit that the CNSC's jurisdiction includes considering the adequacy of the emergency plans in place at nuclear power plants. Therefore, in deciding whether to issue the licence requested, and/or whether to impose additional requirements by way of licencee conditions to better protect health, safety and the environment, the adequacy of off-site emergency response must be reviewed.[35]

The CNSC is the only licensing authority in Canada for nuclear power plants and should ensure that licences are not issued without adequate assurance of the sufficiency of off-site emergency planning and that the public and environment will be protected in the event of a radiological emergency. Indeed, the NSCA requires the CNSC to limit risk to Canadian society in the event of a nuclear accident.

The IAEA's Safety Standards publication, *Preparedness and Response for a Nuclear Radiological Emergency* sets out the following expectations and responsibilities of the regulator for off-site planning and oversight:

[35] NSCA, at ss 3, 9, 24

Regulatory body

4.12. The regulatory body is required to establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based. These regulations and guides shall include principles, requirements and associated criteria for emergency preparedness and response for the operating organization (see also paras 1.12 and 4.5).

4.13. The regulatory body shall require that arrangements for preparedness and response for a nuclear or radiological emergency be in place for the on-site area for any regulated facility or activity that could necessitate emergency response actions. Appropriate emergency arrangements shall be established by the time the source is brought to the site, and complete emergency arrangements shall be in place before the commencement of operation of the facility or commencement of the activity. The regulatory body shall verify compliance with the requirements for such arrangements.

4.14. Before commencement of operation of the facility or commencement of the activity, the regulatory body shall ensure, for all facilities and activities under regulatory control that could necessitate emergency response actions, that the on-site emergency arrangements:

(a) Are integrated with those of other response organizations, as appropriate;
(b) Are integrated with contingency plans in the context of Ref. [9] and with security plans in the context of Ref. [10];
(c) Provide, to the extent practicable, assurance of an effective response to a nuclear or radiological emergency.

4.15. The regulatory body shall ensure that the operating organization is given sufficient authority to promptly take necessary protective actions on the site in response to a nuclear or radiological emergency that could result in off-site consequences.[36]

ii. Population growth and evacuation

One of the major concerns with requesting a 30-year term to operate Darlington NGS is uncertainty around population growth projected for the region over the course of three decades. The Darlington

[36] International Atomic Energy Agency, *Preparedness and Response for a Nuclear Radiological Emergency,* (IAEA General Safety Requirements No. GSR Part 7 (2015)), online: https://www-pub.iaea.org/MTCD/Publications/PDF/P_1708_web.pdf at pp10-11

Evacuation Time Estimate (ETE) is updated by OPG every 5-years as new census data becomes available,[37] and the ETE study provides:

> …off-site emergency planners with projections on how long it may take for various sectors and emergency planning zones to evacuate if required, as defined in the PNERP. Variables such as time of day, day of week, road restrictions, special event assemblies and weather are assessed as to how those factors may impact the evacuation duration. The 2023 study resulted in increased time estimates compared to the previous 2018 Darlington ETE study. This is primarily a result of population increase, traffic pattern changes and updated planning assumptions.[38]

During a 10-year licence period for a nuclear generating station, an ETE study may be updated once or twice, depending on timing. With that timeframe, it is not too difficult to see how evacuation timing might be impacted by future infrastructure projects (e.g., highway improvement projects) or a slight increase in population, and therefore it is easier for the Commission to assess whether the ETE study will adequately protect the public in the event of an emergency. But with a 30-year licence term, there are too many uncertainties surrounding population growth, the policies and priorities of future municipal and provincial governments shaping the development of the region, and how infrastructure and emergency services will be operating 30-years into the future. Even during Part 1 of this licence renewal hearing, Scott Preston, OPG's director of Emergency Management and Fire Protection, admitted: "…the further out in time you look, of course the uncertainty with each of those estimates grows."[39]

This acknowledgement of uncertainty surrounding evacuation planning and future population growth arose from a response to the following question asked by Commission Member LaCroix:

> I've read in your submission that there is a correlation between the evacuation time estimate and the population increase around the Darlington Nuclear Generating Station. And I was wondering, over the next three decades what will be the impact of the population growth on the evacuation plans devised by OPG?[40]

The intervenors submit that the Commission should apply the precautionary principle when assessing emergency planning and evacuation measures for a PROL renewal application, especially when an applicant is seeking a 30-year term. The intervenors submit there is too much

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[37] Ontario Power Generation, "Darlington Nuclear Generating Station Power Reactor Operating Licence Renewal Application" (May 30, 2024), at p 200 [**OPG Application**]

[38] OPG Application, at p 200

[39] Transcript for Part 1 of the public hearing of the Canadian Nuclear Safety Commission to consider the application by Ontario Power Generation Incorporated to renew its power reactor operating licence for its Darlington Nuclear Generating Station, March 26, 2025, at p 167 [**Hearing Part 1 Transcript**]

[40] Hearing Part 1 Transcript, at p 165

uncertainty with population growth and preparing evacuation time estimates spanning over three decades.

The intervenors also note that with a 30-year licence term, the public has a reduction in opportunities to provide comments on updated ETE studies due to less frequent public hearings. With emergency planning and evacuation planning being top concerns for members of the public living in close proximity to nuclear reactors, the intervenors submit that the Commission should be prioritizing the dissemination of this information to the public, and maintaining more frequent hearings enables the public to engage with the Commission and the licensee on these issues.

The intervenors **recommend** that the Commission apply the precautionary principle to the assessment of Darlington's ETE study, which would require the rejection of a 30-year licence term.

Recommendation No. 5: the Commission should apply the precautionary principle to the assessment of Darlington's ETE study, which would require the rejection of a 30-year licence term.

iii. KI Pill Distribution

The intervenors submit that the distribution and pre-distribution of potassium iodide pills ("KI pills") is an important element of emergency preparedness for nuclear power generating sites, as its ingestion helps to block uptake of radioactive iodine in case of a severe offsite accident. Radioactive isotopes of iodine are among the earliest radionuclides emitted from a nuclear power plant in case of breach of containment or in controlled venting following an accident. Emergency response to protect against radioactive iodine is needed since iodine "concentrates in the thyroid gland... a quarter of all ingested iodine goes to the thyroid under normal circumstances. As a result, when iodine is ingested, the thyroid receives a very large dose compared to the rest of the body (roughly 1000 times as much)."[41]

As an active member of the advisory group to the KI Pill Working Group, CELA submits that the distribution of KI pills is currently inadequate. While operators and regulators have spent years working on understanding the current framework for storing and distributing potassium iodide, the

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[41] IAEA, "Arrangements for Preparedness for a Nuclear or Radiological Emergency" Guide GS-G-2.1 (2007), online: https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1265web.pdf at V.17 states "The thyroid gland absorbs and concentrates iodine once it has been inhaled or ingested; thus the potential exists for large thyroid doses following the occurrence of severe core damage at a large reactor. A large dose to the thyroid can result in deterministic effects in the thyroid gland and radiation induced thyroid cancer. In the event of actual or possible core damage, stable iodine prophylaxis should therefore be used: to prevent deterministic effects in the thyroid gland (e.g. hypothyroidism; to reasonably reduce the risk of stochastic effects (e.g. radiation induced thyroid cancer) from the inhalation of radioiodine within or near the facility" [**IAEA Guide GS-G-2.1**].

critical work has not begun to further distribute KI pills to residents living beyond the current 10 km pre-distribution area.

Expanding the pre-distribution area would support the standard recognized in REGDOC-2.10.1 *Nuclear Emergency Preparedness and Response*, which requires: "...that particular consideration is given to sensitive populations such as children and pregnant women within the designated ingestion control planning zone."[42] The intervenors submit that this statement must be interpreted in such a way that equal levels of protection are provided to all individuals within the Ingestion Protection Zone ("IPZ").

According to OPG's written submission supporting the renewal application, "OPG continues to participate and support the CNSC-led Potassium Iodide Working Group. Any recommendations and lessons learned from this working group will be adopted for Darlington NGS. OPG continues to monitor the changes in the updated regulatory requirements and PNERP, and OPG will maintain compliance.[43] To align with recommendations from the working group, the intervenors **recommend** pre-distribution of KI Pills to all residences within a 50 km radius of Darlington, and pre-stock and selectively pre-distribute to vulnerable populations within the Ingestion Planning Zone ("IPZ"), which should be expanded to a 100 km radius, to align with international best practices.[44]

Recommendation No. 6: We encourage the CNSC to require Darlington to provide KI Pills by way of pre-distribution within a 50 km radius, and pre-stock to 100 km. In accordance with international best practice, the CNSC should extend KI Pill stockpiles to 100 km and ensure that places frequented by vulnerable groups, such as children and pregnant women, maintain sufficient stockpiles.

iv. (Lack of) Emergency Preparedness at Darlington Site

In January 2025, CELA reviewed the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites for 2023* (hereinafter "the ROR") and provided comments on the ROR to the Commission with the support of participant funding. Upon reviewing the Emergency Management

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[42] CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*, online: https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-10-1/index.cfm, at s 2.3.4

[43] Ontario Power Generation, "Written Submission from Ontario Power Generation Inc." CMD25-H2-1 (February 25, 2025) at p 136, *emphasis added* [**OPG CMD**]

[44] *The Heads of the European Radiological Protection Competent Authorities ("HERCA") recommend that emergency strategies for iodine thyroid blocking ("ITB") extend to 100km. The distribution of ITB to 100km is one of three requirements recommended in its 'general emergency response strategy'.* HERCA-WENRA, "Approach for a better cross-border coordination of protective actions during the early phase of a nuclear accident" (2014), online:https://www.wenra.eu/sites/default/files/news_material/herca-wenra_approach_for_better_cross-border_coordination_of_protective_actions_during_the_early_phase_of_a_nuclear_accident.pdf, at pp 9, 38

and Fire Protection SCA section of the ROR, CELA was concerned by an instance of medium safety significance non-compliance occurred at Darlington in August 2023: a reactive field inspection was conducted by CNSC staff due to an adverse trend regarding the audibility issues of the public address (PA) system throughout the station.[45] In the public eye, having a functioning PA system at a nuclear power plant is essential in being able to address emergency situations and ensure safety protocols are being followed. At the time of the ROR being prepared, the PA system was not yet repaired, and that OPG was working through their corrective action plant to repair and replace ageing portions of the PA system.[46]

This PA system issue is mentioned in the CNSC Staff CMD for this licence renewal hearing, as a proposed improvement to Darlington under the Emergency Management and Fire Protection SCA:

> OPG has committed to replace the public address system, with an in-service estimate of December 2026 projected. CNSC staff will continue to monitor the progress towards the completion of this upgrade activity.[47]

The intervenors are concerned about the timing surrounding the PA system malfunction; namely, when PA system arose (unknown), when the CNSC was notified (August 2023), and that it won't be back in service until a projected timeline of December 2026. The intervenors **submit** that these systems should have been undergoing routine maintenance to ensure they are functioning, rather than an action plan arising from a *reactive field inspection*. This is an especially concerning situation with OPG requesting a 30-year licence term (and CNSC Staff recommending the 30-year term). The intervenors are concerned that the Darlington NGS is not adequately maintaining emergency equipment to safely operate and is not sufficiently prepared for an emergency breaking out at the Darlington site.

