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# Written submission from Greenpeace Canada

# Mémoire de Greenpeace Canada

In the Matter of the

À l'égard de l'

**Ontario Power Generation Inc.**

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**Request by Ontario Power Generation Inc. to request to remove the hold point associated with Licence Condition 16.3 of the Pickering Nuclear Generating Station Power Reactor Operating Licence**

**Demande par Ontario Power Generation Inc. visant à supprimer le point d'arrêt associé à la condition 16.3 du permis d'exploitation de la centrale nucléaire de Pickering**

Commission Public Hearing

Audience publique de la Commission

**May 7, 2014**

**Le 7 mai 2014**

Canada

**An Inconvenient Truth:**
**Pickering Exceeds Safety Limits**

GREENPEACE

Prepared by Shawn-Patrick Stensil
Nuclear Analyst, Greenpeace Canada
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## 1. Introduction

In 2013, Ontario Power Generation (OPG) requested approval from the Canadian Nuclear Safety Commission (CNSC) to operate the four Pickering B reactors beyond their design life along with a 5-year operating license for all six reactors at the Pickering[1] site. CNSC staff endorsed OPG's request.

Based on the information provided by OPG, however, Greenpeace advised the Commission it had an obligation to deny the license renewal. This information showed the Pickering nuclear station exceeded the limits traditionally used by OPG and the CNSC to permit reactor operation.

When OPG has exceeded such limits in the past the CNSC or its predecessor (the Atomic Energy Control Board) required safety upgrades to nuclear stations to reduce the likelihood of an accident causing offsite damage and evacuation.

In light of the significant risk to the public as well as the apparent complicity between CNSC staff and OPG to minimize and conceal the full extent of this risk from the Commission, Greenpeace filed two requests for ruling under section 20(3) of the CNSC's rules of Procedures.

Specifically, in the event the Commission decided to renew OPG's operating licence, Greenpeace asked the Commission to:

- Deny OPG permission to operate the Pickering B reactors beyond their design life, pending an additional public hearing once all of the missing data from the safety case can be made public[2]; and,
- Direct CNSC staff to publish a cumulative risk assessment for all six operating reactors at the Pickering site by the end of 2013 and provide this information to Emergency Management Ontario.

Greenpeace cited the following evidence – or lack of evidence – from OPG's license application as reasons why the Commission had a legal responsibility to rule in favour of these requests:

- Despite years of preparation, OPG had failed to release complete safety case to support the continued operation of the Pickering B reactors beyond their operational life.

[1] There are six operating reactors at the Pickering site. The two Pickering "A" reactors and the four Pickering "B" reactors. Two reactors at Pickering "A" have already been permanently shut down. Nevertheless, the Pickering "A" and "B" reactors share a number of safety systems. This submission will refer to all six reactors as simply "Pickering".

[2] This request was submitted by Greenpeace, the Canadian Environmental Law Association (CELA), Durham Nuclear Awareness (DNA), Northwatch and CCNB Action on May 31, 2013.

- OPG's most recent risk assessment for the Pickering B reactors found the large accidental release risk exceeded the limits traditionally used to ensure the safety of Canadians and the environment.
- OPG had failed to release a risk assessment for the two older Pickering A reactors.
- A regulatory loophole tolerated by the CNSC allows the Pickering nuclear station to impose significantly higher levels of risk on the community surrounding the station than around the Point Lepreau nuclear station in New Brunswick.
- In light of empirical evidence, academic observers have concluded that the risk models used by OPG and the CNSC underestimate the likelihood for major accidents.
- The Ontario government's offsite nuclear emergency plans are clearly unable to adequately protect Ontarians from large accidental radiation release accidents. Such accidents are identified as realistic in OPG's most recent risk assessment.
- It is ultimately the Commission – and not staff – who are responsible for preventing "unreasonable risk" to Canadian society under the Nuclear Safety and Control Act (NSCA).

In response, the Commission initially gave OPG a temporary two-month licence extension to "…allow it sufficient time to deliberate and carefully consider all of the information on the record before issuing a final decision."[3] The Commission issued its final decision on August 9th renewing OPG's operating licence for five-years.

The Commission, however, put conditions on OPG's licence in response to Greenpeace's ruling requests. Specifically, the Commission:

- Denied OPG approval to operate the Pickering B reactors beyond their design life before a complete safety case is considered at a public hearing.
- Required OPG to submit the missing Probabilistic Risk Assessment[4] (PRA) for the Pickering A nuclear station before it could operate the Pickering A reactors beyond their design life.
- Required OPG to update both the Probabilistic Risk Assessments for the Pickering A and B reactors taking into account the enhancements required under the Fukushima Action Plan.
- Acknowledged that if the Probabilistic Risk Assessments found a reactor to be operating "…above acceptable limits then safety improvements would be mandatory" and that if

[3] CNSC, "CNSC Extends Operating Licences for Pickering A and B Nuclear Generating Stations," press release, June 24, 2013. See: http://nuclearsafety.gc.ca/eng/resources/news-room/news-releases/index.cfm?news_release_id=462

[4] In this submission Probabilistic Risk Assessment (PRA), Probabilistic Safety Assessment (PSA) and risk assessment will be used interchangeably.

results "are between the limits and the targets, then safety improvements should be put in place if practicable."

- Required OPG to submit an "action plan to address any identified issues should OPG exceed its targeted safety goals."
- Provide a whole-site risk assessment or a methodology for a whole-site risk assessment for the Pickering site.[5]

Despite its decision to renew OPG's Pickering licence for five-years, Greenpeace publicly commended the Commission's decision as an acknowledgement of the deficiencies in OPG's safety assessments.[6] The Commission's decision was also an appropriate rebuke of CNSC staff's failure to properly inform the Commission of the deficiencies in OPG's safety case for both the Pickering A and B reactors.

Indeed, the approach of CNSC staff to these deficiencies indicates the institutional culture at the CNSC has yet to accept and implement lessons from Fukushima. It has been concluded that Fukushima happened because the Japanese regulator and Fukushima's operator ignored safety deficiencies.

