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Written Submission from Jocelyn Simon Daigle

Mémoire de Jocelyn Simon Daigle

In the matter of

À l'égard d'

Hydro-Québec

Hydro-Québec

Application to renew its power reactor decommissioning licence for the Gentilly-2 Facilities for a period of 20 years

Demande visant à renouveler pour 20 ans son permis de déclassement d'un réacteur de puissance pour les installations de Gentilly-2

Hearing in writing based on written submissions

Audience par écrit fondée sur des mémoires

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Canada

GENTILLY-2 NUCLEAR FACILITIES

Licence Renewal, Radiation Protection, and Population Health Risk

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I. Overview and Regulatory Context

The Canadian Nuclear Safety Commission (CNSC) is presently considering Hydro-Québec's application to renew the Power Reactor Decommissioning Licence (PRDL) for the Gentilly-2 nuclear facilities located in Bécancour, Québec — CMD 26-H101 [1]. The reactor, a 675 MW CANDU unit, operated from 1983 until permanent shutdown on December 28, 2012 [2]. Defuelling was completed by September 2013, transition to a safe-storage state was achieved in December 2014, and transfer of all irradiated fuel to dry CANSTOR storage modules was completed in December 2020 [3]. The current PRDL expired June 30, 2026. Hydro-Québec seeks a 20-year renewal — an unusually long term — covering extended dormancy, selected early demolition of non-contaminated peripheral structures, and preparation for eventual active dismantlement.

The proceeding is conducted as a hearing in writing rather than an oral public hearing. Given the exceptional licence duration, the 2022 enforcement order against Hydro-Québec [4], the novel early-demolition authorization, and the magnitude of the public health and environmental issues at stake, this format warrants scrutiny**. The adjacent Gentilly-1 Waste Management Facility — operated by Canadian Nuclear Laboratories on behalf of Atomic Energy of Canada Limited — is co-located on the same site, creating compounding radiation source terms and interface responsibilities that neither application fully addresses in isolation.**

II. IAEA Safety Principles and Key Gaps in the Application

The IAEA's Fundamental Safety Principles (SF-1, 2006) [5] establish ten binding normative principles for all facilities through their entire lifecycle. Three are most directly implicated by the Gentilly-2 application.

Justification

IAEA GSR Part 6 requires that decommissioning strategic choices — including the decision to defer active dismantlement for approximately 40 years — be explicitly justified on radiation protection grounds, not merely on economic or administrative convenience [6]. The application has not published a comparative dose-burden analysis contrasting deferred versus accelerated dismantlement. Deferred dismantlement may result in higher cumulative collective dose to future workers due to building structural deterioration, loss of institutional radiological knowledge, and OBT accumulation in structures — all of which must be weighed against the benefit of radioactive decay reducing individual task doses. The early demolition of peripheral structures similarly requires justification grounded in individual building radiological characterization, not blanket administrative category determinations.

Optimization (ALARA)

IAEA GSR Part 3 (2014) [7] and IAEA-TECDOC-1954 (2021) [8] require that the likelihood, number, and magnitude of exposures be kept as low as reasonably achievable. In a decommissioning context, ALARA must be task-specific, adaptive to a continuously changing radiological environment, and extended without dilution to all subcontractors. The Gentilly-2 licence and CNSC Staff CMD do not demonstrate that task-specific dose constraints — below the regulatory limits — are

set for each category of work during dormancy and early demolition. The practice of concentrating high-dose tasks in contract workers rather than utility employees (dose subcontracting) is a structural ALARA failure that licence conditions must explicitly prohibit.

Limitation of Individual Risk and Intergenerational Equity

The IAEA's updated GSR Part 3 reduced the occupational eye lens dose limit from 150 mSv/year to 20 mSv/year — consistent with the revised ICRP recommendation following definitive evidence of radiation-induced lens opacification [9]. The Gentilly-2 licence must explicitly confirm that Hydro-Québec's dosimetry program includes task-specific eye lens monitoring for workers in proximity to activated or contaminated components. On the public side, the IAEA's 1 mSv/year public limit is applied per facility and does not account for cumulative exposure from Gentilly-2, Gentilly-1, and other sources. The St. Lawrence River corridor communities, including Abenaki peoples whose subsistence practices involve elevated aquatic food consumption, may receive combined exposures that exceed what site-specific models report for the nominal critical group [10].