The intervenors request that OPG explain how the PA system at Darlington fell into disrepair and why it was not upgraded in a timely manner.

The intervenors further request that OPG provide the public with details about how it intends on monitoring the functionality of emergency equipment, and how it is going to ensure that malfunctions of important equipment like the PA system will not occur in the future.

Recommendation No. 7: OPG should explain how the PA system at Darlington fell into disrepair and why it was not upgraded in a timely manner.

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[45] Canadian Nuclear Safety Commission, Regulatory Oversight Report for Canadian Nuclear Power Generating Sites for 2023, CMD 25-M9, at p 28 [**ROR 2023**]

[46] ROR 2023, at p 28

[47] CNSC Staff CMD, at p 71

Recommendation No. 8: OPG should provide the public with details about how it intends on monitoring the functionality of emergency equipment, and how it is going to ensure that malfunctions of important equipment like the PA system will not occur in the future.

v. Public awareness

First and foremost, the CNSC is vested with protecting the public from any accident involving a nuclear reactor or site. This means that before proceeding with any licensing decision, the intervenors submit that CNSC *must* be satisfied that the public is prepared and has the information it needs to be informed *in advance* of a real accident.

Currently, section 10.1 of the proposed Licence Conditions Handbook ("LCH") for Darlington NGS states "The licensee should provide emergency communications outlining what surrounding community residents need to know and do before, during and after a nuclear emergency."[48] The intervenors **recommend** "should" be replaced with the express requirement that "the licensee must provide emergency communications." As currently worded, the LCH leaves the public without a plan should they wish to raise their level of awareness. Also, as a condition of licence renewal, the CNSC should require ongoing public education for emergency preparedness and protective actions.

DNA, SHA, and CELA have been vocal about the issue of public awareness surrounding emergency preparedness during various CNSC interventions. The intervenors submit despite public awareness being a key factor in effective emergency planning, most citizens in the Greater Toronto Area are not aware that they live within the Ingestion Planning Zone—extending 50 km from nuclear facilities—of not one but two very large nuclear generating stations each with multiple existing large units. Even fewer are aware of the SMRs developments proposed in Durham Region.

With the lack of public awareness surrounding nuclear safety and emergency preparedness, groups such as CELA, DNA, and SHA find themselves trying to fill the gaps in public education on the subject matter: "according to a poll conducted in 2018, 54 percent of respondents were unaware of any emergency response plans in case of a nuclear accident, a clear indication of the need for stronger awareness efforts."[49] In an attempt to inform citizens living in a nuclear host community, CELA organized a one-hour information webinar with DNA, Northwatch, and Safecast on April

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[48] CNSC Staff CMD, "Draft Licence Conditions Handbook" at p 98 of 175

[49] Masahda Lochan-Aristide, "Blog: Neighbour of a Nuclear Plant – What Residents of Durham Region Should Know About Nuclear Energy" CELA (April 17, 2024), online: https://cela.ca/blog-neighbours-of-a-nuclear-plant-what-residents-of-durham- region-should-know-about-nuclear-energy/

23, 2024, informing attendees about ways they can become more engaged in nuclear issues impacting their families and communities.[50]

The intervenors **submit** that to ensure there is effective nuclear safety awareness and emergency preparedness in the region surrounding Darlington, more comprehensive public education on emergency response is required. The intervenors **recommend** that the CNSC and OPG collaborate with community groups and intervenors to develop a strategy to better inform the public on what to do in case of emergency.

Recommendation No. 9: Licence Conditions Handbook section. 10.1 should be updated to read "licensee must provide emergency communications" and not "should", as currently drafted.

Recommendation No. 10: The CNSC should require ongoing public education for emergency preparedness and protective actions. The CNSC and OPG should collaborate with community groups and intervenors to develop a strategy to better inform the public on what to do in case of emergency.

C. OPG's licence application fails to adequately consider environmental concerns and climate change modelling.

In addition to protecting human health, the Commission has a duty under the NSCA to protect the environment from unreasonable risk. This requires the Commission to consider both radiological and non-radiological impacts on the environment. With OPG seeking a 30-year licence term for Darlington, the intervenors have concerns regarding OPG's downplaying of environmental effects that have occurred during the current licence period. For instance, there is a lack of discussion surrounding environmental infractions that have occurred at Darlington. Additionally, the intervenors are concerned about the climate change modelling and discussion around climate change mitigation for the proposed 30-year term.

i. Regulatory Compliance

According to OPG, "at OPG, infractions are regulatory non-compliances that have moderate potential for regulatory actions and/or involvement. During the current licence term, there were 13 infractions (as of September 30, 2024), most of which were related to Environmental Compliance Approvals (ECAs)."[51] Unfortunately, OPG does not elaborate on this statement about environmental infractions during the current licensing period. OPG does not provide clarification of what ECAs experienced infractions, or when they occurred.

[50] CELA, "Neighbours of a Nuclear Plant: An Information Session for Durham Residents" (April 23, 2024), webinar, online: https://cela.ca/webinar-neighbours-of-a-nuclear-plant-an-information-session-for-durham-residents/
[51] OPG CMD, at p 119

The CNSC Staff CMD notes that "OPG did not report any ECA non-compliances for air emissions or water effluent to the provincial regulator or the CNSC during the 2016-2023 period."[52] From the information provided by both CMDs, one can infer that either (a) the infractions involved other ECAs, or (b) Darlington proceeded to accumulate a number of ECA non-compliances for air emissions or water effluent during the year 2024 (up until CMDs were published). In either case, there is an absence of detailed discussion surrounding OPG's non-compliance at Darlington. The only releases mentioned in either CMD is an action level exceedance for tritium oxide (more on this below), and 7 ozone depleting substance releases (more on this below). The intervenors **request** that OPG discuss these 13 infractions in more detail—what the infractions were, when they occurred, why they took place, and what OPG has done to resolve them.

Recommendation No. 11: OPG should discuss the 13 infractions that occurred during the current licence term in more detail—what the infractions were, when they occurred, why they took place, and what OPG has done to resolve them.

ii. Radiological release

OPG's CMD briefly discusses a release of tritium oxide:

> During the current licence term, there was an exceedance of the weekly airborne tritium oxide (HTO) action level. This exceedance was attributed to an event at the Darlington NGS Tritium Removal Facility (TRF) due to issues with the tritium immobilization system. OPG took corrective actions to minimize further releases as well as implementing longer-term corrective actions. These include creating a cross-functional team to proactively address conditions in the TRF, implementing a design change to improve the robustness of the tritium immobilization system, improving leak check processes, and strengthening organizational support and prioritization of TRF challenges and equipment reliability.[53]

In order to get a better idea of how big this action level exceedance was, one needs to look at the NPGS ROR covering 2023, which explains that in September 2023, Darlington had an action level exceedance for tritium oxide, in which <u>over double the Action Limit</u> was released: the station Action Limit is 2,670 Ci/week, and 6,469.24 Ci of station tritium oxide was released.[54] This is a large amount of tritium - 2.4 times the weekly limit. It means that about 7% of the elemental tritium emitted by Darlington TRF in the whole of 2023 was emitted during one incident - a worrying amount.

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[52] CNSC Staff CMD, at p 68
[53] OPG CMD, at p 123
[54] ROR 2023, at p 54

The intervenors are concerned that the volume of the release was not explicitly mentioned in the licence renewal application CMDs, and submit that there must be transparency in a licensee's application. The Commission needs to hold licensees like OPG accountable with the disclosure of releases into the environment, as the framing of the tritium oxide release in the CMD seems to be an attempt by OPG to downplay the situation by omitting key details.

The intervenors request more information surrounding this release, namely how it happened, i.e., what does OPG mean by the vague statement of "*this exceedance was attributed to an event at the Darlington NGS Tritium Removal Facility (TRF) due to issues with the tritium immobilization system?" Was this a preventable incident*? Are there refurbishment activities that need to occur at the TRF to protect the environment from tritium oxide releases?

Recommendation No. 12: The Commission needs to hold licensees like OPG accountable with the disclosure of releases into the environment.

Recommendation No. 13: More information surrounding the tritium oxide release is requested, namely how it happened, i.e., what does OPG mean by the vague statement of "*this exceedance was attributed to an event at the Darlington NGS Tritium Removal Facility (TRF) due to issues with the tritium immobilization system?" Was this a preventable incident*? Are there refurbishment activities that need to occur at the TRF to protect the environment from tritium oxide releases?

iii. Non-radiological release

Similar to the action level exceedance of tritium oxide, the licence application materials do not provide much detail on non-radiological releases during the current licence. OPG briefly notes that during the current licence period, there were seven ozone depleting substance releases, all of which have been minimized through routine maintenance of equipment.[55] CNSC Staff explain that "ozone depleting substances are used in refrigeration systems, releases between 10 kg and 100 kg are reported to Environment Canada in semi-annual reports."[56]

This is the extent of the discussion on the seven ozone depleting substance releases; there is no discussion of when they occurred, how much was released, whether it could have been prevented/reduced through thorough monitoring and proper maintenance of equipment. The intervenors request more information about these ozone depleting substance releases, and clarification as to whether they could have been prevented through proper maintenance and monitoring procedures that did not occur.

With OPG pursuing a 30-year licence term, there is the expectation that preventing any and all releases to the environment should be prioritized, and with seven ozone depleting substance

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[55] OPG CMD, at p 124

[56] CNSC Staff CMD, at p 68

releases occurring during the current licence period, it appears that environmental releases are being overlooked until they become abundant in number of instances. This does not instill confidence in the public that OPG is being diligent with its environmental monitoring. Even if releases are not severe in nature, if they are overlooked, especially over the course of 30 years, there is a risk of cumulative effects building in the local environment. As such, the intervenors submit that a 30-year term is an inappropriate request amidst the absence of disclosing details surrounding environmental releases.

Recommendation No. 14: More information about the seven ozone depleting substance releases is requested, and clarification as to whether they could have been prevented through proper maintenance and monitoring procedures that did not occur.

Recommendation No. 15: A 30-year term is an inappropriate request amidst the absence of disclosing details surrounding environmental releases.

iv. Uncertainty with climate change modelling

The intervenors strongly oppose a request for a 30-year licence due to the uncertainty of climate change impacts in Ontario over the next three decades. We submit climate considerations are a necessary component of the licence application if the CNSC is to find, pursuant to section 24(4) of the NSCA, that the licensee will make adequate protection for human health and the environment. CELA raised the following issues at the Point Lepreau licence renewal hearing,[57] and they remain relevant in the context of Darlington's licence renewal application

First, the intervenors submit that it is critical to consider climate vulnerability in the CNSC's review. Potential climate impacts are directly within the purview of the CNSC because of its responsibility to protect people and the environment from unintended radioactive releases. As climate impacts become more frequent and pronounced, we urge the CNSC to review the licence renewal application with express consideration given to climate impacts and climate resiliency.

