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Oral Presentation

Submission from the Canadian Nuclear Society

In the Matter of

Ontario Power Generation Inc., Pickering Nuclear Generating Station

Request for a ten-year renewal of its Nuclear Power Reactor Operating Licence for the Pickering Nuclear Generating Station

Commission Public Hearing – Part 2

June 2018

Exposé oral

Mémoire de la Société nucléaire canadienne

À l'égard de

Ontario Power Generation Inc., centrale nucléaire de Pickering

Demande de renouvellement, pour une période de dix ans, de son permis d'exploitation d'un réacteur nucléaire de puissance à la centrale nucléaire de Pickering

Audience publique de la Commission – Partie 2

Juin 2018

Canada

Submitted online on May 7, 2018

Intervention by the Canadian Nuclear Society (CNS) Before the Canadian Nuclear Safety Commission (CNSC)

Application by Ontario Power Generation (OPG) To renew for a ten year term the operating licence of the Pickering Nuclear Power Station (Ref 2018-H-03)

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Introduction

The Canadian Nuclear Society (CNS) views with great interest the renewal of the operating licence for the Pickering nuclear power station under review today during Day 2 of the hearings by the Canadian Nuclear Safety Commission (CNSC). In this short paper, the CNS will present some perspective on the importance of the Pickering NGS and the role nuclear power plays in Canada and in the province of Ontario.

We will address three areas of interest with respect to the continued operation of the Pickering station:

- The strong continued safety record of all CANDU reactors;
- Consistent, strong safety performance at Pickering;
- The importance of continued operation beyond 2018.

The licensing of a nuclear facility is not an abstract activity. To operate, all regulated nuclear facilities in Canada must meet the safety performance requirements of the CNSC. However, all regulated nuclear facilities in Canada exist for important commercial, research, or energy supply reasons. This means that licensing decisions have direct research, technical and commercial consequences. This paper provides the views of the CNS on the importance of these licensing decisions.

The CNS is Canada's learned society for the nuclear industry. We are a not-for-profit organization representing more than 1,000 scientists, engineers and other nuclear professionals engaged in various aspects within Canada's nuclear industry. We do not represent any company or other organization within the industry. The CNS believes that the views of Canada's nuclear professionals, as embodied by its learned society, may provide useful assistance to the CNSC in its deliberations.

I Nuclear Power in Canada

Nuclear technology plays an important role in Canada, and it has done so for more than 70 years. Canada was the second nation to demonstrate controlled fission with the startup of the ZEEP reactor at Chalk River Laboratories. It was one of the first nations to build a demonstration nuclear power reactor, the NPD-2 reactor at Rolphton, Ontario. As Canada's first commercial nuclear power station, Pickering Units 1 and 2 entered commercial service starting in 1971. This station remains today the world's largest nuclear generating facility under one roof.

As a Tier-1 nuclear nation, Canada is one of the very few nations of the world in which all of the following activities take place:

- Design of nuclear reactor technology
- Construction and operation of nuclear power plants
- Uranium mining, fuel fabrication and production
- Medical and industrial isotope production
- Decommissioning, environmental remediation and high level, long term waste management
- Full scope nuclear laboratory services and R&D
- Post-secondary nuclear education up to doctorate level.

Canada is the second largest producer of commercial uranium in the world, with annual production averaging approximately 10,000 tonnes of uranium consistently over the past 40 years. It has all of the facilities and technology to provide the full spectrum of uranium supply, both to meet Canada's needs and to supply uranium for nuclear power in other nations as well.

The success of Canada's nuclear reactor technology has been shown by its extensive, safe and economic operation in Canada. It has also been acquired by a number of other nations as well, including South Korea, Romania, Argentina and China. In all of these countries, CANDU technology has been shown to be both reliable and economic, providing large quantities of electricity to meet these nations' energy needs. Canada's CANDU technology was also adopted by India and Pakistan, and in the case of India, their heavy water reactor technology is to this day the mainstay of that country's commercial power program.

The following is a list of operating CANDU reactors, both in Canada and around the world.

