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Supplementary Information

Oral Presentation

Submission from Greenpeace

Renseignements supplémentaires

Exposé oral

Mémoire de Greenpeace

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

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

GREENPEACE

Supplementary Comments to18-H6.62

To: The Canadian Nuclear Safety Commission
Date: June 12, 2018
From: Shawn-Patrick Stensil, Senior Energy Analyst, Greenpeace
Re: Supplementary submissions and additions to Greenpeace submission 18-H6.62

This document provides additional background and evidence to support Greenpeace's submission 18-H6.62.

Attachment 1 is Greenpeace's review of the recently released *Implementing Plan for the Pickering Nuclear Generating Station.* It highlights where the provincial government has made inadequate provision to protect the safety of Ontarians in the event of an accident. It provides recommendations for improving public safety, transparency and verifying the adequacy of offsite nuclear emergency planning. Greenpeace encourages the Commission to integrate these recommendations into section 10.1 of the Licence Control Handbook (LCH).

Attachment 2 is a copy of a letter Greenpeace has sent to the Deputy Minister of Community Safety and Correctional Services. It provides additional information related to section 2.3 of Greenpeace's submission. It details Greenpeace's concerns related to the apparent lack of separation between the Ministry and OPG. This raises questions related to the integrity of government oversight of nuclear emergency planning. In Greenpeace's view, the provincial government's ineffectual oversight of nuclear emergency preparedness shows it has not made adequate provision for the protection of public safety and the environment. Greenpeace feels the province's mishandling of emergency management is grounds for rejecting OPG's application to continue operating Pickering.

Attachment 3 is a copy of Greenpeace's recent submission to the Ministry of the Environment and Climate Change detailing why reactor decommissioning should be included on the project list under the proposed *Impact Assessment Act*. It provides additional information related to sections 1.2 to 1.2.3 of Greenpeace's original submission. Notably, the Regional Municipality of Durham in 18-H6.67 has also requested an environmental assessment of OPG's plans to decommission the Pickering nuclear station. The timeline for carrying out an environmental review before the station closes is tight considering that the station could close as early as 2020. Greenpeace encourages the Commission to instruct staff in its ruling to contact the Ministry of the Environment and Climate Change to request decommissioning be included on the project list under the *Impact Assessment Act*. Greenpeace also recommends appropriate wording be included in section 11.2 of LCH to set out the expectation that an environmental assessment of decommissioning will be carried out before the station closes.

Additional Amendments to the LCH Needed

In line with comments provided in sections 2.1 (*OPG's Periodic Safety Review – Insufficient transparency*) and 1.1.1 (*The Need for contingency planning and a closure plan*) Greenpeace requests changes to sections 15.1 (*Periodic Safety Review Integrated Implementation Plan*) and 15.4 (*End of Commercial Operations*) of the LCH. Changes are needed to maintain Commission authority over the

regulatory scope of Pickering's continued operation and improve the transparency. For example, as currently worded section 15.4 would allow staff to allow OPG to continue operating beyond 2024 without Commission approval.

In Greenpeace's view, only the Commission should have the authority to approve or reject a request from OPG to operate beyond 2024. If OPG were to apply to operate Pickering longer, it should trigger a public licensing reviewing as was recently carried out for Bruce Power (Bruce Power had a five-year licence but was obligated to return to the Commission to change the regulatory scope of its operations to enable reactor refurbishment and life-extension). As noted by CNSC staff during Pickering's 2014 licence renewal, proposals to further extend Pickering's lifespan will impact regulatory requirements. As noted in the Commission's 2014 ruling *"CNSC staff further noted that, in case of significantly longer life extension, beyond 247 000 EFPH, some additional requirements would likely be imposed, such as an independent and separate filtered venting system for beyond design-basis accidents at the Pickering station."*[1] In Greenpeace's view, a proposal to operate Pickering beyond what is proposed in the current application should trigger a review of the regulatory scope of the station's continued operations. Greenpeace requests this be stated explicitly in the LCH.

It should also be noted that OPG's current application foresees closing the first unit in 2022 not 2024. This is not reflected in the LCH. Additional amendments should be made to the LCH to ensure it is properly aligned with the plan considered during these hearings.

For further Information:

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[1] Record of Decision, including Reasons for Decision in the matter of Ontario Power Generation Inc's application to request to removal of Hold Point for the Pickering Nuclear Generating Station, May 7, 2014, pg 6.

Attachment 1

GREENPEACE

Comments on the Implementing Plan for the Pickering Nuclear Generating Station

Prepared by Shawn-Patrick Stensil
Senior Energy Analyst
Greenpeace Canada
June 12, 2018

1. Introduction & Recommendations

This document provides Greenpeace's high-level review of the *Implementing Plan for the Pickering Nuclear Generating Station,* which was published the last week of April 2018. Recommendations are outlined below for improving public safety, transparency and verifying the adequacy of offsite nuclear emergency planning.

Greenpeace encourages the Commission to continue using its licensing authority to provoke improvements to offsite emergency planning and public safety. Greenpeace continues to be concerned by the government of Ontario's ineffectual oversight of nuclear emergency response. The government of Ontario is Ontario Power Generation's (OPG) sole shareholder and approves its business plans. Given the province's combined responsibility for offsite safety and OPG's business plans, Greenpeace encourages the Commission to consider not only OPG as the licencee in its deliberations, but also the government of Ontario.

Greenpeace makes the following recommendations:

- The Commission should include a condition in OPG's licence requiring any future changes to the *Implementation Plan for the Pickering Nuclear Generating Station* to undergo public consultation prior to publication.

- The Commission should include a licence condition requiring the government of Ontario to publish the findings of the study it has commissioned to consider the adequacy of current emergency planning distances. The results of this study should be presented to a meeting of the Commission in 2019.

- The Commission should include a licence condition requiring OPG or the province to commission and publish independent modelling of a major accident at Pickering. This modelling should be presented to a meeting of the Commission in 2019.

- The Commission should include a licence condition requiring OPG to work with the province to ensure that preparedness and planning measures are in place to identify and monitor "hotspots" across the entire 50 km Ingestion Control Zone.

- The Commission should instruct staff to encourage the province to adopt an Extended Planning Distance aligned with the larger areas recommended by the IAEA, real-world experience and available accident modelling.

- The Commission should include a licence condition requiring OPG to provide information on how to prepare for a nuclear emergency to all residents of the Contingency Planning Zone by the end of 2019.

- The Commission should include a licence condition requiring OPG to work with province and municipal authorities to identify all hospitals and retirement homes within the 50 km Ingestion Control Zone (IPZ) as well as reception facilities for specialized-care evacuees outside of the IPZ.

- To be responsive to the expectations of Toronto and Durham Regional councils, the Commission should expand requirements for KI delivery to the 20 km area currently proposed for the Contingency Planning Zone.

- The Commission should impose a new licence condition requiring OPG to work with school boards to ensure the stockpiling of KI in all schools within the current 50 km Ingestion Planning Zone before the end of 2019.

- The Commission should include an additional licence condition requiring OPG to inform residents of the Ingestion Planning Zone of their right to order KI tablets for their family or business.

- The Commission should instruct staff to update REGDOC-2.10.1 to require licencees facilitate the stockpiling of KI in schools and daycares within the Ingestion Planning Zone and to inform residents of the IPZ of their ability to order KI free of charge.

- The Commission should instruct staff to include a new requirement in the next iteration of REGDOC-2.10.1 obligating licencees to carry out KI Distribution Time Estimate studies to verify the feasibility of promptly distributing KI in the Ingestion Planning Zone in the event of a severe accident.

2. Transparency & Public Consultation

Despite ongoing public interest in nuclear emergency response, there was unfortunately no public consultation on the *Implementing Plan for the Pickering Nuclear Generating Station.* This shows the Ministry of Community Safety and Correctional Services (henceforth referred to as the "Ministry of Community Safety") still has work to do in order to instil a culture of openness and transparency in its operations.

Since the Fukushima disaster began in 2011, the Ministry of Community Safety and OPG have exhibited a secretive pattern of behaviour and have been resistant to public scrutiny. The Ministry of Community Safety has effectively refused to respond to Freedom of Information requests since 2013.[1] It has also refused to respond to informal information requests.[2]

Notably, the public consultation that took place in 2017 only occurred because of a 2013 political commitment made by the Minister of Community Safety to Greenpeace, the Canadian Environmental Law Association (CELA) and Durham Nuclear Awareness (DNA).[3] Documents subsequently obtained by Greenpeace through Freedom of Information legislation indicate that four years after this political commitment, what finally initiated the public consultation was likely OPG's fears that additional delays could put at risk the licence application now being

[1] Greenpeace filed approximately 30 requests over 2 years that OFMEM only responded to once a complaint was filed with the Office of the Information Commissioner. When Greenpeace filed subsequent requests, OFMEM filed a complaint with the OIC alleging Greenpeace was a veracious requestor.
[2] Dave Nodwell (Ministry of Community Safety) to S-P Stensil (Greenpeace), "RE: Presentation and submission to the Durham Committee," email, October 21, 2015
[3] Madeleine Meillieur (Minister of Community Safety and Correctional Services) to Theresa McClenaghan et al., *letter,* October 21, 2013.

considered by the Commission.[4] To mitigate these risks, OPG went so far as to second staff to the Ministry of Community Safety expedite the PNERP update.[5] This highlights the lack of integrity and independence in the oversight of Ontario's nuclear emergency response plans.

In Greenpeace's view, this puts in question the objectivity, impartiality and credibility of the public consultation carried out by the province and its conclusions. The lack of effective separation between OPG and its shareholder also supports considering the Ontario government as the de-facto licensee in this application.

Commendably, the Ministry has attempted to include the principle of transparency in the revised PNERP, with the addition of clause 1.2.12 which states:

> A policy of truth and transparency *should* be followed in providing information to the public and media prior to and during a *nuclear or radiological emergency*.

Although this is a laudable modification, the behaviour of the Ministry since the PNERP's publication shows that this policy has yet to be integrated into the Ministry's plans or to inform decision making. For instance, the Ministry's position on the public release of the accident study it has commissioned to verify the adequacy of current planning distances shows its attempts to integrate transparency into day-to-day operations has been ineffectual. When asked by Ajax Regional Councillor Colleen Jordan whether this study would be publicly released, Dave Nodwell, the Deputy Chief for Planning and Program Development at the Ministry, stated it had not been considered.[6]

This resistance to change is unsurprising. In 2015, Durham Region, which hosts the Pickering and Darlington nuclear stations, asked the government of Ontario to "…provide all non-confidential data and studies used in considering changes to Ontario's off-site nuclear emergency plans."[7] This motion was passed in response to the province's ongoing reluctance to release information. In spite of this, the government acknowledged in 2017 that nothing has occurred to strengthen its disclosure policies in response to Durham Region's request.[8]

Considering that much of the controversy related to the adequacy of offsite emergency response since Fukushima has focused on the lack of credible accident modelling, it is difficult to fathom that a Ministry tasked with a public safety has not considered the need and desirability of releasing this study. Indeed, information should be publicly available by default and only exempt if authorities can provide sufficient evidence demonstrating that doing so would in fact be a security risk.

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[4] OPG, Risk Registry – Pickering Relicensing 2018, May 31, 2017, FOI # 17-048, pg. 393.
[5] Jim Coles, OPG's Director of Emergency Management is "on loan" to the Ministry of Community Safety "to support development of the new Provincial Nuclear Emergency Plan". See: https://www.linkedin.com/in/jim-coles-97a35442/
[6] Durham Regional Council, March 21, 2018.
[7] Durham Regional Council – Minutes, November 4, 2015, pg. 29.
[8] Minister Marie-France Lalonde (Minister of Community Safety), Response to Written Question No. 248, 2nd Session 41st Parliament, Tabled: May 4, 2017.

Recommendation: The Commission should include a condition in OPG's licence requiring any future changes to the *Implementation Plan for the Pickering Nuclear Generating Station* to undergo public consultation prior to publication.

Recommendation: The Commission should include a licence condition requiring the government of Ontario to publish the findings of the study it has commissioned to consider the adequacy of current emergency planning distances. The results of this study should be presented to a meeting of the Commission in 2019.

3. The Planning Basis & Detailed Planning

Greenpeace is concerned that the province has weakened the criteria used for selecting reactor accidents considered in detailed emergency response plans.

Section 2.2 of the *Implementing Plan for the Pickering Nuclear Generating Station* states that a Design Basis Accident (DBA) "…release provides the main platform for detailed planning." Design Basis Accident releases are comprised of principally short-lived noble gases with effectively no radioiodines or long-lived radioisotopes. A DBA would typically be a level 5 accident on the International Nuclear Event Scale (INES). DBAs are also limited to events with an estimated probability of 1E-5 or one in 100,000 years of reactor operation.