Second, nuclear power plants and associated facilities are particularly vulnerable to climate change effects, including thermal disruptions (e.g., heatwaves and droughts) and extreme weather events. Climate change might increase the likelihood of flooding, which could also create problems for cooling reactors. Further, in the event of an accident, floods would make it harder to access the site, making an emergency response even more difficult.[58]

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[57] Point Lepreau Intervention, at p 29-30

[58] Kopytko, Natalie, *Uncertain Seas, Uncertain Future for Nuclear Power*, (2015) 71(2) Bulletin of the Atomic Scientists 29–38, https://doi.org/10.1177/0096340215571905;
Kopytko, Natalie, and John Perkins, *Climate Change, Nuclear Power, and the Adaptation–Mitigation Dilemma*, (2011) 39(1) Energy Policy 318–33, https://doi.org/10.1016/j.enpol.2010.09.046

Many of these weather events affect the availability of water, which in turn can cause accidents at nuclear power plants. Nuclear reactors circulate large quantities of water through their radioactive cores in order to remove the tremendous amounts of heat produced. Availability of adequate amounts of water at a suitable temperature is critical; absence could result a nuclear accident, as was demonstrated during the March 2011 Fukushima Daiichi disaster. At Fukushima, there was no shortage of water outside the reactor. But it was not possible to circulate this water through the reactor—and therefore remove the heat being generated there—because there was no electricity available to run water circulation pumps. The result was a nuclear meltdown. Such possibilities will become more frequent as climate change becomes worse.

The intervenors **submit** that particular consideration should be given to climate impacts and climate resiliency in the CNSC's evaluation of ongoing site suitability. As set out in REGDOC 1.1.1, *Site Evaluation and Site Preparation for New Reactor Facilities*, the suitability of a site is to be revisited throughout the lifecycle of the nuclear facility's operations.[59] Further, the Commission is required to consider ongoing site suitability as a Contracting Party under the Convention on Nuclear Safety. Article 17 of the Convention provides:

> **ARTICLE 17. SITING**
>
> Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:
>
> (i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;
>
> (ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;
>
> (iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;
>
> [...][60]

Therefore, the intervenors **submit** that site-specific climate change impacts and associated external events have to been assessed and used to set criteria for evaluation of the 30-year licence application.

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[59] REGDOC 1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities at preface and Appendix C.

[60] International Atomic Energy Agency, Convention on Nuclear Safety, Legal Series No 16, IAEA, Vienna (1994) at Article 17, *emphasis added*.

Third, to meet the requirements under section 24 (4) of the NSCA, it is critical that detailed climate analysis be presented within the licence application and considered at the hearing. In OPG's CMD, there is mention of the ***intention*** to develop a climate risk assessment:

> OPG is aware that natural external hazards, e.g., severe weather, may become more significant during the operating life of Darlington NGS due to climate change. As such, Darlington NGS **intends** to perform a forward-looking climate risk assessment using the methodology found in *Electric Power Research Institute Climate Vulnerability Assessment Guidance for Nuclear Power Plants*, and has acquired site-specific climatic indicators to identify possible vulnerabilities and develop strategies, if required, to ensure the nuclear assets are resilient to potential future changes in climate. OPG will identify climate-related hazards followed by an assessment that evaluates the exposure of different components of the plant to these hazards which will lead to a vulnerability assessment where the interactions of the exposed assets and the climate-related hazards are considered to understand the potential impact on nuclear safety. A risk analysis will be used to prioritize adaptation strategies considering the available adaptive capacity.[61]

As this blurb indicates, OPG does *not* currently have this assessment written to accompany its application for a 30-year term. The intervenors submit that this should have been prepared for this application to be reviewed by the Commission, as well as be available for review and comment by Indigenous groups and communities, and members of the public. We reiterate that climate change considerations are directly relevant to the CNSC's determination about whether the licencee will make adequate provision for the protection of the environment and the health and safety of persons. As such, detailed climate analysis and site- specific modelling is necessary so that the public can fully understand the potential impacts, review the information, and provide comments to the CNSC.

Recommendation No. 16: The CNSC should review the licence renewal application with express consideration given to climate impacts and climate resiliency, including in the context of site suitability and impacts on safety and the environment.

Recommendation No. 17: The criteria by which climate change impacts and natural external events have been assessed and evaluated against the 25-year licence application must be clearly set out.

Recommendation No. 18: OPG's detailed climate analysis must be presented in a public forum as part of the CNSC's licensing process.

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[61] OPG CMD, at p 64, *emphasis added.*

D. A 30-year term raises concerns surrounding waste management

One of the major concerns of individuals living in close proximity to the Darlington NGS is the storage of radioactive waste, and this concern is elevated with the prospect of a 30-year licence term, as this means an another 30-years' worth of radioactive waste would be produced and be stored on site at Darlington, situated right beside Lake Ontario.

In particular, members of the public are concerned about the manner in which nuclear waste is stored, with Darlington's dry storage container system being situated in close proximity to Lake Ontario. As more waste is produced, more storage containers are added in between the current dry storage buildings and Lake Ontario, which increases the vulnerability of these new containers to extreme weather events.

Currently, there is no long-term disposal of radioactive waste. As OPG explains, "the Nuclear Waste Management Organization (NWMO), in accordance with the federal Nuclear Waste Act (2002), is responsible for implementing Canada's plan for the safe, long-term management of used nuclear fuel. Under the NWMO's plan, a deep geological repository for used fuel is ***expected*** to be in-service in the mid-2040s."[62] This means that *if* the deep geological repository is established, it won't be functional until Darlington is nearing the end of the 30-year licencing term. The intervenors **submit** that without a permanent and safe disposal site in place for the long-term disposal of radioactive waste, the amount of radioactive waste being produced should be limited.

Furthermore, due to the uncertainty surrounding long term disposal of radioactive waste, OPG's long-term waste strategy is essentially non-existent for this application: "As OPG's waste strategy for permanent disposal continues to evolve over the licence term. OPG will continue to engage with stakeholders and seek amendments to the associated licenses as required."[63] As the intervenors have previously submitted, seeking amendments to the licence does not provide the same fair process for the public to engage with the Commission as a hearing would.

A shorter licence term would be more beneficial; having more frequent licensing hearings, OPG's engagement with stakeholders to discuss Darlington's waste strategy becomes more accessible. The intervenors submit that a shorter licence term is more appropriate to protect and encourage public participation and engagement with issues like radioactive waste storage.

Recommendation No. 19: Without a permanent and safe disposal site in place for the long-term disposal of radioactive waste, the amount of radioactive waste being produced should be limited.

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[62] OPG CMD, at p 146, *emphasis added*

[63] OPG CMD, at p 146

Recommendation No. 20: a shorter licence term is more appropriate to protect and encourage public participation and engagement with issues like radioactive waste storage.

E. OPG's application fails to discuss the implications of the Darlington New Nuclear Project being located at the same lands as the Darlington NGS

The intervenors acknowledge that the Darlington New Nuclear Project ("DNNP"), which proposes up to four small modular reactors ("SMRs") be built at the Darlington site, does not fall within the parameters of the Darlington NGS and that both sites would operate independently from each other. Despite their independence in operations, the intervenors submit the DNNP ought to have been included in more discussions for this licence application, as its siting on the same lands as Darlington NGS has implications for safety measures and emergency planning.

On April 4, 2025, the CNSC announced that OPG is authorized to construct 1 BWRX-300 reactor at the Darlington New Nuclear Project site.[64] The intervenors had prepared submissions for the application for licence to construct hearing for the DNNP,[65] Within these submissions, we had expressed safety concerns about siting multiple reactors in close proximity to each other: "Any consequences and risks from accidents would be magnified by their proximity to multiple sources of material which can achieve critical chain reactions, both in reactor cores and in used fuel storage."[66] It is important to note that while the licence to construct application for 1 SMR unit has been granted, the BRWX-300 design is not complete, and will see updates to its features and details as decisions are made. The incompleteness of the project makes it difficult to be certain of the final waste facility design.[67]

Because the BWRX-300 design is in a state of flux and fine-tuning, the intervenors submit that a 30-year licence for the Darlington NGS limits public engagement on how different stages of the DNNP will interact and impact Darlington NGS. As the DNNP progresses along (and will eventually seek a licence to operate after the completion of construction), it is important that Darlington NGS has a shorter licence term, to ensure waste management strategies and emergency planning and evacuation time estimates can be discussed with concerned members of the public within the context of the new nuclear reactor being sited in close proximity to Darlington NGS.

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[64] CNSC, "Commission authorizes Ontario Power Generation Inc. to construct 1 BWRX-300 reactor at the Darlington New Nuclear Project Site" News Release (April 4, 2025), online: https://www.canada.ca/en/nuclear-safety-commission/news/2025/04/commission-authorizes-ontario-power-generation-inc-to-construct-1-bwrx-300-reactor-at-the-darlington-new-nuclear-project-site.html

[65] *See* CELA, "Written Submission from the Canadian Environmental Law Association" CMD 24-H3.84, online: https://api.cnsc-ccsn.gc.ca/dms/digital-medias/CMD24-H3-84.pdf/object **[CELA DNNP Submission]**

[66] CELA DNNP Submission, at p 14

[67] CELA DNNP Submission, at p 14

The intervenors recommend that the Commission review this licensing renewal application with the DNNP included in the context of emergency planning and waste management issues. We further recommend that the 30-year licence term be denied to ensure there are more frequent engagement opportunities to assess how the two nuclear reactor sites are impacting each other.

Recommendation No. 21: The Commission should review this licensing renewal application with the DNNP included in the context of emergency planning and waste management issues.

Recommendation No. 22: The 30-year licence term should be denied to ensure there are more frequent engagement opportunities to assess how the two nuclear reactor sites are impacting each other.

VI. 30-YEAR LICENCE TERM IS INAPPROPRIATE FOR REACTORS WITH SOME AGED COMPONENTS

The intervenors emphasize that the 30-year licence request is for a nuclear reactor with some components that are old, because refurbishment does not involve the wholesale replacement of all of the parts of a nuclear reactor. Older components are more susceptible to failures, which could lead to severe accidents. Indeed, the likelihood of accidents and failures at old reactors has often been described by something called the bathtub curve.[68] The failure rate is initially high due to manufacturing problems and operator errors associated with new technology. Then curving like a tub, the failure rate declines with experience and rises again as aging related wear and tear starts increasing. The intervenors recommend that CNSC deny a 30-year licence term and only permit a much shorter licence extension, which would allow the public to have more frequent and deeper insight into the rate of failures of components at the Darlington Nuclear Generating Station and its safety.

Recommendation No. 23: The CNSC should deny a 30-year licence term and only permit a much shorter licence extension, thus allowing the public to have more frequent and deeper insight into the rate of failures of components at the Darlington Nuclear Generating Station and its safety.

VII. CONCLUSION AND ORDER REQUESTED

For the foregoing reasons provided in this submission, DNA, SHA, and CELA submit it would be contrary to the responsibility of the Commission to protect the environment and ensuring the health and safety of persons if it were to grant a 30-year licence for the Darlington Nuclear Generating Station, and recommend the CNSC issue an order:

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[68] Lochbaum, David. "The Bathtub Curve, Nuclear Safety, and Run-to-Failure." *The Equation* (blog), November 17, 2015. https://blog.ucsusa.org/dlochbaum/the-bathtub-curve-nuclear-safety-and-run-to-failure/.