What continues to concern Greenpeace is that CNSC staff have been less than forthright – indeed evasive – with the Commission and the public regarding the deficiencies in OPG's safety case. This was clear during the CNSC's relicensing hearings in May 2013. As will be discussed, it continues in 2014.

In March 2014, OPG and CNSC staff provided submissions to the Commission recommending it allow OPG to operate the Pickering B reactors beyond their design life and accept the findings of OPG's latest risk assessments for the Pickering A and B reactors.[7]

Notably, however, CNSC staff have made this recommendation despite OPG's failure to fulfill the requirements set by the Commission in August 2013. Specifically, the Commission required OPG submit an "action plan" for reducing risk from the station if either of the Pickering A or B risk assessments exceeded safety limits.

As will be discussed, the Pickering A reactors were found to be operating beyond safety limits. Worse still, access to Information documents indicate CNSC staff were aware of this in August 2013 – and possibly before – and instead of preparing to advise the Commission on how to

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[5] Recording of Proceeding in the matter of Ontario Power Generation's application to Renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station, August 9, 2013, pgs. 5 -6. See: http://nuclearsafety.gc.ca/eng/the-commission/pdf/2013-05-29-Decision-OPG-Pickering-e-Edocs4177096.pdf

[6] Rob Ferguson, "Pickering nuclear plant gets license extension," *The Toronto Star,* August 9, 2013.

[7] See: OPG, *Request by Ontario Power Generation Inc., to request to remove the hold point associated with Licence Condition 16.3 of the Pickering Nuclear Generating Station Power Reactor Operating Licence,* March 21, 2014, CMD 14-H2.1 and CNSC Staff, *Pickering NGS – Release of Licence Hold Point,* March 24, 2014, CMD 14-H2.

oversee the reduction of risk from the Pickering A reactors instead prepared to ignore this requirement and downplay the relevance of the safety limits.

By ignoring and minimizing the importance of traditional safety limits, CNSC staff are, in Greenpeace's view, showing they are focused on reducing OPG's economic risks instead of risks to public safety. This shows a deficiency in the CNSC's safety culture that should be remedied.

It is ultimately the Commission – and not staff – who are responsible for preventing "unreasonable risk" to Canadian society under the NSCA. Based on the evidence available and past practice, the operation of the Pickering nuclear station is an "unreasonable risk" to Canadian society. It is thus incumbent on the Commission to eliminate this risk or direct OPG to reduce these risks.

**2. An Inconvenient Truth: Pickering Exceeds Safety Limits**

The Pickering nuclear station exceeds safety limits. The station's potential for large accidental radiation releases causing offsite damage contravenes the risk limits. The CNSC has a legal responsibility to either direct OPG to close Pickering or reduce its potential to cause offsite damage.

The purpose of Nuclear Safety and Control Act (NSCA) is to provide a "limitation" on the risk nuclear power generation. To do this, the NSCA gives the CNSC the responsibility to "prevent unreasonable risk" to the environment and the health and safety of Canadians.[8]

The CNSC and reactor operators have historically limited the risk posed by nuclear reactors through two metrics. One is Core Damage Frequency (CDF). This is the likelihood of damage to a reactor core or what is more popularly understood as core 'melt'. Three Mile Island is an example of a core damage accident. The other metric is Large Release Frequency (LRF). This is the likelihood of a large accidental release of radiation, which could lead to the abandonment of land. Chernobyl and Fukushima are examples of large radiation release accidents.

These risk limits are expressed as probabilities. Reactor operators such as OPG use a method called Probabilistic Risk Assessment (PRA), which is also used by the aviation industry, to estimate the frequency of core damage and large release accidents. If a risk assessment finds a nuclear station exceeds a risk limit, action such as engineered upgrades must be taken to reduce the accident risk. This includes the option to close the station.

[8] See: http://laws-lois.justice.gc.ca/eng/acts/N-28.3/page-2.html#h-3

In the Table 1 shows the goals and limits for CDF and LRF. "1E-5" refers to accident events that are estimated to occur once every 100,000 years of reactor operation. "1E-6" references accidents occurring once every 1,000,000 years of reactor operation.

Table 1 also compares these risk limits to OPG's most recent risk assessment for the two Pickering "A" reactors. It shows the risk of a large radiation release has increased significantly since the last Pickering A risk assessment was released in the 1990s, which estimated large radioactive releases to be approximately 1E-7.[9] The latest estimate for Pickering's LRF is 1.26E-5, which is above the limit of 1E-5.

**Table 1 – Pickering A PRA Results**

| Safety Metric | Target | Limit | 2013 Risk Assessment, including Fukushima response | 2013? Risk Assessment before Fukushima Response |
|---|---|---|---|---|
| Severe Core Damage | 1E-5 | 1E-4 | 0.76E-4 | 1.14E-4 |
| Large Off-Site Release | 1E-6 | 1E-5 | **1.26E-5** | 2.68E-5 |

These results were only released due to a request for ruling put forward by Greenpeace and other organizations during the May 2013 relicensing hearings for Pickering nuclear station. The results also confirm Greenpeace's contention during the Pickering relicensing hearings in 2013 that the Pickering A reactors exceeded safety limits.[10]

According to OPG's policy establishing risk targets and limits, it must take action to reduce risks when a limit for core damage or large radiation releases is reached. The Commission also affirmed this in its August 2013 decision, stating that if a risk assessment finds the station is operating "…above acceptable limits then safety improvements would be mandatory" and that if the finds "are between the limits and the targets, then safety improvements should be put in

[9] Ontario Hydro, *Pickering NGS A Risk Assessment, Main Report,* November 1995, p. 13-21.
[10] Greenpeace's 2013 submission stated: "Without access to OPG's latest Pickering A risk assessment it is reasonable to conclude that the two remaining Pickering A also have a large release probability at the limit OPG's own risk acceptability guidelines."

place if practicable." The Commission's decision also required OPG to submit an "action plan to address any identified issues should OPG exceed its targeted safety goals."[11]

There is precedent for this. When the 1995 risk assessment for Pickering A showed the station had a core damage frequency of 1.3E-4, the Atomic Energy Control Board – the CNSC's predecessor – required Ontario Hydro (OPG's predecessor) to invest in design changes to reduce the frequency of core damage to as close as possible to the risk target of 1E-5.[12]

Based on past practice and OPG's own policy, the Commission's license renewal decision required OPG to submit an "action plan to address any identified issues should OPG exceed its targeted safety goals"[13] if it were to gain approval to operate the Pickering B reactors beyond their design life. Despite the findings of OPG's Pickering A risk assessment, OPG has not submitted such an action plan.

