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**Written Submission from
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**Mémoire de
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In the matter of

À l'égard de

Ontario Power Generation

Application to refurbish Pickering Nuclear
Generating Station and to renew licences
for the Pickering Nuclear Generating
Station and Waste Management Facility

Ontario Power Generation

Demande concernant la réfection de la
centrale nucléaire de Pickering et le
renouvellement de ses permis pour la
centrale et l'installation de gestion des
déchets

**Commission Public Hearing
Part 2**

**Audience publique de la Commission
Partie 2**

October 2026

Octobre 2026

**A BASEMENT FAULT BELOW THE
PICKERING NUCLEAR POWER GENERATING STATION**

**A POTENTIAL SEISMIC HAZARD FOR THE
FOUR PICKERING “B” REACTORS?**

RECOMMENDATIONS FOR A CLOSER LOOK

Submission to the Canadian Nuclear Safety Commission as Input into the
Public Hearing on the Pickering Nuclear Generating Station License
Renewal and Refurbishment

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1. Extended Summary

This summary of a more detailed report is submitted as input into the public hearing on the Pickering nuclear generating station (PNGS) license renewal and refurbishment. The body of the report will be provided upon request. An earlier, less complete version of the report was submitted to Ontario Power Generation (OPG) in June 2015 for their consideration. The response 7 months later was that no follow-up was being contemplated.

I have undertaken the substantial research reflected in this report *pro bono*. I am a retired geologist living within a few kilometers of the PNGS that will be producing electricity for another few decades and that is located in a densely populated area. I am keenly interested in the potential for a larger-than-anticipated seismic event affecting our area and the PNGS.

The Canadian Atomic Energy Control Board released a report in 1990 with an account of a newly-documented aeromagnetic lineament below the PNGS interpreted to represent a fault (Wallach, 1990). All eight reactors at the site were already producing energy, i.e., they appear to have been constructed without the knowledge of this feature and its implications for seismic activity and seismic safety.

Subsequent published articles have shown that the fault, now identified as the Niagara-Pickering Linear Zone (NPLZ), is of regional extent, traceable from 120 km to the north of Pickering to a similar distance to the south, a total of some 250 km. The fault is dominantly developed in the metamorphic basement rocks which occur at a depth of 250 m below the PNGS and may have resulted in horizontal and vertical offsets of 140 km and 400 m, respectively. These very substantial movements occurred sometime after 700 million years ago and before 450 million years ago.

The NPLZ may have been reactivated and created small offsets in the overlying Paleozoic sediments at a time after 450 million years, and some documented seismic events on the Niagara Peninsula may have been caused by practically recent movements on the NPLZ. Observed offsets in the glacial deposits exposed along the nearby Rouge River are of ambivalent nature and may be the result of glacial rather than tectonic action,

To the best of my knowledge, the NPLZ has not been physically investigated by drilling, as geotechnical investigations at the PNGS have been restricted to the near-surface portion of the geological column, penetrating only a small fraction of the Paleozoic sediments (Golder Associates, 2007). Such investigations are required by section 4.3.3.3, points a) and b) of the Canadian Standards Association (CSA) document N289.2:21 (*Ground motion determination for seismic qualification of nuclear power plants*).

There are several other, similar faults in western North America, including one at the west end of Lake Ontario near Hamilton, to which known seismic events can be ascribed. Strong, destructive earthquakes have been documented from several seismic clusters in eastern North America. The nearest at a distance of 300 km from Pickering is the Western Quebec Seismic Zone, which produced several strong earthquakes: Montreal in 1732 with a magnitude of 5.8; Timiskaming in 1935 with a magnitude of 6.1; Cornwall-Massena in 1944 with a magnitude of 5.8; Mont Laurier in 1990 with a magnitude of 5.0; and Ste-Agathe-des-Monts in 1996 and 1997 with magnitudes of 4.4 and 4.3

(Adams & Basham, 1989). By note of explanation, the momentum magnitude of an earthquake increases tenfold from one digit to the next.

In contrast, western Lake Ontario has been relatively quiet, with fewer earthquakes of lesser, non-destructive magnitude.