(1) Granting Durham Nuclear Awareness, Slovenian Home Association, and the Canadian Environmental Law Association the status of intervenor;

(2) Granting Durham Nuclear Awareness, Slovenian Home Association, and the Canadian Environmental Law Association the opportunity to make an oral presentation at the June 2025 public hearing;

(3) Denying OPG's request for. 30-yer licence on the basis that:

   a. A 30-year licence would remove the right to public hearing for a full generation, compromise meaningful public participation in nuclear matters and erode public confidence in both the Commission and the licensee;
   b. A 30-yeear licence would be unjustified given OPG's plans to deploy up to four Small Modular Reactors ("SMRs") at the Darlington site during that timeframe;
   c. Off-site emergency planning and preparedness at Point Lepreau is insufficient to protect human health and the environment;

(4) Denying CNSC staff's recommendation for a 30-year licence; and

(5) Directing OPG to revise its licence renewal application, considering all of the deficiencies and recommendations herein.

Sincerely,

On behalf of

CANADIAN ENVIRONMENTAL LAW ASSOCIATION
DURHAM NUCLEAR AWARENESS
SLOVENIAN HOMEOWNERS ASSOCIATION

Sara Libman
Legal Counsel

APPENDIX A – EXPERT REPORT BY DR. IAN FARLIE

EXPERT REPORT

Re: OPG's Application for a 30-year extension of its Operating Licences at Darlington NGS

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Prepared for:
Canadian Environmental Law Association

Contents

Dated May 4, 2025

Executive Summary

This report has been prepared by Dr. Ian Fairlie on behalf of CELA to review OPG's application for extended licences to operate its four reactors and the TRF at Darlington.

OPG is applying for a 30 year licence extension[69] at its Darlington nuclear generating station (NGS) in Durham Region, Ontario. However the 4 reactors at Darlington NGS have already been operating for more than 30 years. No reliable technical guidance exists as to whether it is safe to continue operating nuclear reactors for another 30 years.

We simply do not know for sure whether it would be safe to operate the four reactors for another 30 years. CELA recommends that the Precautionary Principle should be applied and the Darlington reactors should be phased out.

Annual tritium releases from Darlington NGS and its TRF are large in comparison with other nuclear reactors. Local residents receive radiation exposures from tritium releases to air and to Lake Ontario via tritium ingestion, inhalation, and skin absorption. These increase the probabilities of cancer and other radiogenic diseases.

Epidemiology studies at other Canadian facilities emitting tritium indicate increases in cancer and congenital malformations. Recent large statistically powerful, epidemiology studies of nuclear workers in UK, US and France have increased the radiation risks of low-LET radiation, including tritium. This is applicable to Darlington NGS' tritium releases. Also, newly available studies indicate increased incidences of child leukemia near NPPs.

The large tritium emissions, increased estimates of cancer risk and newly available ill-health studies near NPPs together pose health risks to the workers and people living near and downwind from Darlington.

Under the Precautionary Principle, this report recommends that no further licenses be issued for the Darlington NGS.

[69] https://www.opg.com/documents/darlington-ngs-application-for-renewal-of-the-power-reactor-operating-licence-pdf/

A. Introduction

I am a Canadian citizen resident in the United Kingdom. I am an independent scientist who has specialised on radioactivity in the environment with degrees in chemistry and radiation biology. My doctoral studies at Imperial College, UK and Princeton University, US examined nuclear waste technologies. One of my areas of expertise is the dosimetric impacts of nuclear reactor emissions. I have acted as consultant to UK Government departments, the European Parliament, the World Health Organisation, environmental NGOs, and UK local authorities. Between 2000 and 2004, I was head of the Secretariat to the UK Government's Committee Examining the Radiation Risks of Internal Emitters (CERRIE).

Of particular relevance to the CNSC hearings, I have authored numerous scientific articles on the hazards of tritium published in peer-reviewed journals, as follows

- Fairlie I. (2014) A hypothesis to explain childhood cancers near nuclear power plants J Environ Radioact. 133 (2014) pp 10- 17
- Fairlie I. (2010) Hypothesis to Explain Childhood Cancer near Nuclear Power Plants. Int J Occup Environ Health 2010;16:341–350.
- Fairlie I. The hazards of tritium – revisited. Medicine, Conflict and Survival. Vol 24:4. October 2008. pp 306 -319. http://www.informaworld.com/smpp/content~content=a904743144~db=all~order=page
- Fairlie I. RBE and w_R values of Auger emitters and low-range beta emitters with particular reference to tritium. Journal of Radiological Protection. 2007; **27**:157-168. http://www.iop.org/EJ/abstract/0952-4746/27/2/003/
- Fairlie I. Tritium Hazard Report: Pollution and Radiation Risk from Canadian Nuclear Facilities. Published by Greenpeace Canada. June 2007. http://www.greenpeace.org/raw/content/canada/en/documents-and-links/publications/tritium-hazard-report-pollu.pdf
- Fairlie I. Tritium Hazard Report on Cernavoda 3/4: Environment Impact Analysis: Report for Greenpeace Romania. Published by Greenpeace Central Europe. November 2007. http://www.greenpeace.ro/uploads/articole/Cernavoda%20Report%20for%20GP%20Central%20Europe.pdf
- Fairlie I. Uncertainties in Doses and Risks from Internal Radiation. Medicine, Conflict and Survival, Vol 21:2. pp 111 – 126. (2005) http://www.informaworld.com/smpp/content~content=a714004320~db=all~order=page
- Fairlie I. Tritium: The Overlooked Nuclear Hazard. The Ecologist. 22 No 5. 228-232 (1992)

B. Proposed 30-year Licence Extension

The OPG is applying for a 30 year licence extension[70] at its Darlington nuclear generating station (NGS) in Durham Region, Ontario. However the 4 reactors at Darlington NGS have already been operating for more than 30 years. Table 1 shows their commencement dates

Table 1

Unit 1:	November 14, 1992
Unit 2:	October 9, 1990
Unit 3:	February 14, 1993
Unit 4:	June 14, 1993

This means that, as of May 2025, the units at Darlington NGS have been operating for the following number of years as seen in Table 2.

Table 2

Unit 1:	~32.5 years
Unit 2:	~34.5 years
Unit 3:	~32 years
Unit 4:	~32 years

The maximum number of permitted operating hours for CANDU nuclear reactors in Canada has been set by CNSC at 210,000 hours. With an average 80% load factor, this is 7,000 hours per year, or 30 years.

The numbers of years in table 2 are approximate as reactor load factors vary from year to year. However they indicate, in general terms, that the 4 reactors at Darlington have exhausted their permitted operating hours and should therefore be closed. Extending their lives for another 30 years would mean that the reactors would have operated for 62 - 65 years which is unacceptably long as they were originally designed with 30 year lifespans.

Other countries**,** e.g. UK and France**,** only licence their reactors for the designated plant lifespans as shown in Table 3 of CMD 25-H2.A (page 13) reproduced below. It is recommended that CNSC should do the same.

[70] 70 https://www.opg.com/documents/darlington-ngs-application-for-renewal-of-the-power-reactor-operating-licence-pdf/

Table 3: Licence periods and Periodic Safety Review requirements for nuclear power reactors

Country	Licence period	PSR frequency
Canada	10 years	every 10 years
France	plant lifetime	every 10 years
South Korea	30 years, 40 years and 60 years	every 10 years
United Kingdom	plant lifetime	every 10 years
United States	40 years, with 20-year renewal option	Regulatory oversight coupled with the back fitting rule as requested by the licensees

In their submissions, OPG has argued that its recent refurbishments of units 1,2,3 and continued refurbishment of unit 4 will mean that operation of the four units will be safe in future.

In our view, this is mistaken, for a number of reasons.

First, we have seen no probabilistic risk analysis (PRA) indicating that the risks of future accidents resulting in a fatality are less than 1 in a million. No such analysis exists in fact. Second, although retubing has occurred and new equipment (pumps, valves, seals etc.) has been installed, the important cores and calandria have not. The nub of the matter is that these have been exposed to mechanical stresses, high pressures, high temperatures, and most important to neutron bombardment for >30 years.

The result is that any prediction of safe operation over the next 30 years must, of necessity, contain uncertainties. However these have not been quantified.

To a major extent, we are guided in our analysis by a US Technical Letter Report published by PNNL under contract to the US NRC. "Criteria and Planning Guidance for Ex-Plant Harvesting to Support Subsequent License Renewal " December 7, 2017, (PNNL-27120). In essence, this PNNL report for the US NRC attempted to assess the damage and degradation inside generic US nuclear reactors from decades of routine operations as a guide to plant life extensions but it was unable to do so. The technical evidence either did not exist or was considered unsatisfactory.

In other words, no reliable US technical guide exists as to whether it is safe to continue operating its nuclear reactors for another 30 years. Although this report was for US light water reactors rather than Canadian heavy water ones, its broad conclusion applies to both.

The upshot is we simply do not know for sure whether it would be safe to operate the four reactors for another 30 years: we are crossing our fingers and hoping all will OK. If one may apply a car analogy, it's as if a 30 year-old family car were given a new paint job and 4 new tires and declared ready for another 30 years. Let's get real. Instead CELA recommends that the Precautionary Principle should be applied here and that no new operating licence should be granted and that the Darlington reactors should be phased out.

C. Tritium's Releases and Hazardous Properties

This section of the report is focussed on tritium - the radioactive isotope of hydrogen - ^{3}H with a half-life of 12.3 years – as the large tritium releases from Darlington are a matter of considerable concern.

1. Large Tritium Releases

Darlington continues to release large quantities of tritium of the order of petabecquerels per year (PBq/a – see radioactivity units in Annex B). One petabecquerel is 10^{15} Bq, or one thousand trillion Bq, ie 1,000,000,000,000,000 Bq - an extremely large amount or radioactivity. The Darlington reactors plus its Tritium Recovery Facility (TRF) release more tritium than any other nuclear site in Canada, indeed the world. This is not an enviable record and is a matter of concern.

Tritium is released in two forms

(a) elemental tritium gas (HT), and
(b) tritiated water or water vapour (HTO), ie radioactive water or vapour.

As a result of molecular exchange - explained in box 1 below - these two types of releases are routinely added together and treated as HTO (Davis et al, 1997). This is an important matter as the ICRP considers HTO, i.e., radioactive water, to be 25,000 times more radiotoxic than HT hydrogen gas. (see Annual Limits of Intake - https://www.icrp.org/docs/Occupational_Intakes_P1_for_consultation.pdf)

Box 1. Molecular Exchange
In the environment, tritium atoms in HT rapidly exchange with stable H atoms in water through the phenomenon of molecular exchange. Therefore here all tritium releases are treated as HTO. This is common practice in OPG and AECL reports (Davis et al, 1997).

In more detail, in matter, all atoms swap positions with like atoms in other molecules to varying degrees. This means that the tritium atoms in HT exchange with stable H atoms in the environment in the hydrosphere and in biota, including humans. H and T, the smallest atoms (apart from deuterium) are prominent as regards exchange reactions. These exchange reactions are very quick, taking about 10^{-15} seconds on average. That is, 0.000,000,000,000,001 seconds.