However, the last time Ontario's nuclear emergency response plans were reviewed in the 1990s, the Royal Society of Canada (RSC) recommended "…detailed emergency planning should be done for accidents resulting from a credible series of events which could occur with a probability of approximately 10^{-7} /reactor year."[9] The RSC made this recommendation after reviewing the 1995 probabilistic risk assessment for the Pickering A nuclear station. Notably, the 1995 Pickering A risk assessment found accidents leading to significant releases had extremely low estimated probabilities, ranging from 5E-9 to 4E-10.[10] The RSC recommendation informed planning basis in the 2009 PNERP.

Since the 2011 Fukushima disaster, Greenpeace has highlighted that more recent risk assessments for the Pickering, Darlington and Bruce nuclear stations have found major accidents to be more likely than previously thought. Risks assessments published since Fukushima have identified accident sequences leading to large offsite releases meeting the Royal Society of Canada's recommended criteria for detailed emergency planning. Greenpeace's submission to the Commission's 2013 hearings on OPG's application to continue operating the Pickering nuclear station observed that the most recent Pickering B risk assessment found large release accidents at the station to be credible.[11] The 2014 Pickering A risk assessment found large release accidents to have an estimated probability of 4.7E-6[12], showing the estimated likelihood

[9] W.R. Bruce et al, *Report to the Ministry of the Environment and Energy concerning two technical matters in the Provincial Nuclear Emergency Plan,* Royal Society of Canada & Canadian Academy of Engineering, November 1996, pg. 33.
[10] Ibid, pg. 11.
[11] Shawn-Patrick Stensil (Greenpeace), Intolerable Risk: The Continued Operation of the Pickering Nuclear Station, May 2013, CMD 13-H2.119
[12] Greenpeace submission, CMD 14-H2.47

of major accidents increased by four levels of magnitude since the 1995 Pickering A risk assessment.

Greenpeace has found no evidence that the province has independently evaluated the significance of these risk assessments. Instead, it appears that the province has relied on OPG's assurances that emergency preparedness measures remain adequate.

Evidence of the province's overreliance on OPG for policy analysis is apparent in the province's comments provided on the draft environmental assessment report of OPG's proposal to rebuild the Pickering B reactors. This environmental review required OPG to review the impacts of an accident with a probability of 1E-6. Emergency Management Ontario (EMO) - the predecessor to Office of the Fire Marshal and Emergency Mamanage - was also surprised by the land contamination caused by the accident. EMO submitted the following comment on the draft environmental assessment report:

> The recognition that significant ground contamination is possible is also inconsistent with previous statements made by OPG and its predecessor, Ontario Hydro (OH). Over 20 years ago, when the first versions of the PNEP and the dose projection program ERP were under development, EMO (then EPO) was assured by OH that any ground contamination would be minimal or impossible, due to the presence of EFADS high-efficiency particulate air (HEPA) filters. For this reason, OPG deemed it unnecessary to include a Ground Deposition Module (GDM) within ERP. ERP would only model the doses and dose rates resulting from the emission of noble gases and radionuclides, and this remains the case to the present day, even after several revisions and improvements to the ERP codes. EMO has, from time to time, expressed its disquiet at this state of affairs, but in the absence of any evidence to the contrary, has refrained from insisting that a GDM be incorporated into ERP.[13]

In short, the government was surprised by the potential for ground contamination because OPG had assured it repeatedly over twenty years that it need only prepare for accidental releases involving noble gases or Design Basis Accidents. Notably, the accident scenario assessed in the 2008 Pickering B life-extension environmental assessment report met the criteria for detailed emergency planning recommended by the Royal Society of Canada. This shows that EMO was not independently reviewing OPG's probabilistic risk assessments, but simply relying on assurances from the company.

It appears that OPG's belief that only Design Basis Accidents should be considered in detailed emergency planning had become dogma within the company. For example, when OPG reviewed the basis for staffing requirements for nuclear accidents it could find no standard or rationale to support the planning assumptions for on-site emergency plans. OPG called the type of accident used to determine its resource and staffing capacity requirements "an artefact."[14]

[13] APPENDIX 2, Comments and Response Table – Public comments on Draft EA Screening Report for the Pickering Nuclear Generating Station B Refurbishment and Continued Operations Project**,** CEAR # 06-01-21226, pgs. 48 – 49

[14] "Emergency Response Organization Staffing Basis for Responding to Design Basis Accidents: Analysis Summary Report," May 30, 2012, PN208/RP/001 R02.

Unfortunately, this dogma has now been now formalized in the 2017 PNERP. In Greenpeace's view, the decision to reduce the cut-off probability used for determining detailed planning from 1E-7 and 1E-5 shows the province has been motivated more by maintaining the status quo than strengthening public safety.

To provide background on the historic development of the PNERP planning basis, Annex A provides a timeline of reports and decisions that have informed the planning basis over the past four decades.[15] It also documents the findings of industry probabilistic risk assessments over time.

Since the Fukushima disaster, Greenpeace has urged the CNSC and the government of Ontario to verify the adequacy of public safety by openly modelling accident sequences leading to large radioactive releases. As documented in past submissions to the Commission, there are known accident sequences leading to Fukushima-scale radiation releases at all of Ontario's nuclear stations.

Although the CNSC and Health Canada have carried out accident modelling to estimate the impacts of an accident at the Darlington nuclear station since Fukushima, no similar modelling has been undertaken for Pickering. Unlike the four-unit Darlington nuclear station, Pickering is an older design and has six operating reactors that share common safety systems. A million people live within 20 km of Pickering.

Pickering's older design means radioactive releases could be larger than those modelled for the Darlington nuclear station. Pickering's location also increases the potential consequences of an accident compared to the Darlington nuclear station. In considering OPG's licence application, the Commission should acknowledge that there is no publicly available accident analysis to verify the adequacy of offsite emergency measures at Pickering.

Recommendation: The Commission should include a licence condition requiring OPG or the province to commission and publish independent modelling of a major accident at Pickering. This modelling should be presented to a meeting of the Commission in 2019.

4. A Half Measure - Contingency Zone

The province's proposed Contingency Planning Zone (CPZ) is a symbolic half measure that provides no additional public safety benefits and is unaligned with international guidance.

At the April 4th Commission meeting, the Ministry of Community Safety stated that the 20 km CPZ deals with the potential for "severe, low probability accidents "and the possibility of "hot spots"[16] beyond the Detailed Planning Zone (DPZ). However, International Atomic Energy Agency (IAEA) standards, real-world accidents as well as Canadian and international accident modelling shows that the limited 20 km CPZ is insufficient for addressing such events.

[15] Annex A is an extract from Greenpeace's 2017 comments on the PNERP discussion paper.
[16] Meeting of the Canadian Nuclear Safety Commission, Transcripts, April 4, 2018. pgs. 29 and 55. Available at: http://nuclearsafety.gc.ca/eng/the-commission/pdf/Transcript-CommissionMeeting-April4,2018.pdf

To justify the CPZ, the Ministry of Community Safety relies upon CSA standard *N1600-14 General requirements for nuclear emergency management programs. Greenpeace questions the reliance on standard.* CSA standards are developed using consensus-based processes among industry stakeholders. This means that OPG or Bruce Power can block the adoption of any proposed standards that may conflict with their financial costs. OPG's then-director of emergency management Jim Coles, chaired the committee that developed CSA-1600. In short, N1600 is a lowest common denominator standard. N1600 reflects neither best practices nor public expectations for safety.

Moreover, a close review of N1600's supporting citations shows that the industry-produced standard is unaligned with the IAEA's post Fukushima emergency planning guidance. The rationale for the CPZ in *N1600* is based on the guidance contained in the IAEA's 2013 guide *Actions to Protect the Public in an Emergency due to Severe Conditions at Light Water Reactor.*[17] This guide recommends a series of emergency response zones sizes based on a radioactive releases equivalent to a level 6 accident on the International Nuclear Event Scale (INES).[18]

The province's proposed CPZ is based on the IAEA's 2013 recommendation that member states establish an Extended Planning Distance (EPD). This guide describes the objective of this zone as follows:

> In this area arrangements should be in place to provide instructions to reduce ingestion of contaminated material and carry out dose monitoring to locate hotspots that may require evacuation within a day and relocation within a week to a month. It is also recommended that evacuation of those requiring specialized care be to areas beyond the EPD to avoid additional evacuations. [19]

As noted, a purpose of the EPD is to identify and monitor localized contamination – referred to as hotspots - beyond evacuation zones. The need for such planning measures was underlined by the contamination caused by Chernobyl and Fukushima. In both cases, localized contamination extended well beyond traditional planning zones – even hundreds of kilometers from the stations. Such contamination may even require localized evacuations. The CNSC has observed that the limited 20 km CPZ would be "…inadequate for hotspot monitoring."[20]

Notably, the same IAEA guide used to justify the Contingency Planning Zone in CSA Standard N1600 makes recommendations on the size of those zones. This information was curiously omitted from CSA standard N1600. Table 1 below contrasts the IAEA's suggested planning distances with zones proposed in the *Implementation Plan for the Pickering Nuclear Generating Station.*

[17] Page 18 of N1600 cites the 2013 IAEA guide as the basis for its Extended planning distance requirement.
[18] V.A. Kutkov et al., Basic strategies of public protection in a nuclear power plant beyond-Design Basis Accident, *Nuclear Energy and Technology,* 2 (2016), pg. 17.
[19] International Atomic Energy Agency, *Actions to Protect the Public in an Emergency due to Severe Conditions at Light Water Reactor*, May 2013, pg. 21.
[20] Kathleen Heppell-Masys, (Director General, CNSC), Ibid. pg. 9.

Table 1. Suggested planning distances (IAEA vs. PNERP 2017)

Emergency zones and distances	Suggested maximum radius (km)		Provincial Nuclear Emergency Response Plan 2017
	> 1000 MW(th)	100 to 1000 MW (th)	
Precautionary action zone (PAZ)	3 to 5		3 (Automatic Action Zone)
Urgent protective action planning zone (UPZ)	15 to 30		10 (Detailed Planning Zone)
Extended planning distance (EPD)	100	50	20 (Contingency Planning Zone)
Ingestion and commodities planning distance (ICPD)	300	100	50 (Ingestion Planning Zone)

This comparison shows that Ontario's CPZ is significantly smaller than that proposed by the IAEA. The CPZ for Pickering is 80% smaller than the IAEA's recommended planning zone size for stations above 1000 MW and even 40% the size recommended for plants smaller than 1000 MW. Pickering's capacity is over 3000 MW.

Greenpeace does not consider the 20 km CPZ to be credible or sufficient to prevent radiation exposure in the event of a severe accident. The province has provided no evidentiary basis for limiting the CPZ to 20 km. It has only stated that the CPZ size was "….determined by doubling the Primary Zone distance in order to provide a conservative buffer for nuclear emergency planning and response."[21] In contrast, the IAEA's recommended distances were based on modelling of radioactive releases from a level 6 accident on the INES scale.

Notably, after modelling a Fukushima-scale radioactive release the German Commission on Radiological Protection recommended arrangements be in place to assess the radiological situation within 100 km of a nuclear station to determine if emergency measures are needed beyond the 20 km evacuation zone.[22] Also after carrying out accident modelling, Switzerland's aligned its emergency planning requirements with the IAEA's recommended EPD of 100 km.

However, there is Canadian accident modelling showing that the IAEA's suggested 100 km EPD is more appropriate than the province's 20 km CPZ. In March 2017, Health Canada and Environment Canada published the report, *ARGOS Modeling of Accident A and Accident B*

[21] Office of the Fire Marshal and Emergency Management, *Discussion Paper: Planning Basis Review & Recommendations*, May 2017, pg. 5.
[22] German Commission on Radiological Protection (SSK), *Planning areas for emergency response near nuclear power plants*, 2014, pg. 21.

Scenarios, which modeled a severe accident[23] at the Darlington nuclear station based on the weather conditions of 7 days in June and July 2016.[24]

Although the study was limited by the number of days assessed, the results suggest that current proposed Contingency and Ingestion Planning Zones are too small. Based on its analysis, Health Canada made the following observation on the province's proposed zone sizes:

> The contingency planning zone should consider potential scenarios for protective actions that would avert both a Total Effective Dose and the Thyroid Dose. Making these considerations would indicate that distances should be somewhere in the range of the IAEA recommended 50-100 km. The Secondary Zone of 50 km is significantly less than that recommended by the IAEA and US counterparts. HC modeling of severe accidents yields distances similar to the PNERP ingestion control zone for the Fermi facility. A commodities control zone (Secondary Zone) distance between 80-100 km may be more appropriate.[25]

It is worth noting that CNSC staff recommended that "…OFMEM use the planning distance (EPD) used by the IAEA. The CPZ is a CSA N1600 concept and has a different meaning. The spirit of CSA N1600 CPZ is to account for those relatively less probable accidents that would not warrant extensive preparedness and planning. The intent of the zone will affect its size: the proposed 20km could be a reasonable size for contingency planning, but it would likely be inadequate for hotspot monitoring."[26]

In conclusion, the proposed CPZ is not aligned with IAEA recommendations, the impact of real world accidents nor informed by credible evidence. The CPZ is symbolic and provides no clear additional safety benefits to Ontarians in the event of a severe accident.