Notably, CNSC staff's submission omits mention of OPG's obligation to submit an action plan if the station is found to be operating above risk limits. This omission and minimization of Pickering's risk by appears to be pre-planned.

Access to Information documents indicate CNSC staff were aware Pickering A was operating above risk limits in August 2013 – and plausibly before – but instead of preparing to advise the Commission on how to oversee and reduce the risk from the Pickering A reactors CNSC staff prepared to ignore the Commission's directives and downplay the relevance of safety limits.

In correspondence acquired by Greenpeace, Mr. Santini, the Director of the CNSC's Pickering Regulatory Program Division, told the CNSC's Director General of Power Reactor Regulation, Greg Rzentkowksi just days after the Commission its relicensing decision: "There is a risk here that even with the Fukushima enhancements Pick A will not meet the 1E-5 for LRF. This could be a problem as the 'action plan' cannot be ready for the release of the hold point. These results will be much more than the 'estimate' the Commission wants."[14]

Instead of maintaining a safety focus and preparing to advise the Commission on how to address the risk posed by the Pickering A reactors, CNSC staff have focused on minimizing or rationalizing this violation safety limits.

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[11] Recording of Proceeding in the matter of Ontario Power Generation's application to Renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station, August 9, 2013, pgs. 5 -6. See: http://nuclearsafety.gc.ca/eng/the-commission/pdf/2013-05-29-Decision-OPG-Pickering-e-Edocs4177096.pdf

[12] Atomic Energy of Canada Limited (AECL), *Reduction of Severe Core Damage Frequency – Pickering NGS A Risk Assessment (PARA) Review,* October 1999.

[13] Recording of Proceeding in the matter of Ontario Power Generation's application to Renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station, August 9, 2013, pgs. 5 -6. See: http://nuclearsafety.gc.ca/eng/the-commission/pdf/2013-05-29-Decision-OPG-Pickering-e-Edocs4177096.pdf

[14] Miguel Santini to Greg Rzentkowski, "PRA discussions," email, August 15, 2013. Acquired through Access to Information.

In their submission, CNSC staff state that while "Pickering A is slightly above OPG safety goal limit" this is "primarily due to the overly conservative assumptions and simplified methods in the Fire PSA."[15] Faced with a risk assessment in violation of safety limits, CNSC staff are now turning the conservatism typically touted as a precautionary measure into an undue overestimation of the risk posed by the station.

Staff made similar assertions during last year's re-licensing hearings in response to Greenpeace's submission highlighting that the Pickering B reactors were operating beyond safety limits if all risk contributors were taken into account. When this argument failed to convince the Commission, staff asserted that changes required under OPG's Fukushima Action Plan were taken into account, the risk posed by the Pickering station would be reduced by one order of magnitude.

In response, the Commission in its August 2013 decision directed OPG to submit risk assessment results accounting for upgrades required under the CNSC's Fukushima Action Plan. This did reduce likelihood of a large radiation release from the reactors by approximately one order of magnitude (See Tables 4 and 5 in the Appendix). It should be noted, however, that OPG has not released the studies supporting these reduction or had them subjected to an independent third party review.

While Fukushima upgrades reduced the likelihood of a large release accident at Pickering B by almost one level of magnitude these same changes reduced the likelihood of such an accident by only a factor of two at Pickering A. Given Pickering A and B share containment and other safety systems, this raises questions about either the credibility of the Pickering B risk assessment or the unique design weaknesses of the Pickering A reactors.

As will be discussed, the submission of CNSC staff is unbalanced and arguably biased. It omits mention of significant known uncertainties that suggest OPG's risk assessments underestimate the risk posed by Pickering. It also fails to mention the Commission directed OPG to provide an action plan for safety improvements if risk assessment results are "above acceptable limits". What's more, even below limits the Commission expects "…safety improvements should be put in place if practicable."

**Conclusions:**

- The Pickering nuclear station's large accident potential exceeds safety limits.

[15] CMD 14-H2, p. 9.

- OPG has failed to submit an action plan for reducing the risk from the site to below safety limits and has therefore failed to fulfill the requirements set by the Commission in order to gain approval to run the Pickering B reactors beyond their design life.

**3. Not seeing the forest for the trees: Cumulative Risk at Pickering**

OPG's most recent risk assessments for the Pickering A and B nuclear stations significantly underestimate of the risk posed by Pickering: they provide risk estimates on a per reactor basis but no estimate of the cumulative risk. This approach to risk assessment means we don't the forest for the trees.

As discussed, OPG's most recent risk assessment for the Pickering A reactors shows the station's potential for large accidental radiation releases is significantly higher than previously thought. In contravention of past practice, CNSC staff and OPG are asserting that these regulatory limits can be overlooked due to "overly conservative" assumptions.

In the past, conservative assumptions have been touted as a precautionary measure to ensure public safety. From a public interest perspective, such conservatism is fair and reasonable given a nuclear reactor's potential to cause irreversible harm to the public and the environment.

While trying publicly portray the Pickering A risk assessment results as an overestimate, CNSC staff omit mention of the other uncertainties that suggest these results are a significant underestimate.

