

POPULATION MIXING AS AN UNASSESSED PRE-CONSTRUCTION CANCER RISK: THE KINLEN HYPOTHESIS, CANDU RURAL SITING, AND THE ABSENCE OF A LICENSING REQUIREMENT

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1.. Background

The most persistent unresolved question in nuclear epidemiology is why childhood leukemia rates are elevated near nuclear power plants (NPPs) at a magnitude that exceeds what current dose models predict from measured radiation releases. Two hypotheses have dominated the literature for four decades: a radiation causation hypothesis, in which the signal reflects unmodelled or underweighted radiation exposure; and the Kinlen population mixing hypothesis, in which the signal reflects an infectious leukemogenic agent triggered by the influx of a large mobile workforce into a small, geographically isolated, immunologically naive resident population.

The CNSC's own KiKK fact sheet identifies population mixing as "the most likely explanation" for the observed childhood leukemia excess near NPPs [1]. This is a significant regulatory admission: the CNSC accepts that the construction and operation phases of a nuclear facility create a specific, identifiable, peer-reviewed mechanism for elevated childhood leukemia in surrounding communities. Yet no CNSC regulatory document, no licensing proceeding, and no environmental assessment of a proposed Canadian nuclear facility has ever required a population mixing assessment as a pre-construction condition. This paper examines the scientific basis of the Kinlen hypothesis, its specific relevance to CANDU siting in rural Canada, and why its acknowledged credibility by the CNSC makes the absence of a pre-construction assessment requirement indefensible.

2.. The Kinlen population mixing hypothesis

2.1 Scientific basis

The Kinlen hypothesis was first proposed in 1988 based on observations that childhood leukemia clusters occurred not only near nuclear installations but near any large influx of people into previously isolated communities — including new towns, military bases, and oil industry worker camps [2]. The proposed mechanism involves an unidentified oncogenic virus that circulates at low levels in large mobile populations but produces leukemia at elevated rates when introduced into communities with limited prior exposure, analogous to the Epstein-Barr virus dynamic in Burkitt lymphoma in isolated African populations.

The hypothesis has accumulated substantial supporting evidence. Studies of Scottish new towns, rural areas receiving oil industry workers, military camps, and urban-rural migration all show elevated childhood leukemia rates consistent with the mixing model [3, 4]. The hypothesis explains the Seascale cluster (large Sellafield workforce into a small coastal community), the Krümmel cluster (proximity to a major industrial workforce), and the pattern of KiKK findings across all 16 German sites (each representing a concentrated workforce in a previously low-

density area). No competing hypothesis has equivalent multi-site, multi-country, multi-decade support.

2.2 The specific CNSC endorsement

The CNSC’s KiKK fact sheet states: “The most likely explanation is the hypothesis of an infectious agent associated with population mixing around nuclear sites” [1]. This sentence is sourced to Kinlen (1988) [2]. The CNSC therefore accepts the following chain of reasoning: (a) a credible peer-reviewed biological mechanism exists; (b) this mechanism is triggered by large workforce influx into isolated communities; (c) this mechanism is *the most likely explanation* for observed childhood leukemia excesses near nuclear sites. The CNSC then uses this hypothesis to explain away the KiKK finding without requiring that the mechanism be assessed before a new facility is sited.

The CNSC cites population mixing as the most likely explanation for childhood leukemia near nuclear plants — but has never required a population mixing assessment as a condition of nuclear project approval.

3. Relevance to CANDU siting in rural Canada

3.1 Construction workforce demographics

A CANDU-scale nuclear facility requires a construction workforce typically in the range of 3,000–6,000 workers at peak, predominantly from outside the host region, present for 7–10 years. The proposed CANDU-derived facility at Peace River, Alberta would be constructed in a region with a permanent population of approximately 7,000 in the municipality and approximately 20,000 in the surrounding County of Northern Lights. The construction workforce at peak would represent a population influx equivalent to 15–30% of the entire regional population — concentrated in a small geographic area with limited prior exposure to the large mobile workforce populations of southern Canadian cities.