Recommendation: The Commission should include a licence condition requiring OPG to work with the province to ensure that preparedness and planning measures are in place to identify and monitor "hotspots" across the entire 50 km Ingestion Control Zone.

Recommendation: The Commission should instruct staff to encourage the province to adopt an Extended Planning Distance aligned with the larger areas recommended by the IAEA, real-world experience and available accident modelling.

Recommendation: The Commission should include a licence condition requiring OPG to provide information on how to prepare for a nuclear emergency to all residents of the Contingency Planning Zone by the end of 2019.

5. Incomplete Operational Objectives of the Contingency Zone

[23] It should be noted the source term – the inventory of radionuclides released to the environment - used for this study was significantly smaller than Fukushima or Chernobyl.
[24] L. Bergman, et al., *ARGOS Modelling of Accident A and Accident B Scenarios*, Health Canada & Environment and Climate Change Canada, May 15 2017, Report Version 5
[25] Health Canada – Radiation Protection Bureau, EBR Registry 013-0560, Comment ID 210075, July 11, 2017.
[26] Kathleen Heppell-Masys, (Director General, CNSC), Ibid. pg. 9.

The 2017 Provincial Nuclear Emergency Response Plan (PNERP) and the 2018 *Implementation Plan for the Pickering Nuclear Generating Station* indicate there are few additional actions required by provincial and municipal authorities to implement the CPZ.

The only unique requirements for the CPZ are listed in Section 2.2.5(e)(iii) of the PNERP. Those provisions are limited to:

- division into sub-zones
- population estimates for each sub-zone
- development of mechanisms, processes and procedures to provide for environmental *radiation* monitoring and data analysis by the PEOC Scientific Section
- familiarization sessions with impacted municipalities, as required
- identification of existing *response* centres that fall within the CPZ and development of a list of possible alternates located outside the CPZ

Thus, aside from a clearer understanding of population estimates within 20 km of the Pickering nuclear station the CPZ provides no additional safety benefit compared to the 2009 PNERP.

However, as discussed IAEA standards recommend response measures be put in place in the EPD to facilitate the "….evacuation of those requiring specialized care be to areas beyond the EPD to avoid additional evacuations." Greenpeace has been unable to identify whether preparedness measures have been included in the updated PNERP to implement this objective of the EPD.

The lack of detailed planning in the CPZ is also of particular concern to vulnerable communities, including hospital patients and the elderly. In 2015, Greenpeace Canada surveyed the number of hospitals within 30 km of the Pickering, finding 22 hospitals with 7,399 beds. The same area also had 82 retirement homes with 9,368 beds[27] (ideally, a more appropriate survey would include all hospitals and retirement homes within the 50 km IPZ). In contrast, there were 7 hospitals with 800 patients within 20 km of the Fukushima nuclear station.[28]

It should also be noted that in 2017 CNSC staff recommended OFMEM *"…*identify more preparedness activities for the CPZ." Additional measures recommended by the CNSC included *"*such aspects as evacuation plans, the availability of KI before or at time of emergency, location of centres outside this zone."[29]

Recommendation: The Commission should include a licence condition requiring OPG to work with province and municipal authorities to identify all hospitals and retirement homes within the 50 km Ingestion Control Zone (IPZ) as well as reception facilities for specialized-care evacuees outside of the IPZ.

6. KI Distribution

[27] Research commissioned by Greenpeace in 2015.
[28] The National Diet of Japan, *The official report of The Fukushima Nuclear Accident Independent Investigation Commission*, 2012.
[29] Kathleen Heppell-Masys, (Director General, CNSC), pg. 9.

There are both public expectations and technical evidence that support expanding the distribution and accessibility of KI beyond what is proposed in the *Implementation Plan for the Pickering Nuclear Generating Station.*

The Ministry of Community Safety's updated *Implementation Plan for the Pickering Nuclear Generating Station* simply adopts the requirement set by the CNSC in 2014. The Commission established these new requirements due to public expectations for public safety, international best practices, concerns related to the province's slow response to Fukushima, and results from the severe accident study indicating an increased occurrence of childhood thyroid cancer would occur following a nuclear accident.

The 2014 requirements, which are detailed in *REGDOC-2.10.1 Nuclear Emergency Preparedness and Response***,** obligate OPG to deliver KI to all homes and business within the 10 km DPZ and make KI readily available within the 50 km ICZ. However**,** the Commission relied upon these without any specific analysis to justify their use for KI distribution. Former CNSC Commissioner Sandy McKeown referred to the 10 km Primary Zone as a "minimum"[30] for KI pre-distribution.

Notably, the province continued to resist the Commission's strengthened KI distribution requirements[31] while municipalities called for them to be expanded. For example, even after the CNSC's new requirements had been implemented, the province's 2017 Discussion Paper on proposed changes to the PNERP stated that "…no policy recommendations regarding stocking and distribution of Iodine Thyroid Blocking (ITB) have been proposed given that it does not form a component of the Planning Basis."[32]

In contrast, both Durham Region[33] and the City of Toronto[34] have requested the delivery of KI beyond the current 10 km distribution area. This shows strong public support for strengthening the CNSC's 2014 KI distribution requirements.

Available technical analysis also supports expanded KI distribution, in particular to vulnerable communities. In the CNSC's comments on the province's 2017 Discussion Paper, CNSC staff acknowledge that both CNSC and Health Canada modelling indicates that children beyond the 10 km DPZ may need ready access to KI in the event of a major accident. CNSC staff recommended that:

> …the PNERP address how to ensure that KI can be promptly distributed as required in the CPZ or Ingestion/Secondary Zone at the time of emergency. From the Health Canada (HC) data, it appears KI could be promptly needed for children beyond current 10km PZ/DPZ. This is consistent with CNSC Study of Consequence of a Hypothetical Severe

[30] CNSC, Transcripts of Public Meeting, August 21st, 2014, pg. 82.

[31] John Spears, "The real question about nuclear disaster: Federal or provincial issue?", the *Toronto Star,* August 23, 2014.

[32] Office of the Fire Marshal and Emergency Management, *Discussion Paper: Planning Basis Review & Recommendations*, May 2017

[33] The Regional Municipality of Durham, "Regional response to Provincial Discussion Paper entitled "Provincial Nuclear Emergency Response Plan (PNERP) Planning Basis Review and Recommendations". EBR Registry Number 013-0560," #2017-COW-137 [as amended, per Council June 14, 2017]

[34] Toronto City Council, EX28.13 - **T**oronto's Emergency Management Program and Revisions to the Toronto Municipal Code November 7, 2017

> Nuclear Accident and Effectiveness of Mitigation Measures, (SARP) study and is already addressed in *REGDOC 2.10.1*. CNSC staff encourage OFMEM to consider how they will assure that KI would be provided to vulnerable populations in a timely manner (either pre-obtained, or promptly provided at time of emergency).[35]

The Commission's recommendation is reasonable and technical analysis shows that KI would be needed outside of the DPZ in the event of a severe accident. Meanwhile there are several million people, over five hundred schools and an unknown number of daycares within the IPZ that do not have ready access to KI. In short, the large population around the Pickering nuclear station necessitates that the Ministry of Community Safety have plans and capacity in place to carry out a mass KI distribution program in the event of an emergency.

Although licencees must demonstrate the feasibility of evacuation plans through regular Evacuation Time Estimate (ETE) studies, there is no equivalent information in the public domain to verify whether OFMEM could promptly distribute KI across the Pickering IPZ in the event of an emergency. In light of these uncertainties, Greenpeace encourages the Commission to use its licensing authority to increase the accessibility of KI throughout the IPZ.

There are three simple options available to make KI more easily accessible to communities near the Pickering nuclear station. The first is to simply expand the area in which KI is delivered to homes and business. This entails expanding KI pre-distribution beyond the current 10 DPZ.

The second option involves making KI more readily accessible in the area beyond the pre-distribution zone through strategic stockpiling. The placement of such stockpiles should enable rapid distribution in the event of an emergency. As required in *REGDOC-2.10.1*, such stockpiles should pay particular attention to vulnerable communities. In the GTA, the most obvious choice for such stockpiles would be schools and daycares. In complying with REGDOC-2.10.1, Bruce Power has created KI stockpiles in all schools within the 50 km IPZ.[36] OPG has not facilitated the stockpiling of KI in GTA-area schools.

Finally, KI can be made more readily accessible outside of the pre-distribution area by encouraging households and businesses to request KI supplies. Although *REGDOC-2.10.1* requires OPG to make KI available to anyone within the IPZ, it does not obligate OPG *inform* residents of the IPZ of the availability of KI. Notably, Bruce Power sent an information package to all residents in the IPZ surrounding the Bruce nuclear station informing them of the availability of KI.[37] There has been no equivalent effort to inform residents within Pickering's IPZ of the availability of KI.

In summary, the KI distribution requirements contained in the 2017 PNERP and the *Implementation Plan for the Pickering Nuclear Generating Station* are insufficient to adequately protect the public in the even of a severe accident. In light of the Ministry of Community Safety's ongoing resistance to enhancing KI distribution requirements, Greenpeace encourages the Commission to use its licensing authority to drive continuous improvement through additional licence conditions and updates to *REGDOC-2.10.1.*

[35] Kathleen Heppell-Masys, (Director General, CNSC), pg. 5.
[36] Bruce Power, *Application for Renewal of Prol. 18/2020: Supplemental Submission,* February 28, pg. 27.
[37] Ibid.

Recommendation: To be responsive to the expectations of Toronto and Durham Regional councils, the Commission should expand requirements for KI delivery to the 20 km area currently proposed for the Contingency Planning Zone.

Recommendation: The Commission should impose a new licence condition requiring OPG to work with school boards to ensure the stockpiling of KI in all schools within the current 50 km Ingestion Planning Zone before the end of 2019.

Recommendation: The Commission should include an additional licence condition requiring OPG to inform residents of the Ingestion Planning Zone of their right to order KI tablets for their family or business.

Recommendation: The Commission should instruct staff to update REGDOC-2.10.1 to require licencees facilitate the stockpiling of KI in schools and daycares within the Ingestion Planning Zone (IPZ) and to inform residents of the IPZ of their ability to order KI free of charge.

Recommendation: The Commission should instruct staff to include a new requirement in the next iteration of REGDOC-2.10.1 obligating licencees to carry out KI Distribution Time Estimate studies to verify the feasibility of promptly distributing KI in the IPZ in the event of a severe accident.

Annex A

This is an extract from the document "*Greenpeace Canada's Comments on the Discussion Paper – Planning Basis Review and Recommendations",* July 28, 2017. It summarizes the history of the planning basis used for nuclear emergency planning in Ontario. It also summarizes the findings of publicly available industry-produced probabilistic risk studies for the Darlington, Pickering and Bruce nuclear stations.

Section 2

This section reviews the historic development of Ontario's current planning basis as well as the review of offsite emergency response in Canada since the Fukushima disaster.

It identifies a number of patterns: updated risk studies indicating an increase in the likelihood of major accidents since the 1990s, the failure of government authorities to consider these risk studies, the tendency of OPG to modify risk assessments if findings are inconvenient, and the failure of government authorities to consider the impacts of a Fukushima-scale accident.

2. 1 The Evolution of Ontario's Nuclear Emergency Preparedness

May 1980 – Solicitor-General Roy McMurtry sets up Ontario's emergency planning office in response to the Three Mile Island Accident.[129]

April 1984 – The Report of Working Group #3: The provincial government established Working Group # 3 to make recommendations on the "technical basis" for nuclear emergency plans, including reference accidents, planning zones and planning times. Simply put, the group was asked what accidents the province should plan and prepare for. They recommended detailed planning for all accidents with an estimated likelihood below 1E-6 per reactor year or 1E-5 for a station with ten reactors. The working group characterized the hazard of such accidents as having an effective dose of 250 mSv (25 rem) at the boundary of a nuclear station. This remains an assumption of Ontario's nuclear emergency response plan to this day.

This dose estimate was based on the licensing limit requirements of the AECB. The accidental radiation releases used for emergency planning are similar in scale to those resulting from the Three Mile Island accident. Releases would be principally noble gases with effectively no radioiodines or long-lived radioisotopes. This would probably be categorized as an INES 5 accident.