Access to Information documents acquired by Greenpeace show CNSC staff acknowledge the cumulative risk posed by the station is several times higher than portrayed in OPG's current risk assessment. CNSC staff also acknowledge their responsibility under the NSCA to define risk limits for the station. These factors were not mentioned in staff's submission to the Commission.

In an internal memo to CNSC staff Gerry Frappier, Director General of Assessment and Analysis for the CNSC, states that the results of a site wide assessment for Pickering "…will be potential (sic) greater (perhaps 3time (sic) higher) than the per unit numbers and we need to discuss internally what are acceptable levels to demonstrate that there are no "unreasonable risks"".[16]

What Mr. Frappier is referring to is a regulatory loophole the CNSC has tolerated for several decades. This loophole allows the Pickering nuclear station to impose significantly higher levels

[16] Gerry Frappier to Smain Yaloui, "FW: Site PSA estimate – Discussion with OPG", email, September 3, 2013. Acquired through Access to Information.

of risk on the community surrounding the station than around the Point Lepreau nuclear station in New Brunswick.

Specifically, the CNSC and reactor operators have assessed risk on a per reactor basis. It has historically (wrongly) assumed the likelihood of simultaneous accidents was so low it could be discounted. The Fukushima disaster, which saw three reactors at one site release radiation, has highlighted why this loophole, which allows OPG to consider the risk of the six Pickering reactors individually instead of collectively, must be addressed if CNSC is to "prevent unreasonable risk" under the NSCA.

As noted, Greenpeace filed a ruling request under the CNSC's rules of procedure that the Commission direct CNSC staff to publish cumulative risk assessment for all six operating reactors at Pickering site by the end of 2013 if it decided to renew OPG's licence for the Pickering.

In response, the Commission directed OPG to provide a whole-site risk assessment or a methodology for a whole-site risk assessment for the Pickering site before it can gain approval to operate the Pickering B reactors beyond their design life.[17] This was a laudable acknowledgement of a long standing deficiency in the CNSC's regulatory approach. OPG, however, opted to publish just a methodology for a whole-site risk assessment[18] instead a whole-site risk assessment.

OPG's risk assessments, then, still omit consideration of the cumulative risk of the Pickering site. This is a clear underestimation of the risk posed by Pickering's operation. While not acknowledged in the submission of CNSC staff, the underestimation is significant. As noted, CNSC staff privately believe the risk of the site may be three times greater than the per reactor results.

**Conclusion:** CNSC staff have failed to publicly acknowledge how OPG's single unit risk assessment approach underestimates the total risk posed by the Pickering site to Canadian society.

**Request:** In its decision, the Commission should acknowledge that cumulative risk of all six reactors, which staff estimate may be three times higher than the per unit estimates provided by OPG, has not been accounted in the risk assessments provided to the Commission. The

[17] Recording of Proceeding in the matter of Ontario Power Generation's application to Renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station, August 9, 2013, pgs. 5 -6. See: http://nuclearsafety.gc.ca/eng/the-commission/pdf/2013-05-29-Decision-OPG-Pickering-e-Edocs4177096.pdf

[18] Jack Vecchiarelli et al., *Deveopment of Whole Site PSA Methodology,* COG-13-9034 R0, February 2014. Available at: http://www.opg.com/generating-power/nuclear/stations/pickering-nuclear/Documents/COG-13-9034-R0.pdf

Commission should provide reasons for how it treated this omission in determining whether Pickering poses an "unreasonable risk" to Canadian society.

**4. Divergence between real-world experience and risk studies**

In light of empirical evidence, academic observers have concluded that the risk models used by the OPG and the CNSC have underestimated the potential for major accidents. This underestimation has not been acknowledged by CNSC staff and should be factored into the Commission's decision.

A precautionary approach would acknowledge the real-world frequency of major reactor accidents and assume OPG's estimated liklihood for large accidental radiation releases underestimates the station's risk. The CNSC, however, has done the opposite.

Jan Christian Kaiser, for example, estimates another significant accident somewhere in the world within next ten years.[19] The Max Planck Institute for Chemistry has published a paper estimating a significant accident approximately once a decade based on the historic record.[20]

Swiss academics have also compared the historic record to the probabilistic safety assessment estimates used by nuclear regulators and operators. They found that "…for nuclear power events with damage costing more than one billion dollars, their frequencies are underestimated by two orders of magnitude. Moreover, rather than being associated with just a few extreme cases, the power law distribution of losses suggests that the problem has intrinsic structural roots."[21]

The probable explanation of this divergence between the estimated accident frequency of nuclear industry risk studies and real-world experience is likely what's referred to as "Institutional Failure". This refers to the failure of organization, such as reactor operators and regulators, to properly acknowledge and address the risk of hazardous or highly technical industries. Greenpeace has repeatedly warned the Commission that its response to Fukushima ignored consideration Institutional Failure while other international agencies and observers have acknowledged it as a key cause of Fukushima (and past nuclear accidents. Ironically while the CNSC has stubbornly refused to acknowledge Institutional Failure as a

[19] Jan Christian Kaiser, "Empirical Risk Analysis of Severe Reactor Accidents in Nuclear Power Plans after Fukushima," *Science and Technology of Nuclear Installations,* Volume 2012.
[20] J. Lelieveld et al., "Global risk of radioactive fallout after major nuclear reactor accidents," *Atmospheric Chemistry and Physics,* 12, 4245–4258, 2012.
[21] D. Sornette, et al., "Exploring the limits of safety analysis in complex technological systems," July 2012. Available at: http://arxiv.org/pdf/1207.5674v1.pdf

contributor to accident risk, OPG's site-wide risk assessment methodology submission acknowledges it as a key lesson from Fukushima.[22]

Nevertheless, in response to a Greenpeace interrogatory during the environmental review on the proposed life-extension of the Darlington nuclear station CNSC staff stated Institutional Failure wasn't included as a risk contributor because "…there is no consensus on how this can be quantified."[23] The lack of quantitative analysis, however, does not mean the risk is not present.