As the most common hydrogenous material in the environment is water (either in liquid or vapour form), this means that tritium released as HT vert quickly transfers to HTO. In practical terms, this means that downwind, all open water surfaces and biota, including food crops, all plants, animals and humans, become contaminated with tritium up to the tritium concentration in the atmosphere. For example, it would include vegetables and fruit in exposed market stalls and shops (Inoue, 1993).

Tritium releases from Darlington in 2023 are set out in table 1 in petabecquerels - ie 10 to the power 15 (10^{15}) becquerels. All emitted elemental tritium H-3 is assumed to be converted to HTO – as explained above. Almost all atmospheric elemental tritium releases emanate from the Tritium Removal Facility onsite.

Table 1. Tritium Releases from Darlington in 2023 – **PBq = 10^{15} Bq**

Year	tritium (^3H + HTO) emissions to air	tritium (HTO) discharges into Lake Ontario	total tritium release
2023	4.48	0.63	5.62

Darlington's nuclide releases are both to air and to Lake Ontario but we are principally concerned with air emissions for three reasons. First, the key parameter in estimating radiation exposures to local people is the nuclide <u>concentration</u> in environmental materials. Contrary to popular belief, air emissions actually result in much higher environmental concentrations than water discharges[71]. Second, individual and collective doses from air emissions are much larger than from discharges to water. A third reason is that while we can avoid drinking contaminated water to some extent (e.g. with bottled water) we cannot avoid breathing contaminated air.

Darlington's annual air emissions are higher than those from other CANDU nuclear station and significantly higher than other reactor types around the world – see Table 2.

TABLE 2. Annual tritium (H3 +HTO) air emissions from nuclear power facilities in terabecquerels per year (One TBq = 10^{12} Bq)

[71] The reason is dilution. A cubic metre of water contains a million grams of water which dilutes radioactive contaminants far more effectively than a cubic metre of air which only has ~10 grams of water: ie >100,000 times more effectively. This is not to accept that dilution is the solution to pollution - it isn't - it merely reflects existing (unsatisfactory) methods of disposing of gaseous nuclear wastes.

Facility	TBq/a
Darlington (2023)	4,480
Bruce (2019)	800
Pickering (2019)	480
Point Lepreau (2020)	290
Dungeness B (AGR) UK (2016)	6
Sizewell B (PWR) UK (2018)	3
Dungeness A (Magnox) UK (2010)	1.3
German NPPs (2015) (average)	0.5

The above table contains data for different years but they are representative annual emissions.

Noble radioactive gases, including Kr-85 and xenon isotopes, are also emitted at relatively high from most nuclear facilities. However these nuclides are inert and do not interact with body proteins, carbohydrates and lipids - unlike tritium. When they decay in air their beta particles and gamma rays do not result in high external skin doses. And when inhaled, they are exhaled within seconds without interacting significantly with the body – unlike tritium. Some commentators mention C-14 releases from nuclear facilities as well. These do exist but are not discussed here as their emissions are typically about 10^4 to 10^6 times lower than tritium emissions.

2. The Hazardous Properties of Tritium

In order to understand and appreciate tritium risks to local people and nuclear workers, we need to discuss tritium's properties. In the past, scientists employed by the nuclear industry had tended to minimise the risks from tritium and to regard it as "weakly" radiotoxic.

This was incorrect and perceptions have now changed: in the decade 2000 to 2010, 10 major reports on tritium were published by radiation safety agencies in the UK (AGIR, 2008), Canada (CNSC, 2010a; 2010b) and in France where the French Nuclear Safety Authority (ASN, 2010) published a comprehensive White Paper on tritium and the French Institute de Radioprotection and Nuclear Safety published six major reports on tritium (IRSN, 2010a; 2010b; 2010c; 2010d; 2010e; 2010f).

All these reports noted that tritium exposures resulted in internal radiation doses, but their dose estimates contained uncertainties which often rendered them unreliable. The most comprehensive report on tritium was the report by UK Government's senior Advisory Group on Ionising Radiation (AGIR, 2008). This strongly recommended that tritium's hazard (i.e., its radiation weighting factor, w_R) should be doubled from 1 to 2. Other scientists (Fairlie, 2008; Fairlie, 2007a; Fairlie, 2007b; Melintescu et al, 2007; Makhijani et al, 2006) presented evidence for even larger increases in tritium's radiotoxicity, including the US EPA (2006) which recommended an increase from 1 to 2.5.

These reports all drew attention to tritium's properties which marked it as an unusually hazardous radionuclide. These properties include

a. its relatively long half-life of 12.3 years,
b. its mobility and cycling (as ^3H_2O) in the biosphere,
c. its multiple pathways to people,
d. its ability to swap instantaneously with H atoms in adjacent materials,
e. its high relative biological effectiveness (RBE) of 2 to 3,
f. its ability to bind with cell constituents to form organically-bound tritium (OBT) which is heterogeneously distributed in humans,
g. its long residence time in bodies as OBT, and
h. its short-range beta particle, meaning that its effects depend on its location within cellular molecules, e.g. DNA

A third important form of tritium exists - organically bound tritium (OBT). This is bound to the carbohydrates, lipids and proteins in plants and animals, including humans. Unfortunately, official models for tritium do not address radiation tritium incorporated into these organic compounds (Peterson and Davis, 2002), but it is necessary to take into account the long biological half-lives of OBT.

Recently Matsumoto, Hideki et al (2021) stated

> "*To understand the effects of internal exposures by tritium … it is important to realize that a part of tritium atoms (5–6% of HTO absorbed into the body) exists as a component of the body due to exchange with hydrogen atoms in organic compounds such as proteins and carbohydrates in the body, the so-called OBT. OBT, especially tritium bound to carbon atoms in organic compounds, remains longer in the body, because such OBT is difficult to exchange for other atoms in organic compounds. Thus, the biological half-life of OBT is about 40 days for a short-term component and about one year for a long-term component.*"

For these reasons, tritium presents multiple challenges to conventional dosimetry and health-risk assessments. Official models for tritium simply fail to take the above properties of tritium into account. To compound the problem, tritium in its elemental form diffuses through most containers with relative ease, including those made of steel, aluminium, concrete and plastic.

Furthermore, tritium is not detected in either form by commonly-used survey instruments (Okada et al, 1993). Normally liquid swabs have to be taken which are then sent to specialist wet laboratories to determine their tritium concentrations.

3. What happens in practice

When tritium is emitted to air from Darlington, it cycles in the environment because tritium atoms swap quickly with stable hydrogen atoms in the biosphere and hydrosphere. This means that all rivers, streams and all biota, local crops and foods in open-air markets (Inoue, 1993) all animals and humans become contaminated by tritiated moisture up to ambient levels – that is, up to the air concentrations of the emitted tritium[72].

The result is that residents downwind and nuclear workers become tritiated via skin absorption and via breathing contaminated water vapour. Because tritium is quickly transferred to food and water, workers and the public will also ingest tritium by eating contaminated food and drinking liquids (Inoue,1993).

After tritium enters the body, it is readily taken up by exchange mechanisms, by metabolic reactions and by cellular growth. Over 60 per cent of the body's atoms are hydrogen atoms and every day about five per cent of them are engaged in metabolic reactions and cell proliferation. The result is that a proportion of the tritium taken in is fixed to proteins, lipids and carbohydrates, including nucleo-proteins such as DNA and RNA in our cells.

This is termed organically bound tritium (OBT). It is non-uniformly distributed and is retained in our bodies for longer periods than tritiated water. Radiation doses from OBT are therefore higher than from HTO. The longer people are exposed to tritiated water emissions (ie the numbers of days) the higher their levels of OBT become until, in the case of repetitive exposures lasting years, equilibria is established between HTO and OBT levels.

Unfortunately, the dose models used by the International Commission on Radiological Protection (ICRP) assume the opposite – that tritium is homogenously distributed in the body/tissue/organs and is quickly excreted. And ICRP's models only consider single not chronic exposures. The result is that ICRP estimates of OBT doses are hopelessly unreliable.

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[72] Indeed as a result of this pervasive contamination, in the 1980s OPG (then Ontario Hydro) was forced to move its analytical labs away from Pickering as its samples were being rendered useless by atmospheric tritium contamination in the old labs.

It can be seen that tritium's unusual properties suggest it should be regarded as hazardous in radiation protection advice. Sadly, these properties are not at all recognised by the ICRP and authorities, such as CNSC, which take their lead from the ICRP.

This results in the underestimation of tritium 'doses' and its risks. For example, the ICRP's dose conversion factor for tritium is 1.8 x 10^{-11} Sv per Bq, by far the lowest of any common nuclide: it is about 750 times smaller than that for Cs-137.

One major controversy, which has lasted for about 60 years, is the ICRP's continued recommendation of the radiation weighting factor (w_R) for tritium of 1. See Fairlie (2007a). This value is simply wrong as recognised by the UK government (AGIR 2008), and should be at least doubled or trebled.

The problem, in a nutshell, is that CNSC and OPG exclusively use unreliable ICRP dose models for tritium. It should be borne in mind that the ICRP is not an official body, but a voluntary one. It operates rather like a trade association, principally concerned with protecting the interests of its members rather than those of the general public. In our view, non-scientific considerations have played a part in the ICRP's decisions on tritium, as regards nuclear weapons production plants in the past, nuclear reactors at present, and proposed fusion facilities in the future.

D. New Evidence on Increased Radiation Risks

In recent years, important new epidemiological evidence has been published indicating that **all low-LET radiation risks have increased**. Low-LET radiation means low linear energy transfer and includes beta particles from tritium's decays.

The new evidence is from the International Nuclear Workers' Study (INWORKS) meta-studies of nuclear workers in the US, UK and France. The meta-studies are very large (>300,000 participants) which lends considerable authority to their findings. The new studies do not estimate tritium risks directly but do so indirectly. Since tritium is emitted from all nuclear facilities, all nuclear workers in these studies were exposed to tritium as well as to gamma rays which were measured in their film badge dosimeters, of which records had been kept for many years.

In late 2015 and subsequent years, INWORKS published three large studies. The first examined associations between low dose-rate radiation and **leukemia/lymphoma** (Leuraud et al, 2015, 2021). The second studied **solid cancers** (Richardson et al, 2018), and the third studied **circulatory disease** (Gillies et al, 2017).

The main findings from the first two were that radiation risk estimates were higher than old risk estimates from the Japanese bomb survivors' studies. For example, in the solid cancer study, the authors stated

> "*Our estimated association between radiation and solid cancer (ERR = 0.47 per Gy; 90% confidence interval 0.18 to 0.79) is larger than but statistically compatible with the estimate from a mortality analysis of male survivors of the Japanese atomic bomb exposed at ages 20-60 years (ERR = 0.32 per Sv; 95% confidence interval 0.01 to 0.50).*"

The phrase "*statistically compatible*" in the above quote is a jargon phrase used in statistics. It does not mean 'the same or similar'. It means that the confidence intervals in the two studies overlapped – quite a different matter. **Therefore it is necessary to compare the main point estimates of risk**. The actual observed increase between the two studies was 0.47/0.32 = 1.47 fold, or a 47% higher - a significant amount.

Similarly for leukemias. The more recent study in the INWORKS leukemia risks (Leurad et al, 2021) stated

> "i*n the dose range … 0–500 mGy, the linear estimated ERR/Gy …..derived from LSS (0.59; 90% CI − 0.43; 2.03) is substantially smaller than that derived from INWORKS (3.46; 90% CI 1.29; 6.19)*".