The working group arrived at the distances for the Contiguous, Primary and Secondary Zones by applying the inverse square law from radiation protection to a 250 mSv dose at the fence line of the nuclear station. That is, doubling the distance from a source of radiation will decrease exposure by a quarter of the original dose. Thus, 250 mSv at the site boundary would lead to 100 mSv within 3 km. This would require mandatory evacuation. The Working Group designated this the Contiguous Zone where enhanced emergency preparedness is necessary. Similarly, a 250 mSv dose at the site boundary would result in approximately 10 mSv, which is the minimum action level for evacuation, 9 km from the plant. This became the Primary Zone.

To determine the size of the Secondary Zone where arrangements are made ingestion control measures, Working Group # 3 assumed a 2.5 Sv (250 rem) thyroid dose at the site boundary. This would be caused by a release of 37 terra-Becquerels (3.7E+13) of Iodine-131. This would lead to a thyroid dose of 1.5 mSv (0.15 rem) between 20 and 40 km from the plant depending on release duration. The working group thus recommended a Secondary Zone of 50 km.[130] In retrospect, it is

[129] *The Globe and Mail*, "Ontario sets up emergency planning office," 27 May 1980.
[130] Report of Provincial Working Group #3, April 1984, pg. 24.

noteworthy that Ontario's Secondary Zone is based on iodine releases 1,000 times smaller than Fukushima and 10,000 smaller than Chernobyl.

As discussed in section 1.11, as part of the CNSC's efforts to modernize design standards it established a Small Release Frequency (SRF) in 2008. The SRF was established to acknowledge a design vulnerability of CANDU reactors. It limits releases of more than 1E+15 of I-131 to less than 1E-5 per reactor year. This is significant because it meets the probability cut-off for detailed emergency planning recommended by Working Group # 3. Based on the understanding of CANDU accident pathway in 1984, however, Working Group #3 assumed significantly smaller releases of radioiodine.

April 26, 1986 – The Chernobyl accident begins: The accident permanently displaces over 300,000 people living within 30 km area around the station. Other areas hundreds of kilometres from the station are contaminated and require evacuation. The accident eventually leads to thousands of thyroid cancers, particularly in children. It highlights the potential for reactor accidents to cause damage at great distances. Human error also contributed to triggering the accident.

June 1986 – Provincial cabinet finally approves nuclear emergency preparedness plans following Chernobyl.

February 1987 – Cabinet Committee on Emergency Planning discussion of Chernobyl Accident Report: A year after the Chernobyl disaster began, cabinet discussed the implications for emergency planning. The report provided to cabinet stated that Chernobyl raised the question of "…whether the upper limit presently fixed for detailed planning and preparation provides a realistic and adequate margin of public safety?"[131] The report observed that Chernobyl "…highlights another danger in attaching undue importance to the mathematical probabilities of various accident sequences commonly computed in risk analysis studies: the importance of the human factor in the equation, and the difficulty of quantifying it."[132] It also acknowledged that for severe accidents, Ontario's emergency plans envisage "…the improvisation of protective action for the public outside the 10 km Primary Zone." In light of Chernobyl, the report questioned whether this 10 km zone provided an adequate margin of safety and "…to what extend improvisation can be depended on".[133] Cabinet supported a review of the upper limit for detailed planning and preparations in Ontario, and the 10 km primary zone derived from it.[134]

February 1988 –Ontario Nuclear Safety Review (ONSR) Recommendations: The expert panel appointed by government to review the safety of Ontario's reactors following the Chernobyl disaster recommended that "…the Province of Ontario base its nuclear emergency planning on the maximum credible releases of radioactive materials."[135] The review also observes the province only had two staff dedicated to nuclear emergency planning and had failed to allocate sufficient funds to implementing existing nuclear emergency response plans.[136]

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[131] Ministry of the Solicitor General, *Cabinet Submission on Emergency Planning: Chernobyl Accident Report*, February 19, 1987, Pg. 12
[132] Ibid, pg. 13.
[133] Ibid, pg. 13.
[134] Ibid, pg. 1.
[135] Ontario Nuclear Safety Review, *The Safety of Ontario's Nuclear Power Reactors: A Scientific and Technical Review*, Vol. 1. February 1988, pg. xv.
[136] Ibid.

An expert review by the former president of the Atomic Energy Control Board (AECB) commissioned by the ONSR panel also observed that "…the question of the impact on water supplies from the Great Lakes for many millions of people has been largely overlooked."[137] This review suggested the Ontario government may wish to investigate the possible contamination of the Great Lakes and consider alternative sources of drinking water.[138] Such an analysis has not occurred.

June 1988 – Report of Provincial Working Group #8 on The Upper Limit for Detailed Nuclear Emergency Planning – Working Group #8 recommended expanding the range of accidents considered in provincial planning and preparedness from what was originally proposed by Working Group #3. It proposed a two-tier approach to planning: detailed plans and preparedness for a Maximum Planning Accident (MPA) and more conceptual plans for a Worst Credible Radiation Emission (WCRE). The MPA was defined as all "accidents which can be quantitatively determined to be as low as once in 10^5 station-years"[139] or approximately 10E-6 per reactor year for an 8 unit station like Pickering or Bruce. This accident is effectively the same as the detailed planning accident recommended by Working Group #3. Releases occur after twenty-four hours, are principally noble gases, with only 0.1% of a reactor's radioiodine inventory released. (See Table 14 in Appendix A for a full description). The WCRE refers to accidents estimated by industry estimates to below 1E-6, or to be unquantifiable, such as those caused by terrorist attacks or human error.

For planning purposes, the Working Group set the parameters of WCRE accidents as a release occurring within the first twenty-four hours and with 1% of iodine core inventory released within an hour. (See Table 15 in Appendix A for a full description). For WCRE accidents, Working Group #8 recommended emergency measures be in place to protect against early sickness or death.[140] Notably, this accident is still smaller than releases from Fukushima or Chernobyl.

The working group also recommended that the primary zones at Pickering, Bruce and Darlington be expanded from 10 to 13 km, and that the province consider expanding certain emergency measures, including distributing potassium iodide pills, installing early warning systems for the public and restricting new housing construction near nuclear facilities.[141] Notably, Ontario Hydro's representative on Working Group #8 filed a dissenting opinion, stating he was against expanding primary zones to 13 km.[142]

As discussed in Section 1.1, Working Group #8 was mandated to consider hostile action, public perceptions of accident risk, public expectations for safety and safety margins to address uncertainties. These issues were not considered in the Discussion Paper.

September 1993 – Cabinet Committee on proposed changes to nuclear emergency planning and preparedness: Five years after the publication of the Working Group #8 report, a cabinet committee discussed civil service recommendations for strengthening nuclear emergency response. The

[137] A. T. Prince, "Review of Nuclear Emergency Measures Affecting Ontario, and Other Related Matters, "found in Vol. 2. Appendix VI of *The Safety of Ontario's Nuclear Power Reactors: A Scientific and Technical Review*, February 1988.
[138] Ibid, pg. 51.
[139] Report of Provincial Working Group # 8 – The Upper Limit for Detailed Nuclear Emergency Planning, June 30, 1988, pg. 84.
[140] Ibid. pg. 85.
[141] Ibid., pg. iv.
[142] G. Armitage, (Ontario Hydro), *Dissenting Minute*, June 30, 1988.

proposal recommended the government "…expand the technical basis of the Provincial Nuclear Emergency Response Plan to cover accidents beyond the current design basis and implement consequential measures for increasing public safety." It noted the province's current planning basis "…assumes a delay in the emission of radioactivity from the station to the environment, and precludes any early health effects among the public living around the station."[143]

It recommended delivering potassium iodide pills to residents in the Contiguous Zone, expanding the Primary Zones around Bruce and Darlington to 13 km, and implementing early warning systems and priority evacuation zones for the Contiguous Zone.[144] The submission noted that the "vast majority" of stakeholders supported the recommendations of Working Group #8.[145] However, the cabinet submission rejected including the worst credible emission recommended by Working Group #8 in the planning basis because, in part, "Ontario Hydro would incur these additional intended costs."[146]

The committee voted for the Minister of the Solicitor General to report back to the them within twelve months with a full examination of implementation costs so cabinet approval for an amended nuclear emergency plan could be sought within twenty-four months.[147] The NDP government, however, lost to the Progressive Conservatives in the June 1995 provincial election and cabinet never approved the proposed changes.

1995 – Ministry of Energy initiates review of recommendations to expand Ontario's planning basis: In response to Ontario Hydro's concerns, the Ministry of Energy commissioned the Royal Society of Canada and the Canadian Energy Academy (heretofore referred to as RSC/CAE) to review Working Group #8's recommendation to expand planning to include more severe accidents as well as its recommendations to pre-distribute potassium iodide and expand the Primary Zone to 13 km. Notably, the management team seeking advice from the RSA/CAE included Ontario Hydro, which had opposed Working Group #8's recommendations.[148]

March 1996 – Ontario Hydro's Submission to RSC/CAE Review – Ontario Hydro, which had opposed Working Group #8's recommendations to expand the primary zone, provided comments to the RSC/CAE in early 1996. As discussed, Ontario Hydro was also represented on the management team that had commission the RSA/CAE.

Ontario Hydro argued chemical and physical realities as well as changes in understanding related to radioiodine meant that releases would be significantly less than the WCRE by Working Group #8. Ontario Hydro also argued that even if large releases did occur, they would do so after 30 hours due to recent upgrades to containment systems at Pickering.[149] The company asserted that accidents

[143] The Ministry of the Solicitor General and Correctional Services, *Cabinet Submission: Nuclear Emergency Planning and Preparedness*, September 30 1993, pg. 1
[144] Ibid., pg. 3.
[145] Ibid, pg. 4.
[146] Ibid. pg. 9.
[147] Cabinet Committee on Environment Policy, Thursday November 18, 1993, pg. 4.
[148] Deborah E. Farr, (Manager Electricity Operations and Planning Section, Ministry of Environment and Energy) to Linda Liik (Ontario Hydro) et al., Letter with "Terms of Reference for the Review by the Royal Society of Canada & Canadian Engineering Academy of Outstanding Questions related to the Proposed Provincial Nuclear Emergency Plan," 1995.
[149] Ontario Hydro, *Ontario Hydro's Submission of the Review by the Royal Society of Canada & Canadian Academy of Engineering of Outstanding Questions Related to the Proposed Provincial Nuclear Emergency Plan*, January 1996.

causing early radiation effects close to the site boundary would have frequencies below 1E-8 and would therefore be well below the threshold of "credibility."[150]

Ontario Hydro also dismissed several initiating events that have since become an accepted concern. For example, the company argued that, despite 50 years of reactor operations worldwide, "no accident or major upset" has ever arisen due to "external" causes such as earthquakes.[151] In light of Fukushima, such claims would no longer be accepted by the public or regulatory authorities. Notably, the Discussion Paper does not explicitly consider the contribution of external events to accident risk.

Ontario Hydro also dismissed Working Group #8's consideration of hostile action or terrorism even though it was mandated to by the government. The company argued that it "…is hard to imagine how an operation of required magnitude and expertise could be carried out without many hours of awareness by civil authorities prior to any release." Since September 11th, this dismissal of terrorism risks would also not be accepted. As discussed in Section 1.6, OPG has consistently invoked security concerns to withhold reactor risk-related information since September 11th. The Discussion Paper does not address the risk from malevolent events.

Ontario Hydro opposed requiring the pre-distribution of KI within the 3 km Contiguous Zone because "Radioiodine is not considered a significant threat in CANDU reactors." It also argued KI distribution could be "dangerous" because KI distribution could be ineffective. [152] After Fukushima, of course, the CNSC required reactor operators to ensure KI is pre-distributed in the 10 km primary zone and available to everyone within the 50 km secondary zone. Durham Region, which hosts OPG's reactors, has supported and asked for KI distribution to be expanded beyond the 10 km primary zone. The Discussion Paper, however, does not make recommendations on KI distribution.

November 1996 – RSA/CAE Recommendations: *The Report to the Ministry of Energy and Environment concerning two Technical Matters in the Province of Ontario's Nuclear Emergency Response Plan* effectively adopted Ontario Hydro's recommendations. It rejected the pre-distribution of KI in the 3 km Contingency Zone and the expansion of the Primary Zone to 13 km. It recommended that "…detailed emergency planning should be done for accidents resulting from a credible series of events which could occur with a probability of approximately 10^{-7} /reactor year."[153] This is a level of magnitude below what was recommended by Working Group #3 and #8.

Assessing accident scenarios from Ontario Hydro's 1995 risk assessment for the Pickering A nuclear station against the 10E-7 cut off criteria, the RSA/CAE found that current emergency measures were adequate. The 1995 Pickering A risk assessment found accidents leading to significant releases had extremely low estimated probabilities, ranging from 5E-9 to 4E-10.[154] (See Table 4 in Appendix A.)