**Conclusion:** While CNSC staff assert that the findings of the most recent Pickering A risk assessment over-estimate the risk posed by the station, they fail to mention current risk assessment models are known to underestimate the occurrence of major accidents.

**Request:** In its decision, the Commission should acknowledge that the real-world occurrence of major reactor accidents indicates current probabilistic risks assessment models underestimate the frequency of major accidents. The Commission should provide reasons for how it treated this omission in determining whether Pickering poses an "unreasonable risk" to Canadian society.

## 5. An Inconvenient Truth: External events are a key contributor to accident risk

The inclusion of external events into OPG's risk assessments has proven inconvenient for OPG (and apparently CNSC staff). Their inclusion inevitably shows the risk posed by reactors is higher than previously admitted and triggers requirements to reduce risk.

From a public safety perspective, however, this consideration of external events is long overdue. What's more independent observers had predicted consideration of external events would show reactors risks had been underestimated and should trigger investments to reduce risks to the public.

In 2000, a review of the Pickering A Risk Assessment (PARA) commissioned by the Standing Senate Committee on Energy, Environment and Natural Resources concluded that OPG's risk assessment significantly underestimated the risk of a large accident at Pickering, including the failure to consider external events and multi-unit accidents. The Senate report concluded that "…the probability of a large release from Pickering 'A' is likely to exceed 1 per 100 thousand

[22] Jack Vecchiarelli et al., p. 60.
[23] Appendix B- Public and Aboriginal Groups Disposition Table, comments and Responses – Proposed Screening Report – DNGS Refurbishment and Continued Operation, September 2012, Pgs B150 – B151.

years. Internal events, earthquakes and fires would all contribute to this probability, perhaps at roughly comparable levels."[24]

Notably, the Senate committee's 2000 re-assessment of the accident risk posed by the Pickering 'A' reactors is same as the findings of OPG's 2013 risk assessment for the Pickering A reactors even after upgrades since Fukushima. This underlines that the results of the most recent Pickering risk assessment were to be expected and should not be dismissed.

It was only in 2005– that the CNSC required external events be included in probabilistic risk assessments of Canadian nuclear stations.[25] After forty years of reactor operation in Canada, this was an acknowledgement that external events are a key contributor to a reactor's overall accident risk.

As witnessed with Pickering, the inclusion of external events has evidently increased the estimated occurrence or major accidents, but these are in line with estimates by the Senate Committee fourteen years ago.

The real question that should be asked is the following: why did it take forty years for the CNSC and OPG to include external events in their risk assessments?

While CNSC staff claims the Pickering risk assessments over-estimates the risk posed, the Commission remember the inclusion of external events is long over-due and risk assessments have underestimated the risk of Canadian reactors for five decades. Given these risks have been effectively ignored for decades, it should be expected nuclear stations such as Pickering will need to undergo upgrades to reduce accident risk.

**6. An Unneeded Risk: There's no need for Pickering's life-extension**

To judge whether a risk is acceptable or reasonable, it must be asked whether any proposed risky endeavor is in fact needed or can be done by other means. The continued operation is not needed. Despite this, OPG wants to run Pickering longer than it has told the CNSC.

OPG began studying whether to extend the life of the Pickering B reactors in 2009 when it decided the cost of refurbishing the four reactors was prohibitive. At the time, OPG and Ontario's electricity planners believed Pickering would be needed to maintain electricity supply until 2020 when new replacement reactors were expected to go online.

[24] Dr. Gordon Thompson, *A Review of the Accident Risk Posed by the Pickering 'A' Nuclear Generating Station, A Report to the Standing Committee on Energy, Environment and Natural Resources of the Canadian Senate*, August 2000, p. 27. Available at: http://www.irss-usa.org/pages/documents/CanSenReport08_00_000.pdf

[25] CNSC, Probabilistic Safety Assessment (PSA)for Nuclear Power Plants S-294, April 2005.

Since that time, however, the province has cancelled plans for new reactors because of declining electricity demand. Current demand forecasts project massive electricity surpluses until 2020. This underlines there is no need to operate the Pickering B reactors beyond their design life. Indeed, the sequential closure of the Pickering B reactors would likely save Ontario electricity consumers money.

Otherwise put, the original rationale for operating the Pickering B reactors beyond their design life is moot. That said, Greenpeace would like to inform the Commission that OPG plans to run Pickering longer than it admitted in last year's licence application.

In its 2013 request for a five-year licence renewal, OPG informed the Commission it wished the to operate the Pickering B reactors beyond its design life. The end of life of a CANDU designs reactor corresponds to 210,000 Effective Full-Power Hours (EFPH). This is equivalent to operating a to 30 years of operation at 80% capacity factor. The first Pickering B reactor reaches 210,000 EFPH in the summer of 2014. This is the point when a CANDU reactor would be typically be refurbished to maintain safety.

This end of life is set by the principle life-limiting component – *the pressure tubes.* As pressure tubes age, they thin, expand and sag. This increases the risk a pressure tube will come in contact with the calandria tube and potentially break. This increases the risk of a loss-of-coolant accident (LOCA), which can, when combined with a shutdown failure, can result in a dramatic increase in reactor power within four to five seconds[26], resulting in possible core melt or meltdown.

In its 2013 licence application, OPG stated it wished to operate the Pickering B reactors to 247,000 EFPHs – 37,000 hours beyond the normal design life. As noted, OPG failed to provide a full safety case to run the Pickering B reactors to 247,000 EFPHs before last year's licence renewal hearings. [27]

Since that time, OPG has informed the Ontario Energy Board (OEB) it plans to push the life of the Pickering B reactors to 261,000 EFPHs. This is 14,000 EFPH beyond the 247,000 EFPH discussed in last year's licence application and 51,000 EFPH beyond the station's design life.

It is unclear whether these life-extension plans have been raised with the Commission. It also raises questions about an approval to operate beyond the 210,000 will be open ended.