The actual increase in point estimates here was 3.46/0.59 = 5.9 fold or 590%. This quite large increase was driven mainly by the 11- fold increase in chronic myelogenous leukemia (CML) in older workers. In myeloid leukemia, the cancers occur in cells that form red blood cells, some other types of white cells and platelets.

The third study on cardiovascular risks somewhat surprisingly reported **brand new risks** of heart disease and strokes. These are not taken into account in official risk estimates by regulatory agencies which only consider cancer risks - but they should be.

This report assumes that the recorded external gamma doses in the INWORKS occupational studies may be used to comment upon tritium risks. This is reasonable because both forms of radiation i.e. gamma rays and the beta particles from tritium are low-LET forms of radiation with the same radiation weighting factor.[73]

Because the INWORKS findings are far-reaching in their implications, it was necessary to double-check them. A recent exhaustive review (Hauptmann et al, 2020) examined possible sources of bias[74] and confounding[75]. It concluded that the INWORKS studies directly support the conclusion of excess cancer risks from low doses of ionising radiation, with little evidence of bias and confounding. This is similar to another study (Berrington et al, 2020) which reviewed the INWORKS studies using specialist statistical and epidemiological methods to look for evidence of bias and found none.

The new INWORKS radiation studies are pertinent to whether a further license extension should be granted because they

a. provided strong evidence of a dose-response relationship between cumulative, chronic, low-dose, exposures to radiation and leukemia.
b. confirmed that radiation risks exist even at very low dose rates (average = 1·1 mGy per year).
c. observed risks at low dose rates rather than extrapolating them from high dose rates. (e.g. as in the LSS study of Japanese bomb survivors) and
d. found a trend of increasing risk of solid cancer by attained age.

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[73] this report does not take the absolute numerical risks from gamma ray exposures cited in the published studies and apply them to tritium. Instead it uses the risk **increases** (i.e. the ratios of the INWORKS risks compared to the LSS risks). This safeguard allows us to extract useful information from gamma risks and apply it to tritium risks, i.e. the observed risk increases (i.e. in ERRs per Sv) from external gamma rays can be applied as well to tritium.

[74] statistical bias occurs when a model or statistic is unrepresentative of the population being studied: several sources of bias can occur, eg selection bias

[75] Confounding occurs when an extraneous factor causes inaccuracy in the estimated measure of an association, eg smoking in a lung cancer study

Unreliable Dose Estimates

OPG's estimates of low radiation doses from the plant's discharges and emissions are unreliable as they contain large uncertainties. They should not be used to justify the extension of licenses to operate the Darlington reactors.

There are several reasons for this statement. The first is that OPG does not explain how its dose estimates are derived. This process is complex and poorly understood by many people: it is explained in Appendix B.

Another reason is that no monitoring exists of any health outcomes among local residents. For example, no epidemiological health studies have been carried out in the area. In addition, no monitoring of HTO and OBT levels in local residents is carried out.

Third, unsafe limits including DRLs are derived from the unacceptably high level of tritium in drinking water - 7,000 Bq per litre - currently used by Health Canada. This is extremely lax given the recommendation[76] of the Ontario Drinking Water Advisory Council (ODWAC) of 20 Bq per litre. It is recommended that this safer recommended tritium limit should be used throughout these documents. See table 3 on official drinking water limits in use.

Table 3. Official Tritium (HTO) limits in drinking water

Agency	**Tritium limit** (Bq per litre)
Health Canada	7,000
European Union	100
Recommended by Ontario Government's ACES in 1994	20
Recommended by Ontario Government's ODWAC in 2009	20
US State of Colorado	18
US State of California	15

The current Canadian limit for tritium in drinking water of 7,000 Bq/l is unsafe compared with the limits set by all other agencies. The European Commission's limit is 100 Bq per litre. The US State of Colorado has set a standard[77] for tritium in surface water, of 18.5 Bq/l, and the US Department of Energy specified the Colorado state action level for tritium in surface water in its clean-up program at the Rocky Flats plutonium plant in Colorado. The US State of California

[76] Ontario Drinking Water Advisory Council, *Report and Advice on the Ontario Drinking Water Quality Standard for Tritium* (2009), available online: http://meteopolitique.com/Fiches/nucleaire/documentation/01/Nucleaire_eau-potable-Ontario-Tritium.pdf

[77] 500 picocuries per litre.

recommends a limit[78] of 15 Bq/l. Both these limits are based on a 1 x 10^{-6} lifetime risk of a fatal cancer, the clean-up goal under the US Comprehensive Environmental Response Compensation and Liability Act (CERCLA), commonly known as the Superfund Act.
On the other hand, Health Canada's limit for tritium corresponds to a risk of 350 excess fatal cancers per million people which is considerably more lax.

Contrast Health Canada's drinking water objectives for **chemicals** which only allow a lifetime risk of 1 fatal cancer per million people.

In 2009, the Ontario Government's Ontario Drinking Water Advisory Council (ODWAC) published a comprehensive report[79] which recommended that the tritium limit in drinking water should be tightened to 20 Bq per litre. The difference between 7,000 and 20 Bq/l was partly due to ODWAC's choice of a fatal cancer risk factor of 10^{-6} and partly due to its use of a lifetime instead of a first year risk.

Interestingly, the 2009 ODWAC report's recommendations were identical to an earlier 1994 report by the Ontario Government's Advisory Council on Environmental Standards on tritium. In other words, two Ontario Government committees with different scientific memberships over 15 years apart came to very similar conclusions. However Federal Health Canada remains in denial of these reports.

This report recommends that the ODWAC/ACES limit should be used.

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[78] 400 picocuries per litre.
[79] http://www.odwac.gov.on.ca/reports/minister%20reports/minister_reports.htm

E. Epidemiological evidence of risks at other tritium-emitting sites

It is an obvious step to look for evidence of ill health at other areas where people are exposed to radiation. However many of these are ecologic studies (Wakefield, 2008), that is, quick studies which look at health or population **statistics** and not at individual data. Their findings are usually regarded as indicative and not conclusive. If their findings suggest an adverse effect then these should be investigated further by more detailed cohort or case-control studies. The latter match “cases” (i.e. those which have an adverse effect) with randomly-selected similar individuals, in order to minimise under-ascertainment. However fewer of these are carried out because of their expense and long time spans. Below are ecologic studies near Canadian nuclear facilities.

Leukaemia in children near Candu nuclear facilities
Clarke et al (1991) studied mortality and incidence of childhood leukaemia near nuclear facilities in Ontario. Its first report considered leukaemia deaths and cases at ages 0-4, and the second (Clarke et al. 1991) considered cases and deaths at ages 0-14. Data for areas “nearby” (<25 km) the 16 reactors at Bruce and Pickering over the period 1971-1987 were pooled together to increase statistical significance. The findings were 36 leukemia deaths aged 0-14 vs 25.7 expected (SMR = 1.40, 95% CI 0.98 - 1.9) indicating excess leukemia mortality with borderline statistical significance.

However some indications warranted further investigation: higher leukemia death rates after the reactors had started than before; more deaths when counted at place of birth than at place of death; and the size of the higher confidence interval. It is notable that different levels of statistical significance were adopted by the two reports. The first was 10%, and the second 5%. If the 10% level had been used in the second study as it had been in the first, the leukemia increase would have been considered "statistically significant". The authors recommended further case-control research which was not carried out.

Birth defects and infant mortality in the vicinity of the Pickering nuclear facility, Ontario
Johnson and Rouleau (1991) studied birth defects, stillbirths, perinatal, neonatal and infant mortality within 25 km of the Pickering nuclear station. They also studied these endpoints in relation to airborne and waterborne discharges of tritium from Pickering, concentrating on the Pickering and Ajax townships closest to the Pickering plant.

The incidence of central nervous system defects was significantly elevated in Pickering township for the highest level of airborne tritium emissions (odds ratio in highest group = 4.01 (95% CI; 1.25, 14.04)), based on 6 cases)) but no statistically significant trends with tritium emissions (p=0.197) or ground monitoring data (p=0.24) were observed.

Births with Down Syndrome in Pickering township were significantly increased (24 observed *vs.* 12.9 expected (relative risk = 1.85, 95% CI = 1.19, 2.76)). But 23 other birth defect endpoints did not show such an excess. The raised incidence of Down Syndrome cases was notable, as many Chernobyl studies also indicate excesses in areas exposed to radioactive fallout. However the authors of the study queried why the incidence of Down Syndrome alone should be increased and not other forms of congenital malformation. This does not provide a reason to discount the observed association between tritium exposures and Down Syndrome.

Offspring of Canadian nuclear workers
Green et al (1997) assessed cases of congenital abnormalities and matched controls in the offspring of Canadian nuclear workers. (763 case-control pairs of fathers and 165 case-control pairs of mothers). Tritium doses were assessed for those cases/controls having a recorded tritium dose 60 days before conception vs. those with no dose. The study revealed increased chromosomal disorders with tritium exposure, but the number of cases (two) is small and confidence intervals wide.

Offspring of Ontario radiation workers
McLaughlin et al (1992, 1993) considered cases of childhood leukaemia in the offspring (aged 0-14) of Ontario radiation workers and matched cases. Tritium workers were those employed at the AECL laboratories at Chalk River, and 5 power stations (Rolphton, Pickering (A, B), Bruce (A, B); 112 cases and 896 controls). Preconceptional tritium doses were assessed for this group. There was some evidence of raised risks with internal tritium + external radiation exposures but with wide confidence intervals.

Durham Region Health Department (2007)
This study showed statistically significant elevated rates of several radiogenic cancers near the NPPs east of Toronto. Leukemia incidence was significantly increased in Ajax-Pickering and Clarington males in 1993-2004. This study was based on municipal borders, about 10 km from the reactors. The authors admitted some findings were of concern and recommended further more accurate studies, but none have been carried out. The report incorrectly concluded that the overall findings did not indicate a pattern.

Lane Study (Lane et al, 2013)
This study purportedly sought to determine whether radiation doses to members of the public living within 25 km of the Pickering, Darlington and Bruce nuclear power plants (NPPs) were causing an increase in cancer rates from 1990-2008. It reported that some types of cancers were statistically higher than expected but radiation exposures were dismissed as a cause "on the basis of current radiation risk estimates.".

Wanigaratne et al Study (2013)

This study examined cancer incidences (1985–2005) among Pickering and north Oshawa residents including all cancers, leukemia, lung, thyroid and childhood cancers (6–19 years). Person-years analysis showed female childhood cancer cases to be significantly higher than expected (SIR = 1.99, 95% CI: 1.08–3.38). It concluded that "multiple comparisons were the most likely explanation for this finding".