The RSA/CAE identified one scenario from the 1995 Pickering A risk assessment that had a similar severity to the WCRE accident proposed by Working Group #8. This scenario, referred to as Ex Plant Release Category-3 (EPRC-3), had an estimated probability of 9.4E-8, which is just below the cut-off

[150] Ibid, pg 15.
[151] Ibid, pg 15.
[152] Ibid, pg 25.
[153] Ibid, pg 33.
[154] Ibid, pg. 11.

criteria recommended by RSA/CAE.[155] EPRC-3 would release approximately 3.8E+15 Becquerels of radioiodine.[156] It would most likely be characterized as a level 6 INES accident.

As discussed in Section 1.6, PRAs published since 1996 have found accidents leading to major releases to be much more likely than the 1995 Pickering A risk assessment. To Greenpeace's knowledge, the significance of these PRA results have never been considered by OFMEM.

May 2002 – Ministry's choice of severe accident "blueprint" – Emergency Management Ontario (EMO) concluded that "EPRC-3 is a valid 'blueprint' or 'template' scenario for the more severe accident for which planning and preparedness is to be carried out." Because the most "severe impacts to the public from EPRC-3 is to the 1-3 km Contiguous Zone" EMO concluded "enhanced preparedness, including early warning systems and priority evacuations, is appropriate for the Contiguous Zone." [157]

Notably, EMO dismissed more "severe" accidents (EPRC-1 and EPRC-2) found in the 1995 Pickering A risk assessment from consideration due to their extremely low probabilities, comparing such events "…to that of a comet or asteroid strike on Earth resulting in a major extinction of species."[158]

The choice of EPRC-3 as a blueprint for the severe accident in the PNERP highlights a weakness in current emergency planning. Severe accidents in the PNERP are not addressed through detailed plans, but through the belief that existing emergency measures could be expanded in the event of such events. EPRC-3's releases are much smaller than Fukushima and Chernobyl, which means provincial authorities have never considered the feasibility of extending emergency measure in the event of such events. Meanwhile, Fukushima and Chernobyl have been identified at all of Ontario's nuclear station.

2.2 Implications: The Evolution of Ontario's Nuclear Emergency Preparedness

After Three Mile Island, Ontario put in place detailed emergency plans to address accidents similar in scale to Three Mile Island. That is, Ontario's detailed planning was designed to protect Ontarians in the event of a level 5 accident on the International Nuclear Event Scale (INES).

Although it took approximately fifteen years, Ontario eventually increased detailed planning, albeit limited to the Contiguous Zone, to account for level 6 accidents on the International Nuclear Event Scale. Notably, the severe accident chosen by the Ontario government as a "blueprint" is approximately twenty-five times smaller than the accidental releases that occurred at Fukushima.

Although Ontario's emergency plans were modified after Chernobyl to acknowledge more severe accidents could occur, the government has done nothing to assess its ability to address accidents on par with Fukushima or Chernobyl.

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[155] Ibid, pg. 11.
[156] The core fraction of Iodine release by EPRC-3 was estimated to be 2E-3. The 1-131 core inventory for a Pickering A reactor is 1.93E+18. A simple estimate of EPRC-3's iodine release is 3.86E+15 Bq.
[157] Dr. Aadu Pilt, *A Technical Assessment of the Enhanced Planning and Preparedness Arrangements in the Contagious Zone Surrounding Ontario Power Generation Inc. Nuclear Generating stations*, May 2002, pg. 6. Acquired through Freedom of Information.
[158] Ibid., pgs. 2- 3.

2.3 The changing understanding of CANDU reactor risks

As discussed, the RSC/CAE recommended in 1996 that *"…*detailed emergency planning should be done for accidents resulting from a credible series of events which could occur with a probability of approximately 10^{-7}/Reactor year" (Once in ten million years per reactor)[159].

Using this cut-off probability, the RSC/CAE concluded that there was no need to expand the detailed emergency plans recommended by Working Group #3 after Three Mile Island. This was based on the conclusions of Ontario Hydro's 1995 risk assessment for the Pickering A nuclear station, which found that all accidents below with an estimated likelihood above 10E-7 resulted in minor releases only occurring after twenty-four hours.

To address more severe accidents, below the 10E-7 cut-off, the provincial government selected an accident from the Pickering A risk assessment, which fell below to serve as a "blueprint"[160] for severe accident planning. As noted, this scenario, EPRC-3, had an estimated likelihood of 9.4E-8 – just below the Royal Society of Canada's cut-off for detailed planning.

EPRC-3 would release approximately 3.8E+15 of iodine equivalent and would likely be rated as an INES 6 accident. Ontario effectively has detailed plans and preparedness for accidents with releases up to a level 5 INES accident with some "enhanced" measures in the Contiguous Zone to deal with a level 6 INES accident.

For accidents with severity similar to EPRC-3, the government only has conceptual plans and strategies. For accidents with releases above INES 7 or Chernobyl of Fukushima, the province does not even have conceptual plans and strategies.

While basing its recommendations on the accident scenarios found in the 1995 Pickering A risk assessment, the RSC/CAE also noted that "…to this collection of accidents can be added any new analyses of other scenarios if of comparable probability."[161]

As discussed in Section 1.6, since the RSC/CAE recommendations were published, new industry risk assessments have identified accident scenarios that meet the detailed planning criteria and are significantly more severe than those identified in the 1995 Pickering A risk assessment.

Greenpeace has found no evidence that provincial authorities have assessed these scenarios or their implications for emergency planning. In Greenpeace's view, this is evidence of a pattern where PRA results have been selectively used by government authorities.

Publicly Available Reactor Risk Assessments since 1997

1999 Bruce B Risk Assessment: Three years after the RSC/CAE made its recommendations, a new risk assessment for the Bruce B reactors identified a number of more severe accidents that would meet the criteria for detailed planning and preparedness.

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[159] W.R. Bruce et al, *Report to the Ministry of the Environment and Energy concerning two technical matters in the Provincial Nuclear Emergency Plan,* Royal Society of Canada & Canadian Academy of Engineering, November 1996, p. 33.
[160] Ibid.
[161] Ibid.

It found large release accidents had an estimated likelihood of 3.7E-7. It also evaluated the likelihood of "severe releases." A severe release was defined as a release greater than 10 percent of the core inventory of cesium-137. According to these risk assessments, severe releases could lead to early fatalities. It found severe releases had a likelihood of 1.2E-7.[162] This meets the planning criteria recommended by the RSC/CAE. See Table 16 in Appendix A for additional details.

2003 and 2005 Bruce A Risk Assessment: To support the restart of two of the Bruce A reactors, Bruce Power published risk assessments showing credible catastrophic scenarios that would meet the criteria for detailed planning. A summary of Bruce A risk assessment results was provided as part of the environmental assessment of the restart and life extension of the Bruce A reactors. Although Bruce Power did not explicitly identify the large release categories, the socially disruptive accident scenarios can be deduced from the dose estimates. Ex-Plant Release Categories 1, 2, 3 and 4 produce early fatalities with "…an immediate individual dose of >3000 mSv." EPRCs 1 and 2 have probabilities above 1E-7 and meet the criteria for detailed planning recommended by RSA/CAE. See Table 17 in Appendix A for additional details. The 2005 Bruce A risk assessment update found large release accidents had an estimated likelihood of 1.3-6. It also found severe releases had a likelihood of 4.1E-7. Notably, two scenarios would release over 50% of 1-131 and Cs-137. (See Table 18 in Appendix A). Approximately a third of large release accidents were in fact severe release scenarios of more than 10 percent of the core inventor.

2008 Pickering B Risk Assessment: In 2008, OPG released a summary of its most recent PRA for the Pickering B nuclear station to support the environmental review of its proposal to rebuild the four Pickering B reactors. It identified four accident sequences (EPRC1, EPRC4, EPRC5A and EPRC7) that lead to large releases. In this assessment OPG defined large release as an accident that is expected to release more than 1% of Cs-137 into the environment. It found the Large Release Frequency for the station to be 7.1E-7, which is the same as the likelihood estimate for EPRC5A. The other large accident sequences had extremely low probabilities between 1E-10 and 1E-11.[163] See Table 19 in Appendix A for more details.

Notably, CNSC staff directed OPG to assess the consequences of EPRC5A even though 7.1E-7 falls below the cut-off of 1E-6 that the CNSC uses to select accidents for environmental reviews. CNSC staff gave several reasons for this. First, the original risk assessment OPG submitted to the Commission found that EPRC5 had a probability of 6.3E-6. OPG, however, reassessed this accident scenario and lowered its probability to 7.1E-7, which is below the cut-off probability for environmental reviews. CNSC staff noted that this was only "marginally below" the cut-off probability and argued that if external events – flooding, fire, seismic - were considered it be even closer or exceed the assessment criteria.[164]

In Greenpeace's view, OPG's reassessment of EPRC5 highlights a risk to public safety related to an unquestioned reliance on industry risk studies. Such studies can be easily manipulated. Reactor operators have a financial and reputational interest in excluding severe accidents from

[162] Ontario Power Generation, *Bruce NGS B Risk Assessment Summary Report*, November 1999, NK29-REP-03611-00001, pg. 38.
[163] OPG, *Pickering B Risk Assessment Summary Report*, November 14, 2008, pg. 33.
[164] T. E. Schaubel, (Director, Pickering Regulatory Program Division, CNSC) to D. Patrick McNeil (Senior Vice President, OPG) "Pickering B Environmental Assessment (EA) – CNSC Position on Final Malfunctions and Accidents to be used in the EA," August 7, 2007, E-DOCS# 3068013.

environmental reviews and from emergency response. The Discussion Paper does not consider the bias of industry risk studies.

As discussed in Section 1.11, EPRC5A would release approximately 3.64E+15 Bqs of I-131 and 7.1E+13 Bqs of Cs-137.[165] See Table 20 in Appendix A for additional details. The environmental review found that the release of Cs-137 caused localized ground contamination around the station. This surprised Emergency Management Ontario (EMO) because the current planning accident only contemplates the release of noble cases. OPG responded to EMO's concerns by stating that only design basis accidents, which have a probability above 1E-5, are used for emergency planning. Thus, EPRC5 did not meet the criteria for detailed emergency planning.[166] Table 21 in Appendix A shows that OPG considered only Fuel Damage Categories (FDC) 3 – 8 Design Basis accidents. It is unclear how EMO responded to OPG's position.

The 2008 Pickering B environmental highlights two ongoing and worrying patterns: First, OPG has historically argued against planning for larger accidents. In late 1990s, it supported the RSC/CAE's use of the Pickering A risk assessment when the findings of larger releases were highly improbable. A decade later, OPG curiously omitted mention of the RSC-CAE recommendation to plan for accidents above 1E-7 when its own PRA found an accident sequence more severe than the current planning basis. Instead, OPG asserted planning occurs for design-basis accidents. As will be discussed, the second pattern is OPG reassessment and modification of PRA results when they are inconvenient. In light of these patterns, Greenpeace feels the Discussion Paper's portrayal of industry risk assessments as objective and factual is imprudent.

2011 Darlington Risk Assessment: This risk assessment identified two scenarios that would meet the criteria for detailed emergency planning. One scenario leads to releases on par with Fukushima and the other leads to large but early releases.

The assessment characterized Release Category 1 as a "[v]ery large release with potential for acute offsite radiation effects and/or widespread contamination." It had an estimated likelihood of 4.90E-6, but OPG applied "analytical enhancements" to reduce the likelihood to 7.8E-07. During the environmental assessment review of Darlington's proposal to extend the operational lives of the Darlington reactors, Greenpeace alleged these "analytical enhancements" were carried out to avoid having the consequences of this accident assessed in the environmental review.[167] As noted, OPG also reassessed the Pickering B PRA when it found a large release accident should be considered in an environmental review.

Unlike the environmental review of the life-extension of the Pickering B risk assessment, CNSC staff did question OPG's use of analytical enhancements or the failure to consider external events. Notably, the seismic risk assessment found a large release frequency over 1E-6. See Table 22 in

[165] K.S. Dinnie (Director, Nuclear Safety Solutions) to E. Marczak (OPG), "Pickering Life Extension Project: Accidental Air and Waterborne Release for Pickering B Environmental Assessment – EPRC5, *letter*, January 19, 2007, Acquired through Freedom of Information.

[166] Patrick McNeil (Senior Vice President, OPG) to T. Schaubel (Director, CNSC), "OPG's Response to Emergency Management Ontario Comments on the Pickering B final Environmental Assessment Study Report," *letter*, NK30-00531, April 29, 2008. Acquired through Freedom of Information.