As seen throughout this process, OPG – and CNSC staff – have been less than forthright with the Commission and the public about OPG's plans and the state of its safety studies. In light of

[26] J.S. Foster and W.B Loewenstain, *The Pickering NGS "A" Shutdown Systems: A Review of the Need for, and the Nature of Possible Enhancements,* Toronto: Ontario Hydro, January 29, 1992.
[27] EB-2013-0321, Ex. F2-3-3, Attachment 1, Tab11

OPG's new plans, Greenpeace requests the Commission put in place limits on the Pickering B life-extension and additional reporting requirements if it doesn't require the station's closure.

**Request:** If the Commission allows Pickering to operate beyond its design life, it should require an additional public hearing if OPG wishes to operate beyond 247,000 EFPHs.

**7. The Last Level of Defense in Depth: Offsite Emergency Plans**

If the Commission approves the continued operation of Pickering, it will do so knowing Ontario's offsite nuclear emergency plans were not designed to cope with the large accidental radiation accidents identified as realistic in OPG's most recent risk assessments. According to the NSCA, the Commission has a legal obligation to limit such Pickering's risks and provide the public objective information on these risks.

As highlighted during last year's relicensing hearings, Ontario's detailed offsite nuclear emergency plans were only designed to cope with "design-basis" accidents or accidents with an estimated occurrence of about 1E-5. Such accidents are characterized by small radiation releases.

As noted, the most recent risk assessment for the Pickering A nuclear station is operating above traditional safety limits. The likelihood of accidents causing have large radiation is above 1E-5, but this is mostly likely an underestimate of such accidents if real-world experience and the site-wide risk are considered. This should be acknowledged and factored into the Commission's decision.

It is evident that the consequences of an accident at Pickering are substantial and perhaps unique internationally: Pickering is closer than any other nuclear station in the world to a major population centre. The CNSC has not deterministic criteria for judging the acceptability of a reactor site based on population density.[28] Pickering is probably reason why there are no such standards. Since it was first built in the 1960s the population around the station has been allowed to grow unchecked.

Neither OPG, the CNSC nor Emergency Management Ontario have provided evidence that Ontario's offsite emergency plans – which were designed for small accidents – could adequately protect the million people who live within 20 kilometres of the station let alone the four million people in the Greater Toronto Area (GTA). This highlights a lack of objective information on the risks of Pickering's operation.

[28] See CNSC Comment Number GP-63, Appendix-63, appendix B Public and Aboriginal Groups Disposition Table, Comments and Responses – Proposed Screening Report – DNGS Refurbishment and Continued Operation, September 2012, pg, 174.

Through provincial Freedom of Information, Greenpeace has acquired from OPG modeling for the accident consequences for large radiation releases at the Darlington nuclear station. These results show that even at the Darlington site, which is situated at the edge of the GTA, the provincial Protection Action Levels (PAL) can be exceeded in the event of a large radiation release.[29]

There has been no information provided to the public on the impacts of a large accidental radiation release at Pickering. If exposure limits are exceeded at the Darlington site, it will be considerably worse at the Pickering site. Releasing this risk information will create needed momentum for responsible authorities, including the Province of Ontario, Durham Region Emergency of Management Organization, the CNSC and OPG to address these deficiencies.

Greenpeace submits Canadians have the right to understand these risks if the CNSC approves the continued operation of the Pickering reactors, especially given the other risk issues highlighted in this submission.

The Commission also has an obligation to provide such information to Canadians. Section 9(b) of the NSCA states the Commission has an obligation to: "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."

**Request for Ruling**: In the event that the CNSC approves the continued operation of Pickering without an action plan from OPG to reduce the risk from the Pickering A reactors, Greenpeace makes the following request for ruling under section 20(3) of the CNSC's rules of procedure: the Commission direct OPG to model a Generic Large Releases as it has for Darlington at the Pickering nuclear station and publish the public's radiation exposure compared to provincial Protection Action Levels (PALs) by October 2013. OPG's findings should be presented a meeting of the Commission.

**8. Discussion**

Throughout these proceedings CNSC staff have shown a schizophrenic approach to the role of risk assessment in its oversight of Canadian reactor operators. In Greenpeace's view this schizophrenic approach should be replaced with a precautionary approach.

[29] OPG, *Freedom of Information Request 13-101*, February 28, 2014.

This disorganized and contradictory approach to risk assessment was exhibited at last May's relicensing hearings. Faced with risk assessments showing the Pickering reactors are operating beyond safety limits, CNSC staff equivocated. Safety limits that previously triggered regulatory action became mere "expectations". The conservatism embed in risk assessments previously touted as a precautionary public protection measure was now, once limits were exceeded, portrayed as gross exaggerations that render limits meaningless. CNSC staff are still exhibiting this same behavior.

It should be noted that even in the 1970s the Canadian nuclear industry – and AECB staff – complained that probabilistic risk assessment was so conservative that it – unfairly - over-estimated risk.[30] History has proven otherwise. This is why it is important for the Commission to give CNSC staff clear direction on how to address uncertainty.

As highlighted in this submission, past experience shows why it is imperative the Commission instruct staff and licencees to err on the side of caution. The nuclear industry and its regulators have consistently underestimated the risk of nuclear power over the past fifty years. Moving forward the CNSC should be pessimistic about its own abilities to quantify risks even if it is inconvenient for licencees.

It took the CNSC – and its predecessor – forty years to consider the inclusion of external events in risk assessments. It also took fifty years – and a pointed request for ruling from Greenpeace – for the CNSC to acknowledge the cumulative risk of multi-unit nuclear sites. The CNSC has been underestimating the risk from Canadian nuclear stations for decades. We should assume we're still underestimating reactor risks.

Despite fifty years of reactor operation in Canada, the CNSC's licencees still lack confidence in their own reactors. The federal government recently tabled Bill C-22, which includes the Nuclear Liability and Compensation Act, in Parliament. At the request of the CNSC's licensees, and specifically OPG[31], Bill C-22 maintains a cap on the liability reactor operators. This shows that after fifty years of operation OPG still believes major accidents are still a realistic possibility. Indeed, this is confirmed by OPG's most recent risk assessments.