This demographic profile is precisely the combination the Kinlen hypothesis identifies as highest-risk: large, mobile, externally sourced workforce; small, stable, geographically isolated receiving community; limited prior exposure to the circulating infectious agent hypothesised to trigger leukemia in susceptible children. The Peace River region additionally has a significant Indigenous population with documented historical isolation from urban infectious disease exposure, representing the immunologically naive subpopulation the Kinlen model identifies as most susceptible.

3.2 Oil industry OPEX in the Peace Region

The Peace River region has prior operational experience of large workforce influxes associated with oil sands and pipeline construction. Cancer incidence data from the Peace Region health zone shows elevated rates of several cancer types relative to Alberta provincial averages, of aetiology not fully characterised by Alberta Health Services [5]. This elevated baseline is relevant in two ways: it establishes that the population has already experienced conditions partially consistent with the Kinlen mixing model; and it means that the pre-construction

baseline against which any nuclear facility-associated signal would be measured is already compromised, making post-construction epidemiological detection even less likely.

3.3 No pre-construction baseline exists

For a population mixing effect to be detectable after construction commences, a pre-construction baseline epidemiological study of childhood cancer incidence must exist, stratified by age group and geographic proximity to the proposed site. No such baseline has been conducted or required in the Peace River region. CNSC REGDOC-3.1.1 requires characterisation of the existing environment as a pre-licensing condition, but does not specify childhood cancer incidence in the surrounding population as a required component of that characterisation.

4.. The regulatory gap

If the CNSC accepts that population mixing is the most likely mechanism behind the observed childhood leukemia signal near nuclear facilities, then the licensing of a new CANDU facility in a rural community creates a foreseeable, mechanism-identified, regulator-acknowledged cancer risk for children in that community. This risk is not a speculative extrapolation by critics. It is the CNSC's own stated position on the cause of the observed epidemiological signal.

A regulator that accepts a mechanism as the most likely explanation for an observed harm, then approves conditions that will create that mechanism in a new location without requiring any assessment of the mechanism's likely magnitude, has not fulfilled its statutory obligation to protect the health and safety of persons. It has identified a foreseeable risk and proceeded without assessing it.

The CNSC accepts population mixing as the most likely cause of childhood leukemia near NPPs.

No Canadian nuclear licensing proceeding has ever required a population mixing assessment.
These two facts cannot both be correct.

5.. Proposed pre-construction requirements

Three requirements are proposed as pre-construction conditions for any CANDU siting in a rural community where the construction workforce will represent more than 5% of the regional population.

First, a pre-construction population mixing risk assessment should be required, quantifying the expected workforce influx relative to the resident population, the degree of prior population isolation, and the predicted magnitude of mixing exposure relative to documented cases where mixing has produced elevated childhood leukemia rates.

Second, a pre-construction baseline epidemiological study of childhood cancer incidence should be required for all children under five within 15 km of the proposed site, stratified by distance, with follow-up studies at 5-year intervals through the construction and first decade of operation phases.

Third, the CNSC should publish a regulatory position explaining how the population mixing mechanism it identifies as “most likely” in its KiKK fact sheet is addressed in the licensing framework for new rural CANDU siting. The current framework contains no such position.

6.. Conclusion

The Kinlen population mixing hypothesis is not a speculative proposal. It is the CNSC’s own cited preferred explanation for the childhood leukemia signal near nuclear power plants. The MONARK program and CANDU-derived projects proposed for rural Alberta will create precisely the demographic conditions the hypothesis identifies as leukemogenic: large external workforce, small isolated community, no prior exposure. The absence of any pre-construction assessment requirement for this mechanism — a mechanism the CNSC itself endorses — represents the most straightforward regulatory gap in Canadian nuclear licensing. It requires no new science to close. It requires only that the CNSC apply its own stated scientific position to its own licensing practice.

7.. References

- [1] Canadian Nuclear Safety Commission, "Fact Sheet: The KiKK Study Explained," cnsccsn.gc.ca, last modified October 24, 2025.
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