[167] See Commission Member Document 12-H13.181, Submission from Greenpeace Canada; Also see CNSC Commission Hearing Transcripts, December 5, 2012, pgs. 367 – 419.

Appendix A. This highlights how the CNSC has also been inconsistent in its oversight of industry PRAs.

As noted, 98% of the accident sequences within Release Category 1 is a multi-unit accident.[168] This explains the large catastrophic radiation releases associated with this scenario. The assessment also found one scenario, referred to as Release Category 2, to be a large and early of more than 1E+14 Becquerel of Cesium-137. Even though this scenario meets the criteria for detailed planning, early releases are not contemplated in Ontario's detailed emergency plans. See Table 23 in in Appendix A for more details.

As discussed, the source term for this accident was used for the CNSC's Severe Accident Study, which is a key reference to the Discussion Paper. However, neither the Discussion Paper nor the CNSC's Severe Accident Study acknowledges that this accident scenario is an early release.[169] This undermines the credibility of both the Discussion Paper and the CNSC's Severe Accident Study.

***2013 Pickering B Risk Assessment**:* This risk assessment found the estimated likelihood of catastrophic accidents had risen by four levels of magnitude since the previous assessment for Pickering B was released in 2008. These Chernobyl scale accidents met the criteria for detailed emergency planning recommended by the RCA/CAE.

Release Category 1 had an estimated probability of 2.9E-06 and is described as follows: "Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of (I-131/Cs-137)". [170] This would be considered a level 7 INES accident. See Table 24 in Appendix A for addition details.

The significant change in the findings between the 2008 and 2013 Pickering B risk assessments highlights the significant uncertainty inherent in industry risk assessment. This uncertainty is not acknowledged in the Discussion Paper. Indeed, the Discussion Paper only used the word uncertainty once when citing a Health Canada study.[171]

During CNSC hearings in 2013 on OPG's application to continue operating the Pickering nuclear station, Greenpeace highlighted that the risk posed by the station was much higher than previously thought. Greenpeace also noted that the findings of the OPG's most recent risk studies required OPG to invest in risk reduction measures according to its own policies.[172] Neither the CNSC nor OPG had acknowledged this in their submissions.

CNSC staff responded to Greenpeace's concerns by simply asserting that recent enhancements in response to the Fukushima disaster would reduce the likelihood of an accident by 10 to 100 times. Staff provided no evidence for this during the hearings. CNSC staff did not acknowledge or explain

[168] Yolande Akl et al., *Discussion Paper on Safety Goals – Stage 1: Analyze Issue, Probabilistic Safety Assessment and Reliability Division*, March 2013.
[169] See page 34 of Discussion Paper where it acknowledges that the source term of the accident assessed in the CNSC's Severe Accident Study "…of a similar magnitude to a postulated accident with a frequency of 3.74×10^{-7}". This is the probability of Release Category 2, which is also an early release.
[170] OPG, Pickering B Risk Assessment Summary Report, NK30-REP-03611-00021-R000, February 2014.
[171] *Discussion Paper*, pg. 37.
[172] See: Commission Member Document 13-H2.119, Submission from Greenpeace Canada.

why the likelihood of large release had increased by a factor of a thousand.[173] In Greenpeace's view, this is an example of the Canadian regulator "disowning" risk assessment information when challenges orthodoxy.

In response to Greenpeace's submission the Commission directed OPG to "…provide an action plan to address any identified issues should OPG exceed its targeted safety goals." Greenpeace also highlighted that the current approach to risk assessment does not consider the aggregate risk of multi-unit nuclear stations like Pickering. As a result, the Commission directed OPG to develop "…a whole-site PSA or a methodology for a whole-site PSA, specific to the Pickering NGS site." Notably, the CNSC's formal review of the Fukushima accident failed to identify the single reactor approach to risk assessment as problematic or an underestimate of risk. Despite this, a new approach to assess site-wide risk has yet to be developed. The Discussion Paper fails to acknowledge this weakness in current PRA methodology. This is significant given all of Ontario's reactors are multi-unit stations.[174]

2014 Pickering A Risk Assessment*:* This risk assessment found a scenario that leads to catastrophic releases within the first twenty hours that meet the criteria for detailed planning. This risk assessment was only released due to a formal procedural request made by Greenpeace during aforementioned 2013 licence renewal hearings.[175] It shows a significant increase in the likelihood of major accidence since RSC/CAE reviewed the 1995 Pickering A risk assessment.

Release Category 1 has an estimated likelihood of 4.69E-6 and is described as a "Large early release with potential for acute offsite radiation effects and/or widespread contamination". Release Category 1 also leads to the release of 3% of the core inventory of iodine and caesium.[176] This would be a level 7 INES accident. See Table 25 in Appendix A for additional details. As shown in Table 6 in Section 1.6 of large – and early – radioactive releases has increased by four levels of magnitude since the 1995 Pickering risk assessment used by the RSC/CAE during the last review of nuclear emergency planning. This is not acknowledged in the Discussion Paper.

2013 Bruce A Risk Assessment: The 2013 Bruce A risk assessment also showed a significant increase in the likelihood of major accidents compared to the previous PRA. Release Category 0 and Release Category 2 release approximately 8.5E-16 Bq of I-131. Their respective estimated frequencies are 2.90E-6 and 6.72-06.[177] The Bruce A risk assessment describes Release Category 0 sequence as a "…severe core damage at all four reactors more or less simultaneously. These sequences are predicted to result in containment failures within 24 hours of the initiation of the accident sequences."[178]

Similar to the findings of the 2013 Pickering B risk assessment, the revised Bruce A probability estimated would typically require Bruce Power to invest in system upgrades. Bruce Power responded to this by asserting that the post-Fukushima enhancements – referred to as Emergency Mitigating Equipment (EMEs) - would reduce the likelihood of such accidents by up to a factor of 10.

[173] CNSC Public Hearing Transcripts, May 30, 2013, Pickering, Ontario, Pgs. 284 – 336.
[174] CNSC, Record of Decision, including Reasons for Decision, in the Matter of OPG's Application to renew the Power Operating Licence for the Pickering Nuclear Generating Station, August 2013, pg. 23.
[175] Ibid, pg. 23.
[176] OPG, *Pickering A Risk Assessment Summary Report*, NA44-REP-03611-00036-R000, April 2014.
[177] Bruce Power, *Bruce A Level 2 At-Power Internal Events Risk Assessment*, NK21-03611.5, December 2013, pg. 319
[178] Bruce Power, *Bruce Level 2 At-Power Internal Events Risk Assessment*, December 2013, NK21-03611.5 P NSAS, pg. 319.

Notably, even with EMEs many of the severe accident sequences would still meet the criteria for detailed planning recommended by the RSA/CAE in the 1990s. See Table 26 in Appendix A for additional details.

2015 Bruce B Risk Assessment: The 2015 Bruce B risk assessment also found the likelihood of large releases had increased significantly. Release Categories 1 and 2 would release more than 3% of a reactor's inventory of I-131 or approximately 8.88E+16 Bq of radioiodine. These categories have frequencies 4.71E-06 and 4.97E-07 respectively. See Table 27 in Appendix A for additional details.

Again, Bruce Power asserted the frequencies were in fact lower due to the use of EMEs. These frequencies, however, still do not consider the contribution of external events to accident risk. It also does not explain why the more recent risks assessments found major accidents to be more likely than previously thought.

2015 Darlington Risk Assessment: In 2015 OPG released an updated risk assessment for the Darlington nuclear station to support its application to rebuild and extend the operation of the plant. Notably, the baseline release estimates in this risk assessment all assumed EME credit. Table 28 in the Appendix A compares the results of the 2012 and 2015 Darlington risk assessments.

Greenpeace requested OPG provide release category estimates with and without EME credit as Bruce Power had done in its 2014 risk summary report.[179] OPG responded that in its level 2 internal events risk assessment "…the case with no EME or SIOs is only a sensitivity case. As such, the results or this sensitivity case were not derived on an individual release category basis. The LRF without EME or SIOs is $1.5 * 10^{-6}$ occurrences per reactor year."[180] It appears that the push to have EME credits reduce release frequencies since has significantly changed the methodologies and verifiability of Canadian probabilistic risk assessments.

As will be discussed in the next section, CNSC staff internally referred to Release Category 1 as having an estimated likelihood of 4.7E-6 in 2015 in briefings prepared for the CNSC's Executive Committee.[181] This is different than the probability estimates OPG has publicly used for this scenario.

2015 Internal CNSC Assessment of Station Blackout Scenarios: At the request of the CNSC's Executive Committee, CNSC staff assessed station blackout scenarios at the Bruce and Darlington stations in 2015. It concluded "…a large release of fission products, in particular radioactive caesium, can occur within the first 24 hours for Bruce." It concluded a similar scenario at Darlington "…would have the largest of releases at around 60 hours."[182]

Table 27 below from the CNSC Executive Briefing show these known accident scenarios, which meet the RCA/CAE criteria for detailed planning, to have releases on par with Chernobyl and Fukushima.

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[179] S-P Stensil to R. Manely, "Information request for additional Probabilistic Risk Assessment estimates", *letter*, August 13, 2015.

[180] Memorandum to Greenpeace, "Response to Request from Greenpeace for Information from Darlington NGS Probabilistic Safety Assessment" September 10, 2015, N-CORR-03611-0562767 LOF

[181] Briefing for the President, *Severe Accident Progression Without Operator Action*, August 24, 2015, EDoc#: 4811602, pg. 6.

[182] Ibid.

Table 29 – Comparison of Station Blackout Scenarios at Bruce B and Darlington

Significant Events	Bruce B Timing	Darlington Timing	Cs-137 and I-131 Release (% of Core Inventory)	Cs-137 Release (Bq)	I-131 Release (Bq)
Core collapses First stage of release to the atmosphere	5.9	10.7	Bruce B: 2.1% DNGS: 0.2%	Bruce B: 5.3E+15 DNGS: 5.2E+14	Bruce B: 2.4E+17 DNGS: 2.3E+16
Shield tank side wall melts through. Corium relocates to the Fuelling Machine Duct. Limited core concrete interaction occurs before the corium is quenched. Second stage of release to the atmosphere	18.9	25.0	Bruce B: 9.2% DNGS: 0.7%	Bruce B: 2.3E+16 DNGS: 1.8E+15	Bruce B: 1.1E+18 DNGS: 8.2E+16
Corium becomes uncovered in the Fuelling Machine Duct. Molten core concrete interaction resumes. Third stage of release to the atmosphere.	33.3	58.3	Bruce B: 11% DNGS: 8%	Bruce B: 2.8E+16 DNGS: 2.1E+16	Bruce B: 1.3E+18 DNGS: 9.3E+17

2.3 Implications: The changing understanding of CANDU reactor risks

Although the Discussion Paper repeatedly appeals to recent reactor enhancements to justify maintaining current emergency response plans, it does not mention how recent PRAs have found major accidents to be much more likely than previously thought. In Greenpeace's view, this indicates a biased and selective use of risk assessment information.

Indeed, while reactor operators and the CNSC have asserted that post Fukushima enhancements will reduce the likelihood of an accident by a factor of 10 or 100, industry risk estimates have shown the likelihood of such events to have increased by a factor of 1000. Although accidents on par with both Fukushima and Chernobyl have met the criteria for detailed planning recommended by the RSC/CAE in the 1990s, Greenpeace has found no evidence to show that OFEMEM has seriously considered these scenarios.

This highlights both how easy it is to modify PRA results if inconvenient and the significant uncertainties inherent in such risk assessments. What's more, this pattern of selectively using risk assessment information is in line with Dr. John Downer's observation that reactor operators and nuclear regulators find justifications to "disown" inconvenient risk assessment information. In Greenpeace's view, this calls for a more precautionary approach to nuclear emergency response.

2.4 Canada's Review of Emergency Preparedness since Fukushima

Similar to Chernobyl, the Fukushima accident should have initiated a transparent assessment of whether the current limits on detailed emergency preparedness measures are still appropriate. However, since Fukushima federal, provincial safety authorities and reactor operators have shown a

pattern of avoiding an open and rigorous assessment of the adequacy of offsite emergency measures against a Fukushima-scale radiation release.

Despite misleading assertions from the CNSC, there has been no public assessment of the consequences of a Fukushima-scale accident. This has deprived the public and decision-makers of key information on the risk of continuing to operate eighteen reactors in Ontario.

March 11, 2011 – An earthquake and tsunami trigger an accident leads to radiation releases from three reactors at the Fukushima Daiichi nuclear station. The accident releases approximately 1.6E+17 of Iodine-131. The Fukushima releases are over twenty times larger than the accident previously chosen as a "blueprint" for Ontario's severe accident planning.