III. Health Physics Society Analysis of Dose Limit Adequacy

The Health Physics Society (HPS) — the largest professional body of radiation safety scientists in North America — formally recommends against quantitative cancer risk estimation below an individual dose of 50 mSv in one year or a lifetime dose of 100 mSv above background [11]. This position does not declare low doses safe; it states that the Linear No-Threshold (LNT) model cannot produce reliable cancer risk estimates at the dose levels experienced by the Bécancour population. The scientific basis of LNT — originally extrapolated by H.J. Muller from extreme high-dose experiments on Drosophila in the 1920s, predating modern understanding of DNA repair mechanisms — has never been empirically validated at environmental dose levels [12].

The regulatory discrepancy between Canada's CNSC-applied 20 mSv/year occupational limit (ICRP-aligned) and the US NRC's 50 mSv/year limit reflects policy choices, not biological findings [13]. Neither limit incorporates the NCRP's biologically-derived cumulative lifetime guidance: that an occupational worker's total dose should not exceed age (years) × 10 mSv. A 50-year-old Gentilly-2 decommissioning worker whose career spans the full licence period could accumulate doses within annual legal limits that approach or exceed this lifetime guidance without triggering any regulatory review [14]. No licence condition in the present application addresses this gap.

Canada's tritium drinking water standard of 7,000 Bq/L — adopted decades ago and unchanged — is 70 times the European Union limit and approximately 400 times higher than certain US state standards [15]. Gentilly-2 was a heavy-water CANDU reactor, meaning its tritium inventory is substantially higher than that of light-water reactors. Organically bound tritium (OBT), which binds to cellular macromolecules and carries a biological half-life potentially as long as 500 days — far longer than the regulatory 10-day tritiated water assumption — is incorporated into developing fetal tissue and is not captured by current monitoring protocols [16]. The combination of an outdated national tritium standard, OBT underestimation, and the proximity of the facility to municipal and subsistence drinking water users on the St. Lawrence constitutes a demonstrable public health surveillance gap.

IV. Epidemiological, Toxicological, and Bioinformatic Evidence of Cancer Risk

Occupational Cohort Evidence

The International Nuclear Workers Study (INWORKS) — the most statistically powerful occupational radiation epidemiology study ever conducted, following 309,932 workers across France, the UK, and the USA for 10.7 million person-years — found that solid cancer mortality increased by approximately 47% per Sievert of cumulative dose, with the dose-response relationship persisting across the lowest exposure ranges (0–100 mSv) [17]. Leukemia mortality increased by over 250% per gray of red bone marrow dose, and associations included chronic myeloid leukemia, acute myeloid leukemia,

myelodysplastic syndrome, and multiple myeloma [18]. The 2024 INWORKS update additionally confirmed a statistically significant positive dose-response between cumulative radiation dose and circulatory disease mortality — a non-cancer endpoint not currently captured in any regulatory dose-risk framework applied to Gentilly-2 [19].

Residential Proximity: The Global Synthesis

A 2024 meta-analysis and meta-regression published in Current Environmental Health Reports synthesized 47 studies covering 175 nuclear power plants in 17 countries, encompassing 7.5 million residents [20]. Residents living near nuclear plants showed significantly elevated risks for all-cancer, thyroid cancer, and leukemia. Children under 5 years old exhibited the highest risk for all cancers — directly relevant to the Bécancour community, where young families reside within the 5-kilometre zone surrounding the facility. A 2025 Harvard T.H. Chan School of Public Health study (Environmental Health) examining Massachusetts communities with adjustment for income, race, smoking, particulate matter, and access to care found residual cancer incidence elevations near reactor sites — strengthening the inference that proximity itself, not confounders, drives the association [21].

The KiKK Study and Childhood Leukemia

The German KiKK study (2008) — a methodologically rigorous case-control study of all German nuclear power plant sites — found that children under 5 living within 5 km of a nuclear reactor faced more than double the background risk of leukemia (OR = 2.19 within 5 km; OR = 1.33 within 10 km) [22]. The finding has been independently replicated at a qualitative level across studies in France, Switzerland, and the UK, though the latter studies have been criticized for inadequate statistical power to refute rather than fail to confirm the German findings [23]. The central mechanistic question — whether fetal incorporation of radionuclides (particularly OBT, Carbon-14, and episodic iodine-131 during CANDU refuelling operations) delivers doses to developing hematopoietic tissue far exceeding current regulatory dose models — remains unresolved and unaddressed in the Gentilly-2 licence application [24].