This also highlights why a conservative bias must be a requirement of any reactor risk assessment. Canadians ultimately assume the consequences of any nuclear accident and any miscalculation by the CNSC's licencees.

Section seven of the Charter of Rights and Freedoms gives every Canadian the right to the following:

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[30] Norman Rubin, *The Perils of Probabilities. Energy Probe's Response to AECB 1149, "Proposed Safety Requirements for Licensing of CANDU Nuclear Power Plants (The IOWG Report),* Energy Probe, September 1979.

[31] OPG requested the federal government the new Nuclear Liability and Compensation Act maintain the cap on its liability in a 2012 letter Greenpeace acquired through Access to Information.

> …the right to life, liberty and **security of the person** [emphasis added] and the right not to be deprived thereof except in accordance with the principles of fundamental justice.

The large radiation release accidents discussed in this submission would deprive many Canadians of their Charter rights. These accidents are likely according to the traditional risk limits developed by licencees.

In Greenpeace's view, the Commission has an obligation to be conservative and pessimistic in its approach to OPG's risk assessments. OPG is unwilling to ultimately assume responsibility for facilities. Canadians, however, are guaranteed the right to security of the person by the Charter of Rights and Freedoms. The Commission therefore has an obligation approach to licensing in a conservative manner. It is a public right.

**9. Questions regarding the duty to report significant risks to Canadians**

The risk information – reluctantly - released as part of OPG's request to operate the Pickering reactors beyond their design life raises important questions regarding the legal and ethical obligations of OPG and CNSC staff to release information to the Commission and the public regarding risk of nuclear stations in Canada.

As noted, it was acknowledged in the submission of CNSC staff the Pickering A reactors were found to be operating with a LRF of 2.68E-5 before Fukushima changes were taken into account. Even after Fukushima changes are taken into account, which haven't been released to the public or publicly review, the Pickering A reactors are still operating above safety limits.

This is a significant violation of safety limits. It raises the following questions:

- When did OPG acquire the results of the Pickering A probabilistic risk assessment finding that the reactors had a LRF (including external events) of above 1E-5?
- When did CNSC staff become aware that the results of the Pickering A probabilistic risk assessment finding that the reactors had a LRF (including external events) above 1E-5?
- Did OPG report these findings to: 1) its Board of Directors, 2) the CNSC, and 3) Emergency Management Ontario? And if so, when?

As discussed, Access to Information documents acquired by Greenpeace indicate CNSC staff were aware of this in August 2013 that the Pickering A reactors would likely exceed safety limits even after changes from the CNSC's Fukushima Action Plan were taken into account. This implies that CNSC staff were already aware Pickering was operating beyond safety limits. It raises the question whether CNSC staff were aware but failed to report this significant violation of safety limits to the Commission during the public relicensing hearings just two months earlier.

OPG was also clearly aware Pickering was operating beyond safety limits in August 2013. Three days after the Commission released its relicensing Decision, which directed OPG to submit the Pickering A risk assessment and an action plan for upgrades if the station was above limits, Jody Hamade, OPG's Director of Enterprise Risk, noted in an email that Probabilistic Risk Assessment for the Pickering A was already considered an "an emerging risk" for the company.[32] Mr. Hamande is responsible for making quarterly on enterprise risk to OPG's board of directors.[33]

To Greenpeace's knowledge, the last known publicly available risk assessment for the Pickering 'A' reactors was released in 1995.[34] Other Access to Information documents, however, show CNSC have reviewed new iterations of the Pickering A risk assessment in 2006 and 2009 (Confirm).[35] These results of these studies have not been released to the public.

Given the hazard and the violation of safety limits, it is alarming neither OPG or CNSC failed to report this risk information to the public or Commission. Indeed, the key lesson from the Fukushima disaster is that information on the tsunami risk was available and preventative measures could have been taken. This risk information, however, was dismissed by Fukushima's operator and the Japanese regulator.

In this case, it appears that both OPG and CNSC staff were aware that the Pickering A reactors posed an "unreasonable risk" to Canadian society in violation of the NSCA, but instead of reporting the information to the public and Commission they concealed it.

Greenpeace submits OPG and CNSC staff have failed to report information on the increased accident risk posed by the Pickering A reactors during the May 2013 re-licensing hearings was if not legal an ethical dereliction of duty to provide pertinent information to the Commission and the public.

**Request**: OPG and CNSC staff should clarify on the record when they were aware Pickering was operating with a LRF above 1E-5 and what, if any, obligations they have to report such information to the public and the Commission. If there are no such obligations, Greenpeace urges the Commission to provide direction to OPG and licencees.

**10. Conclusions**

- The Pickering nuclear station exceeds safety limits.

[32] Jody Hamade to John Gierlach, "Pickering 5 yr License," August 13, 2013, email. Acquired through Freedom of Information.
[33] See: http://www.energyriskevents.com/canada/static/jody-hamade
[34] Ontario Hydro, *Pickerinng NGS A Risk Assessment, Main Report,* November 1995.
[35] G. Banaseanu to T. Schaubel, "Pickering NGS Risk Assessment (PARA) 2009 Update (JMS 20352)", Memorandum, NA44-CORR-00531-06266, January 14, 2011. Acquired through Access to Information.

- OPG has failed to submit an action plan to reduce risk from the site to below safety limits and has therefore failed fulfill the requirements set by the Commission for winning approval to run the Pickering B reactors beyond their design life.

- The large accident potential for the station is underestimated because the CNSC has failed to aggregate the risk posed by multiple reactors at one site. The need to consider the hazard of all facilities at a nuclear site is a key lesson from the Fukushima disaster.

- CNSC staff estimate site-wide risk from the Pickering station could be three times higher than per unit risk estimates provided by OPG.

- Academic observers have concluded that the risk models used by the CNSC and the nuclear industry significantly underestimate the potential for major accidents. This also indicates that the Pickering nuclear station's current risk assessment also underestimates the likelihood of an accident.