March 20, 2011 –Hearings on OPG's proposal to build new reactors at the Darlington nuclear station begin despite requests from civil society organizations to delay the hearings to provide time to learn lessons from the Fukushima disaster. In line with CNSC policy, the environmental assessment does not assess the consequences of a Fukushima-scale accident because industry experts such events to be too "improbable." The ability of Ontario's emergency response plans to cope with such a large accident was not assessed. The accident considered within the environmental assessment, which was referred to as a "Safety Goal Release" (SGB) assumes 1E+15 Bq of I-131 is released into the environment. As discussed, this release also ended up serving as the basis for the CNSC's Severe Accident Study.

However, in its final report in August 2011 the Joint Review Panel recommends OPG be required "…to evaluate the cumulative effect of a common-cause severe accident involving all of the nuclear reactors in the site study area to determine if further emergency measures are required."[183] This has not occurred.

October 2011 - The CNSC's Fukushima Task Force's observed "…it may be useful for the environmental assessment process to include consideration of severe accidents, should this be regarded as responsive to public concerns".[184] The CNSC's exclusion of major accidents from environmental assessments has been a long-standing complaint of civil society organizations.

May 2012 – In response to the CNSC's Fukushima Task Force report, Greenpeace asked for the CNSC to change its policy of withholding information on the consequences of major accidents from the public.[185] This included expanding the scope of the environmental assessment on the proposed life-extension of the Darlington nuclear station to include severe accidents. Greenpeace also requested the Commission expand the scope of its review of the Fukushima disaster to include regulator capture. The Commission refused.

November 2012 - During hearings on the environmental review of OPG's proposal to extend the operational lives of the Darlington reactors, hundreds of citizens ask for an assessment of the impacts of a Fukushima-scale accident at Darlington. Greenpeace specifically highlighted Release

[183] Joint Review Panel – Darlington New Nuclear Power Plant Project, *Environmental Assessment Report*, August 2011, Report pg. vi.
[184] CNSC, *Fukushima Task Force Report Draft,* (October 2011) pg. 56.
[185] Shawn-Patrick Stensil, *Greenpeace Comments on the Canadian Nuclear Safety Commission's Response to Fukushima*, April 2, 2012**,** CMD 12-M23.8.

Category 1 in the Darlington 2012 risk assessment as a known and realistic accident scenario that could cause significant offsite impacts.

During the hearings, CNSC staff admitted they could have assessed such accidents, but had simply decided not to do so. On the last day of the 2012 hearings, CNSC staff committed to publish an analysis of a large release before the current hearings. This commitment would become the Severe Accident Study discussed in the Discussion Paper.

April 2013 – Following a private meeting with OPG, CNSC staff accepted the company's recommendation for the accident to be assessed in CNSC's the Severe Accident Study. As discussed, this recommended source term has also been used in Health Canada's 2017 ARGOs study. (See Table 13 in Section 1.20 for a comparison of source terms.)

OPG recommended Commission staff use a "Goldilocks" approach to selecting an accident for its severe accident study. That is, "not too big, not too small, just right." [186] Specifically, OPG recommended the study use the same accidental release scenario that OPG used for the environmental review for new reactors at Darlington.

OPG may have considered this release scenario as "just right" because it was effectively the same as the "blueprint" (EPRC-3) accident the province selected for severe accident planning. This scenario would thus not put in question any current emergency measures. It was also effectively the same as the accident reviewed in the environmental assessment of OPG's proposal to build new reactors at the Darlington site.

However, OPG did recommend an additional "sensitivity" case with releases ten times larger than current blueprint for emergency response. This was a reasonable proposition because the estimated emissions within a Release Category can vary by a factor of ten.[187] Nevertheless, this sensitivity case was still ten times *smaller* than the Fukushima accident. CNSC staff accepted OPG's recommendations.

October 2013 – OPG, the CNSC and Emergency Management Ontario (EMO) meet to discuss the Severe Accident Study. At the meeting, OPG stated the study's objective was "to determine if the existing emergency plans and countermeasures in place today protect the public from the consequences of potential off-site Beyond Design basis (BDB)/Severe accidents." OPG says the study finds the province's emergency plans provide "appropriate countermeasures and are generally protective."[188]

January 2014 – CNSC management review a draft of the Severe Accident Study and ask for the sensitivity case to be removed from the public release of the study. Francois Rinfret, Director of the Darlington Regulatory Program Division, told colleagues "…this document would be used malevolent-ly in a public hearing." He requested the "sensitivity case", which was ten times the size of the baseline release, but still smaller than Fukushima, to be removed from the study. CNSC

[186] John Peters to Fred Dermarkar et al., "Minutes of SARP meeting with CNSC – April 2013", *ema*il, April 9, 2013, 9:26 pm. Acquired through Freedom of Information.
[187] Bruce Power, *Bruce A Level 2 At-Power Internal Events Risk Assessment*, NK21-03611.5, December 2013, pg. 77.
[188] OPG, Overview of OPG's approach to Off-Site Consequence Assessment arising from a "Severe Accident – OPG – EMO – CNSC meeting October 16, 2016", *presentation*. Acquired through Freedom of Information.

director Greg Rzentkowski the early release scenarios were removed from the study released to the public.[189]

As will be discussed in Section 2.4, the suppressed sensitivity case showed a potential need to expand emergency measures. For example, radiation levels would be high enough to require KI consumption 20 km from the reactor and sheltering could be required as far as 40 km from the station. The release of the study was delayed from February to June 2014.

February 2014 – EMO staff asked staff from the Ministry of Energy to undertake a study related to "the scientific basis of the PNERP". The Ministry of Energy has refused to release this document to Greenpeace through Freedom of Information, citing cabinet confidence. Available information indicates the Ministry of Energy adopted OPG recommended accident scenarios for assessment.[190] Although the government has told the Office of the Information Commissioner that this analysis will inform eventual cabinet recommendations for a revised PNERP, it is not cited in the Discussion Paper. This indicates that the public has been deprived of risk related information that has already informed the Discussion Paper's recommendations.

June 2014 – The CNSC released its draft report *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures*. The original sensitivity case was replaced by a release only 4 times larger than the baseline release. In the public study, CNSC staff asserted that increasing the source term was to address the possibility of an accident at all four Darlington reactors. Due to the small source term, this study did not respond to the concerns Greenpeace raised during the 2012 Darlington hearings.

November 2015 – OFMEM requested comment on a draft discussion paper to industry stakeholders such as OPG and Bruce Power entitled "PNERP Planning Basis Review & Recommendations". Although not publicly available, CNSC documents obtained through Access to Information indicate that the study relies on the CNSC's severe accident study to assess the adequacy of offsite emergency preparedness.[191] The Discussion Paper concludes there is no need to expand offsite emergency measures.

November 2015 – At hearings to approve the life-extension of the Darlington nuclear station, hundreds of citizens complain about the lack of information on a Fukushima-scale accident. CNSC staff assert the study fulfils public expectations because the dose projections in the study are similar in magnitude to the doses observed following Fukushima accident. Civil society groups and concerned citizens overwhelmingly reject this CNSC misleading portrayal of public expectations.

December 2015 – Following the 2015 Darlington hearings, OFMEM's Director of Prevention and Risk management writes to the CNSC to ask for assistance with the emergency review. Mr. Suleman noted that the CNSC's Severe Accident Study "validated" the current planning basis. However, he said it "… has now been brought to his attention that a more appropriate basis for severe accident dose consequences would, in fact, be the Probabilistic Safety Assessment (PSA) studies prepared by

[189] Greg Rzentkowski to Andrew McAllister et al., "RE: Update on Study of Consequences of a Severe Nuclear Accident," *email*, January 7, 2014, 3:02. Acquired through Access to Information.

[190] Greenpeace has filed supporting evidence with the Office of the Information Commissioner as part of appeal No. PA 14-543

[191] Internal correspondence in which CNSC staff discussed the reference to the Ministry of Energy's severe accident modelling in the 2015 draft Discussion Paper was obtained through CNSC Access to Information request A-2015-0148.

the nuclear generating studies. Given that we neither have access to these studies, nor do we have the in-house resources to scientifically assess them in a timely manner, we kindly request CNSC resources be made available to provide OFMEM with the distance versus dose consequences and probability of the applicable PSAs for Pickering, Darlington and Bruce."[192] This is a significant admission in light of the foregoing discussion on the findings of industry risk assessments since the 1990s. It appears OFMEM was not aware that it should review PRA findings to assess the adequacy of nuclear emergency response. It is unclear whether the CNSC did provide modelling on Darlington, Bruce and Pickering to OFMEM.

May 2017 – OFMEM released a *Discussion Paper on Provincial Nuclear Emergency Response Plan (PNERP): Planning Basis Review and Recommendations* for public comment. The Discussion Paper relies heavily on the CNSC's severe accident study to support its recommendations. It also cites a new 2017 study produced Health Canada. The Health Canada study, which uses more sophisticated climate modelling, uses effectively the same source term as the CNSC's Severe Accident Study. The Health Canada study also notes that the CNSC has provided a new source term to OFMEM for suggested use in emergency planning.[193] This source term is not modelled in the Health Canada study or discussion in the Discussion Paper. The Discussion Paper recommends against strengthening nuclear emergency preparedness.

2.5 Implications: Canada's Review of Emergency Preparedness since Fukushima

Despite real-world experience and the findings of industry risk assessments since the 1990s, federal and provincial authorities have avoided evaluating the offsite impacts of accidents of any accident scenarios with a severity significantly greater than EPRC-3, which was chosen by the Ontario government in 2002 as a "blueprint" for a severe accident.

Table 28 below compares the Iodidne-131 from releases from publicly available assessment and assessments that have either been suppressed by the CNSC or never undertaken.

Table 30: Comparison 1-131 Release Scenarios

Publicly Available Assessments			Assessments not Available to the Public		
Ontario's "Blueprint" Severe Accident EPRC-3	CNSC's Severe Accident Release	CNSC's Public Severe Accident Sensitivity Release	CNSC's Supressed Severe Accident Release	Fukushima Release	Release from Release Category 1 at Bruce A
3.86E+15	4.4E+15	1.7E+16	4.4E+16	1.6E+17	1E+18

[192] Al. Suleman (OFMEM) to T. Jamieson, *letter*, December 18, 2015. Acquired through Access to Information.
[193] L. Bergman, et al., *ARGOS Modelling of Accident A and Accident B Scenarios,* Health Canada and Environment and Climate Change Canada, May 15, 2017.

As discussed in Section 1.8, Germany[194] and Switzerland[195] have carried out open evaluations of Fukushima-scale accidents at their nuclear stations since 2011. These reviews have recommended expanding offsite emergency measures.

In Canada, however, the CNSC and OPG have acted in unison to avoid any public assessment of such accident scenarios. Meanwhile, OFMEM has taken direction from both the CNSC and OPG.

For Greenpeace, the coordinated actions of the CNSC, OPG and OFMEM raise questions about the independence of public safety authorities in Canada. It also shows a need for new mechanisms fto enable the public to scrutinize and challenge the potentially faulty beliefs and rationales of OFMEM and the CNSC. In Greenpeace's view, there is a need to both plan for larger accidents and empower citizens to ensure public authorities consider public expectations for safety.

2.6 The CNSC's Severe Accident Study: What was hidden from Canadians?

Since its release, the province has cited the CNSC's *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures* to conclude that current offsite measures are adequate.

As noted, however, the reference accident used in the study is effectively the same accident the province used as a "blueprint" (EPRC-3) for current severe accident planning. It is, then, not surprising that the study concludes current offsite measures are adequate and robust. In short, the study did not respond to public requests for offsite emergency measures to be stress tested against a Fukushima-scale accident.

As discussed, CNSC management believed that the sensitivity case, which was still ten times smaller than Fukushima, would be used "malevolently" by the public.[196] What terror did CNSC management fear? It appears that CNSC management feared public calls to expand offsite nuclear emergency measures.

Although the CNSC withheld the original sensitivity case from the public report, they did include a smaller sensitivity case four times larger than the baseline release. The baseline and sensitivity case show public dose estimates increase linearly in proportion to the scale of releases. It is thus possible to extrapolate from the results of the public study to determine what CNSC staff feared would be used "malevolently".

The Table 31 below compares the results of the CNSC's public report, which confirm the adequacy of current offsite measures, to the supressed sensitivity case and to an even larger Fukushima scale release, which is what the public intervenors have called for since 2011.

Table 31 – Comparison of Public and Supressed SARP Scenarios

[194] The Federal Office for Radiation Protection, *RODOS-based simulation of potential accident scenarios for emergency response management in the vicinity of nuclear power plants,* June 2015

[195] Inspection fédérale de la sécurité nucléaire IFSN, *Examen des scénarios de référence pour la planification d'urgence au voisinage des centrales nucléaires,* 2013.