Molecular Toxicology: Non-Targeted and Epigenetic Effects

Contemporary radiation biology has fundamentally revised the classical target-theory model of radiation carcinogenesis. Three non-targeted mechanisms now have strong empirical support and direct regulatory implications. The radiation-induced bystander effect — in which irradiated cells induce genomic instability, mutations, epigenetic changes, and apoptosis in non-irradiated neighbouring cells — demonstrates a non-linear dose-response that is visible at very low doses and may produce carcinogenic outcomes in tissues receiving no direct ionizing track traversal [25]. Radiation-induced DNA methylation changes — particularly hypermethylation of tumour-suppressor gene CpG islands — have been detected in occupationally exposed workers and provide a direct epigenetic carcinogenic pathway operating independently of double-strand break misrepair [26]. Most consequentially for long-term public health monitoring, transgenerational epigenetic inheritance of radiation-associated methylation changes has been demonstrated in multiple vertebrate species, raising the possibility that parental radiation exposure near Gentilly-2 across its 29 years of operation may carry forward cancer-risk consequences in the children and grandchildren of exposed community members [27]. No biomonitoring program capable of detecting these signals has ever been established for the Bécancour population.

V. Specific Gaps in the Licence Application and Recommendations

The convergence of IAEA principles, HPS scientific positions, and global peer-reviewed epidemiological and molecular evidence points to the following specific, actionable deficiencies in the Gentilly-2 licence renewal application and CNSC Staff CMD as currently constituted.

No peer-reviewed epidemiological study of cancer incidence in the Bécancour and Mauricie-Centre-du-Québec communities has ever been conducted using Gentilly-2 proximity as a primary exposure variable with confounder adjustment. The Quebec Cancer Registry (INSPQ) contains 43 years of incidence data from reactor startup to present. A licence condition requiring

Hydro-Québec to fund an independent epidemiological study — conducted by researchers without industry financial ties, published in peer-reviewed journals, and covering the full operational and decommissioning period — is warranted and achievable [28].

Tritium monitoring must be expanded beyond the immediate site boundary to include systematic measurement of tritiated water and OBT in St. Lawrence River water, sediment, aquatic biota, and fish tissue at stations extending from the Bécancour discharge point to Quebec City. Results must be publicly reported and OBT must be specifically quantified rather than assumed equivalent to tritiated water in dose calculations [29].

A biomonitoring baseline for Bécancour residents — measuring DNA methylation patterns, radiation-associated gene expression signatures, and chromosomal aberration frequencies in a representative population sample — should be established now, before active dismantlement begins, to provide the scientific baseline against which future exposures can be assessed. **This recommendation is consistent with IAEA SSG-47 guidance on decommissioning health surveillance and with the emerging bioinformatics literature on radiation epigenetic biomarkers [30].**

Licence conditions must explicitly require cumulative dose management for workers against the NCRP age-weighted lifetime guidance; task-specific dose constraints below annual regulatory limits for all identified work categories including dormancy surveillance and early demolition; dose equity requirements ensuring high-dose tasks are not systematically allocated to subcontract workers; and task-specific eye lens dosimetry for all workers in proximity to activated or contaminated materials [31].

Emergency preparedness plans must be updated to reflect the current radiological inventory of both Gentilly-2 and the co-located Gentilly-1 Waste Management Facility, with shared interface plans filed with Quebec Public Health authorities and downstream municipal water system operators [32].

Finally, the CNSC must commit to regular health outcome reporting — including non-cancer cardiovascular endpoints — for the Gentilly-2 decommissioning workforce for the full duration of the licence period, with latency-extended follow-up extending at least 30 years beyond the final active dismantlement phase. The evidence from INWORKS and the global occupational cohort literature confirms that radiation-associated cancers and cardiovascular disease continue to manifest decades after the last occupational exposure [33].

Conclusion

The Gentilly-2 decommissioning licence proceeding occurs at the intersection of nuclear safety regulation, environmental public health, and the rights of a community that has lived alongside a nuclear power plant for more than four decades. The evidence surveyed here — from IAEA normative principles through HPS scientific positions through the most current peer-reviewed epidemiology and molecular biology — converges on a consistent finding: the radiation protection framework as applied in the current licence application does not fully account for the mechanistic complexity of low-dose radiation carcinogenesis, the vulnerability of children and pregnant women in the surrounding community, the inadequacy of Canada's tritium standard, or the absence of population-level health surveillance adequate to detect the signals that the global literature suggests are plausible. The Commission has both the authority and the public health obligation to remedy these deficiencies through specific, enforceable licence conditions before a 20-year renewal is granted.

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