Table 1: CANDU Nuclear Reactor Performance - 2017

Reactor	In Service	Capacity (MW)	Performance in 2017 (%)	Lifetime Performance (%)
Point Lepreau	1983	705	89.1	70.5
Wolsong 1*	1983	679	40.4	72.6
Wolsong 2	1987	678	90.0	92.4
Wolsong 3	1998	698	32.7	89.9
Wolsong 4	1999	703	99.2	94.0
Embalse	1983	648	0	74.0
Cernavoda 1	1996	707	96.3	90.1
Cernavoda 2	2007	705	89.5	94.0
Qinshan 4	2002	700	76.6	89.8
Qinshan 5	2003	700	94.4	91.5
Pickering 1	1971	542	57.8	64.2
Pickering 4	1973	542	87.8	66.9
Pickering 5	1983	540	63.8	73.6
Pickering 6	1984	540	98.1	78.5
Pickering 7	1985	540	83.0	77.3
Pickering 8	1986	540	85.6	75.5
Bruce 1	1977	825	96.6	68.9
Bruce 2	1978	825	97.4	65.3
Bruce 3	1978	825	83.8	73.5
Bruce 4	1979	825	94.2	73.3
Bruce 5	1985	872	70.3	84.6
Bruce 6	1984	872	80.2	81.9
Bruce 7	1986	872	92.8	84.5
Bruce 8	1987	872	97.7	83.2
Darlington 1	1992	934	60.3	83.6
Darlington 2	1990	934	0	76.0
Darlington 3	1993	934	93.9	86.2
Darlington 4	1993	934	98.7	85.8

https://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CA
Notes
1. Darlington 2 entered plant refurbishment, October 2016.
2. Embalse undergoing plant refurbishment.
3. All reactor performance now based on Load Factor, not Capacity Factor

In total, these reactors have produced more than 3600 TWh of electricity during their years of operation.

From a historical perspective, the only significant change to world electricity production over the past 50 years has been the emergence of nuclear power and to a lesser degree the use of natural gas. The proportion of electricity generated from hydraulic sources in 1950 was roughly similar to the current proportion. However, starting in the late 1950s, nuclear power began to emerge as a major source of new electricity generation. Its impact over the past half-century has been to displace principally oil-fired generation, and to a considerable extent coal-fired generation particularly for base load applications.

To a considerable extent, nuclear and gas complement each other. Nuclear with its high fixed costs and low operating costs works best as base load generation. Gas, with its low fixed costs and high proportional fuel costs, works best as a peaking power source. (Approximately 90 per cent of the lifetime total cost of a gas-fired CTU comes from fuel purchase and not construction and operation. Nuclear by contrast has much less than 10 per cent of its total lifetime cost in the purchase of fuel.)

For Canada, electricity consumption from all sources was 643 TWh annually. Canada is the seventh largest electricity jurisdiction in the world:

Table 2: World's largest electricity jurisdictions

	Consumption(TWh)
China	6,142
United States	3,166
European Union	3,166
India	1,289
Russia	1,008
Japan	976
Canada	643
Germany	589
Brazil	559
France	536

CIA World Factbook, 2018

Nuclear power remains about 17 per cent of Canada's total electric energy production, above the world average noted above. It should be noted that all of these jurisdictions rely on nuclear power to some extent for their electricity supply.

Canada however is very different from the large nations.

Table 3: Canada's Electricity Sources

	% share
Hydraulic	63.4
Nuclear	16.6
Coal	14.3
Natural Gas	4.0
Wind	1.5
Other	>0.3

The Canadian Nuclear Factbook 2017, CNA

Canada has more than half its electricity produced by hydraulic energy, whereas the dominant form of generation for all of the other large nations is coal. With approximately 80 per cent of Canada's electricity supply coming from hydraulic and nuclear energy, Canada has one of the cleanest large electricity systems in the world. There has been some new hydraulic construction over the past 40 years, principally the La Grande generating complex in Quebec. But the vast majority of new electric generation in Canada over those 40 years was nuclear power.

It is reasonable to draw several conclusions:

1. That Canada's nuclear power stations have absorbed most of the growth in electricity production over the past half-century;
2. That Canada's nuclear power stations have displaced fossil fuels in Canada, principally coal and oil; and,
3. That 80 per cent of Canada's electric generation is free of atmospheric emissions from the point of generation.

It should be noted that Canada is the only nation in the world, with all of the above-mentioned aspects of nuclear technology and infrastructure, which has developed its nuclear industry for purely peaceful purposes.