All of the above studies show increased ill effects, some statistically significant and others with borderline statistical significance. Some studies showed increases for some illnesses but not others. However as Altman and Bland (1995) stated "absence of evidence is not evidence of absence". In addition, methodological limitations (in particular the small sizes of some of these studies) meant they were simply unable to detect effects with statistical certainty. But lack of statistical significance should NOT be used as a reason for dismissing these studies. See https://www.ianfairlie.org/news/uk-and-us-scientists-call-for-statistical-significance-tests-to-be-dropped-in-health-studies

Despite the positive numerical findings in all these studies, their published conclusions were negative, often on flimsy or untenable grounds such as inconsistent results, too many comparisons, lack of an overall pattern, etc. In the case of the Lane et al study, it was because the observed increases in cancer incidence were greater than predicted by official estimates of radiation dose. In other words, the authors refused to accept the evidence of their own study, preferring to believe in official dose estimates. This is poor science.

Instead the above studies, taken together, provide indicative evidence for increased health effects from exposure to tritium. This could be confirmed with larger, case-control or cohort studies, or by meta-studies, but the CNSC has refrained from commissioning such studies or meta-studies.

F. Newly available evidence on increased child leukemias near NPPs

The issue of increased child leukemias near NPPs is contentious. Nevertheless a surprisingly large volume of epidemiological studies exists showing such increases - including the Canadian studies described above. Indeed, a strong pattern of epidemiological evidence indicates increased leukaemia and solid cancer risks near nuclear plants **world-wide**.

Laurier and Bard (1999) and Laurier et al (2008) examined the literature on childhood leukaemia near NPPs world-wide. These two articles identified a total of over 60 studies. An independent review (Fairlie and Körblein, 2010) of them indicated that the large majority (>70%) showed small increases in childhood leukaemia although some were not statistically significant. Laurier and Bard, and Laurier et al, employees of the French Government's Institut de Radioprotection et Sûreté Nucléaire, confirmed that clusters of childhood leukaemia cases existed near most NPPs but they refrained from drawing conclusions.

Fairlie and Körblein (2010) in their review of the above studies concluded that the copious evidence, specifically in young children, was convincing. This conclusion was supported by two meta-analyses of national multi-site studies. Baker and Hoel (2007) assessed data from 17 research studies covering 136 nuclear sites in the UK, Canada, France, the US, Germany, Japan, and Spain. In children up to nine years old, leukaemia death rates were 5% to 24% higher and leukaemia incidence rates were 14% to 21% higher. The second meta-analysis by Körblein (2009) covering NPPs in Germany, France and the UK also found a statistically significant increased risk of child leukemias and relative risk of leukaemia deaths near NPPs (RR = 1.33; one-tailed p value = 0.0246).

Further studies indicated raised leukaemia incidences in France (Guizard et al, 2001) and Germany (Hoffman et al, 2007). Similarly, Bithell et al (2008) and Laurier et al (2008) found increases in child leukemias near UK and French NPPs respectively. In both cases, the increases were low and the authors dismissed them because they were not "statistically significant". However such negative conclusions for narrow statistical reasons are nowadays considered unreliable: see Appendix C.

The most important epidemiology study was the German government's KiKK study (Kinderkrebs der Umgebung von KernKraftwerken - Childhood Cancer in the Vicinity of Nuclear Power Plants) (Kaatsch et al, 2008; Spix et al, 2008). This found a 120% increase in leukemias and a 60% increase in all cancers among infants and children under 5 years old living within 5 km of all German NPPs. The increase of risk with proximity to the NPP site, tested with a reciprocal distance trend, was statistically significant for all cancers ($p < 0.0034$, one-sided), as well as for leukemias ($p < 0.0044$, one-sided).

KiKK was a large, well-conducted study; its findings were scientifically rigorous; its evidence was particularly strong; and the German government's radiation protection agency, the Bundesamt für Strahlenschutz (BfS) which had commissioned the study, confirmed its findings. A BfS-appointed expert group stated (BfS, 2008)

> "*The present study confirms that in Germany there is a correlation between the distance of the home from the nearest NPP [nuclear power plant] at the time of diagnosis and the risk of developing cancer (particularly leukemia) before the 5th birthday. This study is not able to state which biological risk factors could explain this relationship. Exposure to ionising radiation was neither measured nor modelled.*" (BfS, 2008).

Although the KiKK study avoided discussing the reasons for its findings, one hypothesis (Fairlie, 2014) has been published. This was that the infant leukemias were a teratogenic effect of *in utero* exposures from intakes of NPP-emitted radionuclides during fetal development. The risks from NPP emissions to embryos/fetuses in pregnant women living nearby were apparently much larger than currently estimated. For example, haematopoietic (i.e. blood-forming) tissues are known to be considerably more radiosensitive in embryos and fetuses than in children. The combined immaturities of children's nervous and blood-forming systems make them particularly vulnerable to radiation exposures from NPPs.

Without exception, official organisations have found it difficult to accept that cancer increases near NPPs may be due to their radioactive emissions. For example, in the US in 2017, the NRC cancelled its proposed study on childhood cancers near US NPPs (San Bernadino Sun, 2017). In their view, official doses from NPP emissions were too low to explain the observed increases in risks. This assumes that official risk models are correct and that their dose estimates are without uncertainties. However the report of the UK Government's CERRIE Committee in 2004 stated that official dose estimates from internal emitters contained uncertainties which could sometimes be very large (CERRIE, 2004).

G. Recommendations

The main recommendation is that CNSC should not extend operating licences for Darlington NGS.

Additional ancillary recommendations are

i. CNSC should apply the Ontario Government's ODWAC recommendation of 20 becquerels per litre (Bq/L) for drinking water
ii. CNSC should implement its own 2010 design guide[80] for groundwater for tritium of 100 Bq/L for tritium levels in wells near Darlington NPS.
iii. Urine tests and non-invasive bioassay tests should be carried out on volunteers from the community to ascertain local HTO and OBT levels.
iv. Residents within 10 km of the plant should be advised to avoid consuming locally-grown foods including honey from hives, wild foods such as mushrooms and berries and produce from their gardens.
v. In view of the discussion in Appendix C, local women intending to have a family, and families with babies and young children should consider moving elsewhere. It is recognised this recommendation may cause concern but it is better to be aware of the risks to babies and young children than remain ignorant of them.
vi. Darlington employees, especially young workers and women workers, should be informed about the hazards of tritium.

[80] Canadian Nuclear Safety Commission. An Update on Tritium Contamination in Groundwater at SRBT. March 2010 (e-doc 3523400)

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APPENDIX A. Organically Bound Tritium

Organically bound tritium (OBT) which is bound to carbon atoms is termed non-exchangeable OBT. It is produced through photosynthesis (ie growth) in plants and by metabolic reactions and growth (ie cell reproduction) in animals. It is detected in most organic materials in plants, animals and soils. A second form of OBT which is more loosely bound to P, N and S atoms is called exchangeable OBT.

The behaviour of OBT (both forms) in the environment is not particularly well understood. For example, its distribution in natural ecosystems is very heterogenous. Nevertheless OBT is increasingly recognized as being more significant than HTO in understanding tritium's behaviour in the environment (Kim et al, 2013). This is partly because OBT measurements provide a more accurate representation of tritium in the environment due to its longer retention time than HTO. (Kim and Roche, 2012)

OBT can be incorporated into all biochemical compounds, including amino acids, sugars, starches, lipids and cell structural materials: it therefore has longer retention times than tritiated water which only has a biological half-life of about 10 days. Some biomolecules are very long-lived, e.g. phospholipids in nerve cells and the DNA and RNA macromolecules. These longer retention times result in OBT's greater radiotoxicity than tritiated water. The ICRP has recommended an OBT ingestion exposure coefficient 2.3 times greater than that for HTO[81]. However much evidence suggests it should be at least 5 times or more greater (Fairlie, 2008).

Following a single HTO intake, the current ICRP model assumes 3% is bound as OBT and "may be neglected". But Trivedi et al (1997) estimated that up to 9% is bound as OBT. Animal studies also indicate that OBT levels must be considered – essentially because OBT is cleared from the body much more slowly than HTO. Commerford et al (1982) found, after a transient HTO exposure to mice, tritium remained bound to DNA and histone 8 weeks later. They concluded that the OBT doses from them would exceed HTO doses overall.

The same goes for chronic exposures except more so. Commerford, Carsten and Cronkite (1977) found most of the tritium dose came from OBT 2 to 3 days after stopping chronic HTO administration to mice. Rogers (1992) concluded OBT was the principal determinant in tritium doses to mice following chronic HTO exposure. More recently, Kim et al (2013a) discussed the OBT contribution to tritium exposures from chronic tritium releases to air. They compared 11 studies whose mean OBT contribution to total tritium exposures was 21%. In other words, any estimates of HTO exposures from Darlington emissions should be multiplied by the factor 5/4.

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[81] ICRP dose coefficients for adults are 1.8×10^{-11} Sv/Bq for tritiated water and 4.2×10^{-11} Sv/Bq for OBT.

Longevity of OBT in the environment

Eyrolle-Boyer et. al (2014) stated that OBT levels can persist in the environment for several decades. They found that terrestrial biomass pools, contaminated by global atmospheric fallout from nuclear weapons testing in the 1950s and 1960s constituted a significant delayed source of OBT, resulting in an apparent enrichment of OBT levels compared to HTO. This finding helps explain OBT/HTO ratios greater than 1 observed in areas not affected by industrial radioactive wastes. This finding supports the findings by Ichimasa (1995) of long-term raised OBT levels near Chalk River following chronic HT releases.

A more recent study (Thompson et al, 2015) has emphasised the importance of OBT in the environment. It stated that, as soil acts as a repository for decaying organic matter, OBT soil concentrations represents long-term reservoirs of past tritium releases. It added "Our data support the mounting evidence suggesting that some parameters used in environmental transfer models approved for regulatory assessments should be revisited to better account for the behaviour of HTO and OBT in the environment and to ensure that modelled estimates (e.g. plant OBT) are appropriately conservative." Unfortunately, these parameters have not been revisited by the CNSC.

APPENDIX B. Uncertainties In Dose Estimates

OPG and CNSC reports contain dose figures to members of the public: these are invariably very small. However these do not explain that these are estimates not measurements and may contain large uncertainties.

How these dose estimates are derived is not widely understood by scientists, and usually not at all by members of the public. In fact, the method is complicated, as they are derived using many computer models in sequence, with the median value from each model being plugged into the next model and so on. Although there are many smaller sub models, the main models include:

- environmental transport models for radionuclides, including weather models
- human metabolism models for nuclide uptake, retention and excretion
- dose models which estimate doses from internally retained nuclides, and
- risk models

A major source of uncertainty is that we often do not know where radionuclides wind up inside the body after inhalation/ingestion. It is often assumed they are uniformly distributed - but this there is no way of proving this.

Each of the above model results will contain uncertainties which have to be combined to gain an idea of the overall uncertainty in the final dose estimate (Fairlie, 2005). Further uncertainties are introduced by unconservative radiation weighting factors and tissue weighting factors in official models (Fairlie, 2007a). The cumulative uncertainty in dose estimates could be very large as formally accepted by the UK Government's CERRIE Committee in 2004 (www.cerrie.org) particularly for internal emitters.

APPENDIX C: Misuse of Statistical Significance Tests in Health Studies

In the past, epidemiology studies often stated that they "did not find" increased health effects following radiation exposures … even when they actually observed them. To give two examples, Bithell et al (2008) and Laurier et al (2008) found increases in child leukemias near UK and French nuclear power plants (NPPs) respectively. However, instead of stating this, the authors incorrectly reported that there was "no evidence" (Bithell et al) and "no suggestion" (Laurier et al) of leukemia increases near UK or French nuclear reactors. They did so because their observed increases lacked "statistical significance".