- OPG has informed the Ontario Energy Board (OEB) that it plans to push the life of the Pickering B reactors beyond what it informed the Commission in its 2013 licence application. OPG wishes to run the Pickering B reactors to 261,000 EFPH. This is 14,000 EFPH beyond the 247,000 EFPHs discussed in last year's licence application and 51,000 EFPH beyond the station's design life.

**11. Requests**

- The CNSC should deny OPG approval to run the Pickering B reactors beyond their design life instruct OPG to provide a plan for the orderly closure of all six reactors at the station.

- If the Commission approves OPG's request to operate the Pickering B reactors their design life, it should direct to OPG provide an action plan for reducing the Large Release Frequency from the Pickering A reactors as originally required by its August 2013 licence renewal decision.

- In its decision, the Commission should acknowledge that cumulative risk of all six reactors, which staff estimate may be three times higher than the per unit estimates provided by OPG, has not been accounted in the risk assessments provided to the Commission. The Commission should provide reasons for how it treated this omission in determining whether Pickering poses an "unreasonable risk" to Canadian society.

- In its decision, the Commission should acknowledge that the real-world occurrence of major reactor accidents indicates current probabilistic risks assessment models

underestimate the frequency of major accidents. The Commission should provide reasons for how it treated this omission in determining whether Pickering poses an "unreasonable risk" to Canadian society.

- If the Commission allows Pickering to operate beyond its design life, it should require an additional public hearing if OPG wishes to operate beyond 247,000 EFPHs.

- In the event that the CNSC approves the continued operation of Pickering without an action plan from OPG to reduce the risk from the Pickering A reactors, Greenpeace makes the following request for ruling under section 20(3) of the CNSC's rules of procedure: the Commission direct OPG to model a Generic Large Releases as it has for Darlington at the Pickering nuclear station and publish the public's radiation exposure compared to provincial Protection Action Levels (PAL) by October 2013. OPG's findings should be presented a meeting of the Commission.

- OPG and CNSC staff should clarify on the record when they were aware Pickering was operating with a LRF above 1E-5 and what, if any, obligations they have to report such information to the public and the Commission. If there are no such obligations, Greenpeace urges the Commission to provide direction to OPG and licencees.

## 12. Appendix

**Table 2.**

**Pickering A 2013 PRA Results before Fukushima Upgrades**

| Model | Operational State | CDF | LRF |
|---|---|---|---|
| | | Limit: 1E-4 | Limit: 1E-5 |
| Internal Events | At Power | 1.6E-5 | 4.7E-6 |
| | Shutdown | 0.7E-5* | N/A** |
| Internal Fires | At Power | 4.7E-5* | 8.4E-6 |
| | Shutdown | N/A** | N/A** |
| Internal Floods | At Power | 1E-5 | 2E-6 |
| | Shutdown | 0.2E-5 | 0.2E-6 |
| Seismic Events | At Power | 0.3E-5 | 3.2E-6 |
| | Shutdown | 0.1E-5 | 0.1E-6 |
| High Winds | At Power | 2.7E-5* | 8E-6* |
| | Shutdown | 0.1E-5* | 0.2E-6* |
| Total | | 1.14E-4 | 2.68E-5 |

**Table 3.**

**Pickering A 2013 PRA Results after Fukushima Upgrades**

| Model | Operational State | CDF | LRF |
|---|---|---|---|
| | | Limit: 1E-4 | Limit: 1E-5 |
| Internal Events | At Power | 0.8E-5 | 1.5E-6 |
| | Shutdown | 0.6E-5 | N/A* |
| Internal Fires | At Power | 4.7E-5 | 8.4E-6 |
| | Shutdown | N/A** | N/A** |
| Internal Floods | At Power | 0.6E-5 | 0.9E-6 |
| | Shutdown | 0.2E-5 | 0.2E-6 |
| Seismic Events | At Power | 0.2E-5 | 0.4E-6 |
| | Shutdown | 0.1E-5 | 0.1E-6 |
| High Winds | At Power | 0.3E-5 | 0.7E-6 |
| | Shutdown | 0.1E-5 | 0.2E-6 |
| Total | | 0.76E-4 | 1.26E-5 |

**Table 4.**

**Pickering B 2013 PRA Results before Fukushima Upgrades**

| Model | Operational State | CDF | LRF |
|---|---|---|---|
| | | Limit: 1E-4 | Limit: 1E-5 |
| Internal Events | At Power | 0.4E-5 | 3.9E-6 |
| | Shutdown | 01.E-5 | N/A* |
| Internal Fires | At Power | 0.4E-5 | 3.2E-6 |
| | Shutdown | N/A* | N/A* |
| Internal Floods | At Power | 0.1E-5 | 0.7E-6 |
| | Shutdown | N/A* | N/A* |
| Seismic Events | At Power | 0.1E-5 | <0.1E-6 |
| | Shutdown | N/A* | N/A* |
| High Winds | At Power | 0.8E-5 | 8E-6 |
| | Shutdown | N/A* | N/A* |
| Total | | 0.19E-4 | 1.58E-5 |

**Table 5.**

**Pickering B 2013 PRA Results after Fukushima Upgrades**

| Model | Operational State | CDF | LRF |
|---|---|---|---|
| | | Limit: 1E-4 | Limit: 1E-5 |
| Internal Events | At Power | 0.1E-5 | 0.3E-6 |
| | Shutdown | 0.1E-5 | N/A* |
| Internal Fires | At Power | 0.1E-5 | 0.4E-6 |
| | Shutdown | N/A* | N/A* |
| Internal Floods | At Power | 0.1E-5 | 0.7E-6 |
| | Shutdown | N/A* | N/A* |
| Seismic Events | At Power | 0.1E-5 | <0.1E-6 |
| | Shutdown | N/A* | N/A* |
| High Winds | At Power | <0.1E-5 | 0.3E-6 |
| | Shutdown | N/A* | N/A* |
| Total | | 0.05E-4 | 0.17E-5 |