II Nuclear Power in Ontario

Ontario is home to all but one of Canada's 19 operating nuclear power reactors. These reactors are concentrated in two main areas: Durham Region with the Pickering and Darlington nuclear power stations; and Bruce County with the Bruce nuclear power station.

Of all of the provinces in Canada, Ontario's electricity system has perhaps the greatest diversity of electricity sources. Nuclear generation is only one part, albeit the most significant part in terms of percentage share, of a large system producing and distributing electricity from a variety of sources:

Table 4: Ontario's Electricity Production – 2017

	Energy(TWh)	%Share
Nuclear	90.6	63
Hydro	37.7	26
Gas	5.9	4
Wind	9.2	6
Biofuel	0.4	<1
Solar	0.5	<1

http://www.ieso.ca/en/corporate-ieso/media/year-end-data

Importance of Pickering NGS in Ontario's electricity supply

The Pickering nuclear power station consists of six operating reactors, with the performance characteristics shown below:

Table 5: Performance of the Pickering Reactors in 2017 and Lifetime

Reactor	In Service	Capacity (MW)	Performance In 2017 (%)	Lifetime Performance (%)
Pickering 1	1971	542	57.8	64.2
Pickering 4	1973	542	87.8	66.9
Pickering 5	1983	540	63.8	73.6
Pickering 6	1984	540	98.1	78.5
Pickering 7	1985	540	83.0	77.3
Pickering 8	1986	540	85.6	75.5

https://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CA

On a continuing basis, Pickering's six reactors supply about 14 per cent of the province's total electricity requirement. It should be noted that for the past decade annual performance of the Pickering reactors is significantly higher than lifetime performance. This means that generally the Pickering power station is improving performance with age, rather than the reverse.

It is the view of the CNS that this mid-life improvement in performance is a testament to the investment OPG has made in plant and equipment, personnel and training.

III The Safety Record of CANDU Reactors at Pickering

It has become axiomatic in the operation of nuclear power facilities that strong performance with respect to safety is essential to allowing strong production performance. This is true not just in Canada for CANDUs but for all other types of nuclear power reactors around the world. A strong safety performance comes from a large number of factors:

- Nuclear safety culture

- Plant training and human performance
- Attention to plant maintenance, elimination of maintenance backlogs, and focus on ageing and obsolescence management
- Strong coordination for various aspects of safety and plant operation with local communities and governments
- A strong research, technical and industrial support base
- An effective, independent nuclear regulator.

It should be noted that in general, CANDU technology has a record of safety performance second to none throughout its more than half-century history in operation. At no time has any worker been killed or injured by exposure to radiation. And at no time has any member of the public been exposed to any significant radiation release from any CANDU reactor anywhere in the world. The six reactors at Pickering are a key part of that record. The Pickering station has been operating since 1971. With nearly 50 years of operating experience at the station, Pickering provides a solid background of information on long term operation and maintenance of CANDU reactors. This operating record provides important information to all CANDU reactor operators, not just those at Pickering. Thus it is reasonable to state that Pickering operating experience contributes to the safety and performance of all CANDU reactors.

Nuclear power is in fact the safest possible way to generate electricity on any large scale particularly when measured in terms of loss of life or injury as a result of plant operations. This has been noted strongly by the Paul Scherrer Institute report: Project GaBE: Comprehensive Assessment of Energy Systems; Severe Accidents in the Energy Sector, 1st Edition, 1998.
http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/30/045/30045581.pdf

This report first issued in 1998 has been updated by PSI at regular intervals over the past 20 years.

Nuclear safety is not achieved in isolation. It is accompanied by other highly related performances such as industrial accident rate. The Commission should note that the Lost Time Accident (LTA) rate for Pickering in the fourth quarter of 2017 was just 0.06 injuries of any kind.
https://www.opg.com/news-and-media/Reports/PickeringPerformanceReport2017Q4.pdf
It should be noted that workplace safety performance in Canada's nuclear industry and OPG runs strongly counter to overall industrial safety trends in Canada.
http://www.safethink.ca/resources/pdf/Canadian%20Workplace%20Injury%20and%20Fatality%20Facts.pdf

These figures should not be taken as criticism of Canada's overall industrial safety record. With an LTA rate of less than one, Canada's industrial environment remains one of the safest in the world. What it does show is that the Canadian nuclear industry has a safety record unmatched in Canada by any other industry. In fact, there are clear differences between nuclear safety culture and safety culture generally within Canada's or essentially any other industrial system. And these differences extend to all aspects of safety, not just the safety of the reactor core and radiation protection.