Several problems here need to be disentangled then explained.

The first is that the word "significant" does not mean what laypersons would normally think, i.e. "relevant" or "noteworthy". Instead it is a jargon word used in statistics to describe whether the increases met the authors' chosen statistical test. In such cases, the adjective "significant" should always be preceded by the adverb "statistically" to alert readers that a statistical test has been applied. In the past, this was rarely done.

Second, the above epidemiology studies on cancers near industrial sites should have reported their observed leukemia increases then added there was a >5% probability they could have occurred by chance. This also was rarely done.

The third point is that the strictness of the test, commonly a 5% level (ie a less than 5% probability of the finding occurring by pure chance) is quite arbitrary. 10% or even 20% levels could equally have been used. This should also be explained but it is rarely done.

Fourth, such studies should state that the probability that the observed effects may be due to chance (i.e. their p-values) is affected by both the magnitude of the effect <u>and the size of the study</u> (Whitley and Ball, 2002).

The above considerations taken together mean statistical tests must be used with caution: the use of an arbitrary cut-off for statistical significance can lead to incorrectly accepting the null hypothesis (nil effect) merely because it is not statistically significant (Sterne and Smith, 2001). This is termed a type II error in statistics. This can often occur in small studies simply due to their small size rather than lack of effect (Everett et al, 1998).

And Axelson (2004) has pointed out that the findings of many epidemiology studies with negative results statistically speaking, are "of questionable validity as they may obscure existing risks".

This raises questions about the actual value or otherwise of statistical testing. Indeed in 2019, the influential British journal “Nature” published a landmark editorial (Nature, 2019) headlined “It’s time to talk about ditching statistical significance” which argued against the indiscriminate use of statistical testing in health studies.

The same BMJ edition contained a commentary (Amrhein et al, 2019) “Scientists rise up against statistical significance” signed by 853 scientists worldwide. It called for an end to the dismissal of possibly crucial effects in health studies through the inappropriate use of statistical testing.

The Nature editorial simultaneously reported (Wasserstein et al, 2019) that US scientists at the American Statistical Association had just published a scientific article with the same conclusions. The nub of the matter is that, as reported in the Nature editorial “the rigid focus on statistical significance encourages researchers to choose data and methods … that yield statistical non-significance for an undesired result …. thereby invalidating any conclusions.”

This damning verdict applied to clinical trials, but it equally applies to undesired results of observed increases in health effects in epidemiology studies. For decades, many scientists, including those employed at government agencies and regulatory bodies, have dismissed risk findings in epidemiology studies near nuclear facilities by concluding they showed “no significant” raised risks or that excess risks were “not significant” or similar phrases. Often, they just said there were “no” increases. Now, in theory, they will not be able to do this as easily as they have in the past, as this poor scientific practice has been exposed.

ANNEX A. Acronyms And Abbreviations

Bq	becquerel (SI unit of radioactivity)
CERRIE	UK Committee Examining the Radiation Risks of Internal Emitters
Ci	curie (US unit of radioactivity)
COMARE	UK Committee on the Medical Aspects of Radiation in the Environment
CNSC	Canadian Nuclear Safety Commission
DRL	derived release limit
EC	European Commission
EPA	US Environmental Protection Agency
EU	European Union
Gy	gray (unit of absorbed radiation dose)
HTO	tritiated water
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
LET	lineal energy transfer (energy transferred per unit length of track)
LNT	linear no-threshold (model of radiation's dose-effect relationship)
LSS	Life Span Studies of the Japanese bomb survivors
NEA	Nuclear Energy Agency of the OECD
NCI	US National Cancer Institute
NGS	nuclear generating station
NPP	nuclear power plant
NRC	US Nuclear Regulatory Commission
NRPB	former UK National Radiological Protection Board
OBT	organically bound tritium
rad	US unit of absorbed radiation dose
rem	US unit of radiation dose
SI	Systeme Internationale
Sv	sievert (SI unit of equivalent or effective radiation dose)
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organisation

ANNEX B. Système Internationale (SI) Units

E = exa	= 10^{18}	d = deci (one tenth)	= 10^{-1}
P = peta	= 10^{15}	c = centi (one hundredth)	= 10^{-2}
T = tera (one trillion)	= 10^{12}	m = milli (one thousandth)	= 10^{-3}
G = giga (one billion)	= 10^{9}	μ = micro (one millionth)	= 10^{-6}
M = mega (one million)	= 10^{6}	n = nano (one billionth)	= 10^{-9}
K = kilo (one thousand)	= 10^{3}	p = pico (one trillionth)	= 10^{-12}

Common examples are:

PBq	= petabecquerel (one million billion becquerels)	= 10^{15} Bq
TBq	= terabecquerel (one trillion becquerels)	= 10^{12} Bq
GBq	= gigabecquerel (one billion becquerels)	= 10^{9} Bq
mSv	= millisievert (one thousandth of a sievert)	= 10^{-3} Sv
µSv	= microsievert (one millionth of a sievert)	= 10^{-6} Sv
nSv	= nanosievert (one billionth of a sievert)	= 10^{-9} Sv

ANNEX C. Glossary Of Common Radiation Terms

Absorbed dose — Quantity of energy imparted by ionising radiation to unit mass of matter such as tissue. 1 Gy = 1 joule per kilogram.

Activity — rate at which radioactive substances decay. Unit – the becquerel (Bq).
1 Bq = 1 disintegration per second.

Annual limit of intake (ALI) — The amount of material inhaled or ingested in 1 year that would result in a committed effective dose of 20 mSv.

Beta particle — An electron emitted by the nucleus of a radionuclide.

Decay — The process of spontaneous transformation of a radionuclide. The decrease in the activity of a radioactive substance.

Decay product — A nuclide or radionuclide produced by decay. It may be formed directly from a radionuclide or as a result of a series of successive decays through several radionuclides.

Dose — General term for quantity of radiation. See absorbed dose, effective dose, equivalent dose.

Dose factor — committed effective dose resulting from the inhalation or ingestion of 1 Bq of a given radionuclide. Unit - sievert per becquerel, symbol - Sv/Bq.

Effective dose — The quantity obtained by multiplying the equivalent doses to various tissues and organs by the tissue weighting factor appropriate to each and summing the products. Unit sievert, symbol Sv.

Equivalent dose — The quantity obtained by multiplying the absorbed dose by the appropriate radiation weighting factor to allow for the different effectiveness of the various ionizing radiations in causing harm to tissue. Unit sievert, symbol Sv.

Gamma ray — A discrete quantity of electromagnetic energy, without mass or charge.

Half-life — The time taken for the activity of a radionuclide to lose half its value by decay.

Ionisation — The process by which a neutral atom or molecule acquires or loses an electric charge. The production of ions.

Ionising radiation — Radiation that produces ionisation in matter.

Nuclear fission — The process in which a nucleus splits into two or more nuclei and energy is released.

Radionuclide — An unstable nuclide that emits ionizing radiation when it decays.

Risk factor — The probability of fatal cancer or leukaemia per unit effective dose.

Sievert — See effective dose.

APPENDIX B – SUPPORTING DOCUMENTS AND MATERIALS

Chronologically listed references in main report

1. CNSC, "Notice of Public Hearing and Participant Funding" (March 18, 2024), online: https://api.cnsc-ccsn.gc.ca/dms/digital-medias/2025-H-02-Notice-of-Public-Hearing-and-PFP-OPG-Application-for-Licence-Renewal-for-Darlington-Nuclear-Generating-Station.pdf/object

2. Canadian Nuclear Safety Commission, "CMD 25-H2: A Licence Renewal – Ontario Power Generation Inc. Darlington Nuclear Generating Station," (26 March 2025)

3. Canadian Nuclear Safety Commission, "CNSC renews the Darlington Nuclear Reactor Operating Licence" (December 23, 2015), online: https://www.canada.ca/en/nuclear-safety-commission/news/2015/12/cnsc-renews-the-darlington-nuclear-power-reactor-operating-licence.html

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6. CNSC, "Record of Decision In the Matter of Cameco Corporation, Application to Renew the Uranium Mill Licence for the Key Lake Operation, Saskatchewan" DEC 23-H6 (October 24, 2023), https://api.cnsc-ccsn.gc.ca/dms/digital-medias/Decision-Cameco-Key-Lake-Licence-Renewal-DEC23-H6-e.pdf/object

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8. CNSC, "Record of Decision In the Matter of Cameco Corporation, Application to Renew the Uranium Mine Licence for the McArthur River Operation, Saskatchewan" DEC 23-H6 (October 24, 2023) https://api.cnsc-ccsn.gc.ca/dms/digital-medias/Decision-Cameco-McArthur-River-Licence-Renewal-DEC23-H6-e.pdf/object

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10. Coalition for Responsible Energy Development in New Brunswick and CELA Submission to CNSC for Renewal of Point Lepreau Nuclear Generation Station Power Reactor Operating Licence (2022), online: https://cela.ca/wp- content/uploads/2022/03/Submission-Point-Lepreau-Nuclear-Generating-Station.pdf

11. International Atomic Energy Agency, “Stakeholder Engagement in Nuclear Programmes” (2021), online: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1967_web.pdf

12. Canadian Environmental Safety Commission, “Safety and Control Areas” (Date modified: 2023-03-06), online: https://www.cnsc-ccsn.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas/

13. United States Nuclear Regulatory Commission, Part 51, online: https://www.nrc.gov/reading-rm/doc- collections/cfr/part051/index.html; Part 54, online: https://www.nrc.gov/reading-rm/doc- collections/cfr/part054/index.html

14. NSCA at s 24(4); General Nuclear Safety and Control Regulations, SOR/2000-202 at ss 3(1), 5.

15. REGDOC 2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures

16. REGDOC 1.1.1, Site Evaluation and Site Preparation for New Reactor Facilities

17. REGDOC 2.10.1, Nuclear Emergency Preparedness and Response

18. REGDOC 2.4.1, Deterministic Safety Analysis

19. REGDOC 1.1.3, Licence Application Guide: Licence to Operate a Nuclear Power Plant, Version 1.1

20. REGDOC 1.2.2, Licence Application Guide: Class 1B Processing Facilities

21. REGDOC 2.3.3., Periodic Safety Reviews.

22. International Atomic Energy Agency, Preparedness and Response for a Nuclear Radiological Emergency, (IAEA General Safety Requirements No. GSR Part 7 (2015)), online: https://www-pub.iaea.org/MTCD/Publications/PDF/P_1708_web.pdf at pp10-11

23. Ontario Power Generation, “Darlington Nuclear Generating Station Power Reactor Operating Licence Renewal Application” (May 30, 2024)

24. Transcript for Part 1 of the public hearing of the Canadian Nuclear Safety Commission to consider the application by Ontario Power Generation Incorporated to renew its power reactor operating licence for its Darlington Nuclear Generating Station, March 26, 2025

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36. CELA, "Written Submission from the Canadian Environmental Law Association" CMD 24-H3.84, online: https://api.cnsc-ccsn.gc.ca/dms/digital-medias/CMD24-H3-84.pdf/object [

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