The seismic risk for the PNGS in light of the refurbishment of the B reactors was evaluated for and by OPG in 2007 and 2018:

- Golder Associates Ltd., 2007 compiled a list of the locations and strengths of twenty-one seismic events with a magnitude of $M \geq 2.5$ from 1853 to 2000 within 100 kilometers of the PNGS. The strongest with a magnitude of 4.2 occurred in 1954 at a distance of 79 km from the PNGS. Based in this review, the Golder report concluded: "*The seismic hazard for the Local Study Area [immediate PNGS site] is low to moderate.*"
- The relevant section in the OPG 2018 summary risk assessment report for Pickering B estimates the likelihood of an event causing "*severe [reactor] core damage*" at $1.3E-7$ per year, or once every 7.7 million years. The study employs a strictly probabilistic approach. It uses worldwide statistical data for the expected frequency of a seismic event capable of causing the severe reactor core damage and pairs it with the "*plant-level limiting containment fragility*" as input.

As a geologist, I have a problem with the extrapolation of 150 years of documented seismic events in the western Lake Ontario region to a time frame 50 000 times longer.

Alexander et al., 2007, report that the seismic resiliency of the Pickering A reactors was evaluated for a peak ground acceleration of 23%g that would occur once every 10 000 years (100%g is the gravitational acceleration of the earth at 9.81 m/sec^2). An acceleration of 23%g may be caused by a seismic event of $M = 5.0$ (10 to 15 km away) or a larger event of $M = 6.5$ to 7.0 at distances of 50 to 100 km (Mr. Google). Seismic upgrades were subsequently performed at the Pickering A 1 and 4 units. It appears that the Pickering B plant is more resilient, but an actual number for the achieved peak ground acceleration could not be found.

Predicting the frequency of seismic events of a given magnitude worldwide on a statistical basis appears reliable. The relationship is basically logarithmic: an earthquake of magnitude 5 will be ten times more frequent than one of magnitude 6, while it is ten times as weak. The global statistics, however, cannot be applied to individual faults with any degree of certainty. For example, the absence of a strong documented movement along the NPLZ may indicate that the fault is essentially inactive, and is likely to remain so; conversely, it may mean that strain is accumulating without release along the fault that will lead to a large seismic event in future.

In general, I agree with the notion that a seismic event devastating for the PNGS is unlikely to occur within the foreseeable future; however, there cannot be any certainty. Given that Pickering B has a life expectancy of perhaps five decades (refurbishment, operations and dismantling) it is my opinion that additional investigations of a deterministic nature are required to provide more clarity on the current and future seismic behaviour of the NPLZ and as a complement to the probabilistic risk approach. A useful program would have the following components:

- Compilation and georeferencing of all existing geological and geophysical (aeromagnetic and seismic) data in an area stretching from Georgian Bay to Lake Erie and from Kitchener to

Madoc into a set of maps at several suitable scales, with regional to local coverage. Regional coverage is critical for an understanding of the tectonic framework in this area.

- Completion of several seismic survey lines in the vicinity of the PNGS with the aim to map the PNLZ in the basement rocks and to cover its potential extension into the overlying younger strata. Detailed planning of layout and instrumentation needs specialists.
- Based on the results of the seismic surveys, a drill program would follow that produces several intercepts through the NPLZ and tests any offsets indicated to occur in the overlying strata. The drill core would provide material for the physical characterization of the fault, its rock fill, and for age dating of the last movement. Instrumentation would be inserted into the drill holes to monitor any creep/movement along the fault and to provide information of the existing strain regime in the surrounding rocks. The instrumentation may also function as an early warning system for an impending seismic event.

Some parts of this program may have been impleted by the geotechnical drill programs undertaken by OPG in 2024 and 2025, for which no public information could be found. While I cannot provide even an approximate cost for the proposed program (specialists in the various disciplines would have to do so), the proposed program constitutes a comparatively inexpensive insurance policy for the continued long-life operation of Pickering B by furnishing additional physical information on the fault and by providing an early warning system for any significant seismic risk posed by it.

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