With respect to radiation safety, Pickering had only one reportable spill in 2017. It is the understanding of the CNS that this was fully contained within the plant and there was no release of radiation to the environment.

In short, improvements in radiation and workplace safety have gone hand in hand with improvements in overall electricity production at Pickering. It is the view of the CNS that improvements in safety of all kinds are a central contributor to improvements in economic performance.

As noted by the Association of Workers Compensation Boards of Canada, the fatality rate for Canada's industrial workers varied between 750 and 1100 fatal injuries annually between 1993 and 2005. This number does not include fatalities not covered by workmen's compensation, such as farm labour. The Association further noted that there was a generally rising trend over the years. By contrast, the fatal accident rate for workers at Pickering and Canada's nuclear workers generally has been zero.

When looking at Canada's industrial sectors, the electricity industry is one of the safest overall with an LTA (Lost Time Accident) average of about 0.7 (hours lost per 200,000 hours worked). By comparison, mining in Canada has a typical LTA of approximately 2.0, and forestry about 2.25. Relatively safe as the electricity industry in Canada is, with an LTA of about than 0.7, Canada's nuclear plants including Pickering are more than an order of magnitude less than that. With such a low LTA rate, common workplace injuries in plants such as that of Pickering are a very tiny fraction of Canada's overall industrial accident rate. It can reasonably be said that Canada's nuclear power plants are perhaps the safest places in the country in which to work.

The importance of such a low industrial accident rate cannot be understated. It comes from highly developed plant procedures, continued investment in personnel training and procedures, and strict attention to detail. It can be reasonably stated that the safety culture of nuclear facilities such as Pickering could and should serve as a model for Canadian industrial activity generally. In terms of safety at Pickering, the CNS observes that the station has won the highest safety rating from the CNSC for the past two years.

Larger aspects of nuclear safety in terms of avoiding radiological accidents and preventing public radiation exposure can therefore be seen as a function of an overall safety culture that reduces the incidence of injury from all causes.

IV Pickering Continued Operations to 2024

In January 2016, the Province of Ontario endorsed the plan of OPG to continue operation of the Pickering NGS to 2024. The provincial government incorporated this continued operation in its 2017 Long Term Energy Plan.

The CNS agrees with this decision of the Province of Ontario. At this time, Pickering supplies approximately 14 per cent of Ontario's electricity supply. It is the view of the CNS that the loss of electricity generation by premature closure of the Pickering station cannot be provided by any other electricity source in the short term. The result would be an absolute shortage of electricity in Ontario, producing blackouts and electricity curtailment. Such a circumstance would require operation of Ontario's gas-fired plants at much higher cost and atmospheric emissions.

The CNS also suggests that any loss of significant reliable generation to Ontario's electricity supply system itself would constitute increase public safety hazards. Loss of Pickering will mean reduced electricity availability. This in turn means greater risk of load shedding and loss of electrical grid stability.

V Conclusions

The CNS is therefore of the view that operation of the Pickering nuclear power station must continue, provided that it meets all of the safety requirements of the CNSC. Our reasons are as follows:
1. Nuclear power is essential to Ontario for the supply of base load electricity that cannot be provided economically from any other available source.
2. Electricity supplied by Pickering is an essential part of that base load electricity supply, meeting 14 per cent of Ontario's total electricity demand.
3. Any premature loss of generation from Pickering cannot be met in the short term by either construction of new generating facilities or by increased imports from other jurisdictions.
4. OPG has demonstrated in dialogue with the CNSC a strong response in emergency preparedness and in investment in equipment and personnel.
5. OPG constitutes a strong ongoing source of high technology employment for engineers and skilled trades, providing a solid base for both Ontario industrial capacity and Ontario's academic and apprenticeship training programs.
6. Provision of a 10-year operating licence will add certainty and reliability of regulatory requirements into the 2020s.
7. For more than 15 years, OPG has demonstrated a strong and improving record in radiation and workplace safety.

Therefore, the Canadian Nuclear Society strongly supports the application by OPG for the renewal of its operating licence for the Pickering nuclear power station.