[196] Andrew McAllister, to Julie Burtt et al., "FOR REVIEW: Draft Study of the Consequences of a Severe Nuclear Accident and associated CMD 14-M5," *email,* December 9, 2013, 4:56 PM. Acquired through Access to Information.

Dose mSv								
	24-24(1)		24-24*4(2)		24-24*10		Fukushima *23	
Distance from Plant	Whole Body	Thyroid	Whole Body	Thyroid	Whole Body	Thyroid	Whole Body	Thyroid
1	**25.4**	**431**	**101.6**	**1724**	**250**	**4310**	**575**	**9913**
3	*4.5*	**70.7**	**18**	**282.8**	**45**	**407**	**103.5**	**1626.1**
6	*1.75*	*26.7*	*7*	**106.8**	**17.5**	**276**	**40.25**	**614.1**
12	0.67	*9.82*	*2.68*	39.28	*6.7*	**98.2**	**15.41**	**225.86**
20	0.31	*4.4*	*1.24*	*17.6*	*3.1*	*44*	*7.13*	**101.2**
28	0.18	*2.49*	0.72	*9.96*	*1.8*	*24.9*	*4.14*	**57.27**
36	0.13	*1.75*	0.52	7	*1.3*	*17.5*	*2.99*	40.25
50	0.07	0.95	0.28	3.8	0.7	*9.5*	*1.61*	21.85
70	0.04	0.52	0.16	2.08	0.4	*5.2*	0.92	11.96
90	0.03	0.39	0.12	1.56	0.3	*3.9*	0.69	8.97

Bold = greater than the PNERP's lower Protective Action Level (PAL) for evacuation of 10 mSv; italics greater than the PNERP's lower PAL for Sheltering of 1mSv; 50 mSv PAL for thyroid blocking.
1) Taken from Table 6.1 of the CNSC's Severe Accident Study (pg. 46).
2) Taken from Table 6.2 of the CNSC's Severe Accident Study (pg. 47).

The accident scenario removed from by CNSC management shows an expansion of emergency measures would be advised to address accidents ten times smaller than Fukushima. In such a scenario:

- Evacuation would be required for the entire Primary Zone. Detailed planning for such a scenario is already in place.
- KI consumption could be required out to 20 km. KI is currently only pre-distributed to residents within the 10 km primary zone.
- KI consumption could be required for vulnerable communities, children and pregnant women, out to 40 km. It is unclear what planning the province has put in place to rapidly distribute KI within 50 km of Ontario nuclear stations.
- Sheltering could be required out to 40 km.

Based on the CNSC's methodology, a Fukushima-sized accident would require a significant expansion in pre-prepared emergency measures. In such a scenario:

- Evacuation would likely required out to 20 km. There is currently no detailed preparation for such an evacuation.
- KI consumption required to 30 km. KI is currently only pre-distributed to residents within the 10 km primary zone.
- KI consumption could be required for vulnerable communities out to 50 km. It is unclear what planning the province has put in place to rapidly distribute KI within 50 km of Ontario nuclear stations.
- Sheltering required out to 60 km. This exceeds the current 50 km Secondary Zone.

3. Conclusion

In this submission, Greenpeace set out to answer the following question:

> *Does the Discussion Paper's recommended upper limit for detailed planning and preparedness provide adequate safety margins considering real-word experience, the public's expectations for safety as well as the unique hazards associated with the location of Ontario's nuclear stations on both the Great Lakes and in the densely populated Greater Toronto Area?*

The answer is 'no.' Safety margins are a means of compensating for uncertainty. In spite of real world occurrence of nuclear accidents, the Discussion Paper relies exclusively on industry risk studies to justify its recommendations. In Greenpeace's view, Ontario must abandon its probabilistic approach to nuclear emergency planning and replace it with a precautionary and deterministic approach. That is, the Ontario government should select an updated planning basis accident by considering best practices, public expectations, real-world experience as well as insights from industry technical assessments.

The Discussion Paper fails to consider real world experience or public expectations for safety. The government should therefore reject its recommendation to maintain the historic planning basis accident. Instead it should at a minimum match the precedent set by Switzerland and put in place measures to protect Ontarians in the event of a level 7 INES accident at any of the twenty-five reactors that line the Great Lakes.

Appendix A

Table 1 – International Nuclear Event Scale (INES)

INES Scale	Description	Equivalent in Iodine 131	
		Lower Limit	Upper Limit
7 Major Accident	Widespread health and environmental effects. External release of a significant fraction of reactor core inventory. Long-term environmental consequences.	$5*10^{16}$	-
6 Serious Accident	Likely that protective action such as sheltering and evacuation will be judged necessary to prevent or limit health effects on members of the public.	$5*10^{15}$	$5*10^{16}$
5 Accident with Wider Consequences	Some protective action will probably be required (e.g. localized sheltering and/or evacuation to prevent or minimize the likelihood of health effects).	$5*10^{14}$	$5*10^{15}$
4 Accident with Local Consequences	Protective action will probably not be required, other than local food controls.	$5*10^{13}$	$5*10^{14}$
1-3		No limits	

(1) International Atomic Energy Agency, *The International Nuclear and Radiological Event Scale: User's Manual*, 2008 Edition.
Available at: http://www-pub.iaea.org/MTCD/publications/PDF/INES2009_web.pdf

Table 2 – Multiunit Large Release Scenarios

PRA	Release Category #	Description	Release Frequency without external events
2011 Darlington PRA	Release Category 1	Very large release with potential for acute offsite radiation effects and/or widespread contamination.	4.90E-006
2013 Pickering B PRA	Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of (I-131/Cs-137)	2.9E-6
2014 Pickering A PRA	Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of I-131/Cs-137)	4.69E-6
2013 Bruce A PRA	Release Category 0	Early very large release - > ~3% core inventory of I-131 occurring mainly after 24 hours.	2.9E-6

2013 Bruce A PRA	Release Category 1	Late very large release -> ~3% core inventory of I-131 occurring mainly after 24 hours.	2.45E-7
2015 Bruce B PRA	Release Category 0	Early very large release - > ~3% core inventory of 1-131 occurring mainly after 24 hours.	4.71E-06
2015 Bruce B PRA	Release Category 1	Late very large release -> ~3% core inventory of I-131 occurring mainly after 24 hours.	4.96E-07

Table 3 – Recent Early Releases Scenarios

PRA	Release Category #	Description	Release Frequency without external events
2011 Darlington PRA	Release Category 2	Early release in excess of safety goal "Large Release" of more than 10^{14} Becquerel of Cesium-137.	3.70E-007
2013 Pickering B PRA	Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of (I-131/Cs-137)	2.9E-6
2014 Pickering A PRA	Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of I-131/Cs-137)	4.69E-6
2013 Bruce A PRA	Release Category 0	Early very large release - > ~3% core inventory of I-131 occurring mainly after 24 hours.	2.9E-6
2015 Brue B PRA	Release Category 0	Early very large release - > ~3% core inventory of 1-131 occurring mainly after 24 hours.	4.71E-06

Table 4 - Pickering A Ex-Plant Release Categories 1995

Ex-Plant Release Category	Release Frequency (RY)	Description (2)
EPRC 1	4E-10	A large unfiltered release from containment in the period 0-24 hours after accident initiation. The release occurs through a pre-existing opening in the containment envelope.
EPRC 2	5.9E-9	A large, unfiltered release from containment in the period 6-24 hours after accidents initiation. Scenarios are very similar to EPRC 1 except that there is no pre-existing opening in the containment envelope.
EPRC 3	9.4E-8	An unfiltered release from containment in a period 1 day to 1 month after accident initiation. Many of the event sequences in EPRC3 involve a late containment failure due to a hydrogen explosion.
EPRC 4	2.2E-8	A release from containment in the period 0-6 hours after accident initiation. The release occurs through a pre-existing opening in the containment envelope. Many of the event sequences in EPRC4 are similar to those in EPRC1, but the release is smaller because some of the containment subsystems are operational, mitigating the driving forces and filtering the release.
EPRC 5	1.8E-8	A release through the heat transport system to the external environment, bypassing containment. Typical release pathways involve failure of steam generator tubes, or blowback through the emergency coolant injection system.

EPRC 6	2.6E-7	Early release within a few second of the accident, but short in duration. Sequence could involve a Loss of Coolant Accident (LOCA) with subsequence failure to shut down the reactor, resulting in a large power excursion, but with all containment subsystems available.
EPRC 7	1.3E-4	Severe core damage occurs with the containment intact and all subsystems available.

1) The Ex-Plant Release Category and Release Frequency are taken from Table 12.2-1 of OPG's 1995 *Pickering A Risk Assessment, Main Report.*
2) Descriptions are adapted from the summaries provided by Dr. Gordon Thompson in his report to the Canadian Senate: *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*, 2000, pgs. 43-44.
3) In the Pickering A Risk Assessment, OPG decided not to calculate the source term and potential consequences of EPRCs 1 and 2. OPG gave the following reason: "At some level, the likelihood of occurrence of a particular EPRC becomes sufficiently low that it can no longer be meaningful to evaluate risk, irrespective of the consequences. Below this level there is no need to evaluate the consequences in detail although, the frequencies of the omitted categories should still be incorporated into the comparison with safety goals and final conclusions of the study. A precedent exists for such a frequency cutoff in the Canadian licensing process, where consequences analysis is not required for the individual event sequences whose calculate frequency falls below 10^{-7}/year. In the PARA, a cutoff of 10^{-8}/year was chosen to ensure that no event of possible significance just below the 10^{-7}/year threshold had been missed." *Pickering A Probabilistic Risk Assessment Main Report*, Chapter 13, p. 13-1.
4) The release for EPRCs 3 – 6 were calculated by multiplying the release factions provided in Table 13.3-1 (p. 13-3) of the Pickering A Risk Assessment for Iodine and Cesium against the core inventory for each isotope. The Release fractions for Iodine and the Cesium for each EPRC are as follows: EPRC3 - 2E-3, EPRC 4 – 7E-3, EPRC 5 – 1E-3, EPRC 6 – 3E-4. Table 13.4-2 states that a Pickering reactor core contains 1.93E+18 of Iodine-131 and 5.03E+16 of Cesium-137. The Cesium releases were multiplied by 40 to express the releases in radiological equivalence of Iodine-131 as required by the International Nuclear Event Scale User's Manual.

Table 14 - Maximum Planning Accident (MPA)

Reactor Status	Equilibrium
Hold-up Time in Containment	24 hours**
Power Level	1750 MW (th)
Plume Release Height	20 m
Releases to the Environment	
Noble Gases	100% of core inventory***
Iodines	0.1% of core inventory***
Removal Time	1 day
Weather (from end of hold-up period)	Pasquill F weather for first 6 hours (wind speed of 1m/s). Pasquill D weather for next 18 hours (wind speed of 5m/s)
Wind Direction	Steady for 24 hours
Wind Meander	22.5®

*Report of Provincial Working Group #8 – the Upper Limit for Detailed Nuclear Emergency Planning, June 30, 1988 p. 47.
**When Working Group 8 made its recommendations it thought this was a conservative assumption because "Changes to be made in the up-coming years to the Pickering site will result in a longer hold-up time."
*** During hold-up, much of the noble gases (and iodine) inventory will decay by radioactivity. The actual release is then less than 100% (or 0.1%).

Table 15 - Worst Credible Radiation Emission (WCRE)*

Reactor Status	Equilibrium
Hold-up Time in Containment	Zero
Power Level	1570 MW (th)
Plume Release Height	20 m
Releases to the Environment	
Noble Gases	100% of Core inventory
Iodines	1% of Core inventory**
Rates of Release	
Noble Gases	10% per hour
Iodines	1% in first hour
Weather (from end of hold-up period)	Pasquill F weather for first 6 hours (wind speed of 1m/s). Pasquill D weather for next 18 hours (wind speed of 5m/s)
Wind Direction	Steady for 24 hours
Wind Meander	22.5®

* *Report of Provincial Working Group #8 – the Upper Limit for Detailed Nuclear Emergency Planning,* June 30, 1988, p. 65.

Table 16 – 1999 Bruce B Ex-Plant Release Categories

Release Category (1)	Characteristics	Frequency (occ/yr)	Population Dose (P-Sv) (2)
EPRC 1	Large early radioactivity release into containment (0-24 hours after initiating event); Ex-plant release driven by steaming with vault coolers unavailable to mitigate.	$2.8*10^{-9}$	32,900
EPRC 2	Large delayed release into containment (at least 6 hours after initiating event); Pre-existing containment envelope impairment, Ex-plant release driven by steaming with vault coolers unavailability to mitigate.	$9.1*10^{-8}$	35.400
EPRC 3	Significant early release into containment (0-24 hours after initiating event); Pre-existing containment envelope impairment; Ex-plant release driven by steaming with vault coolers unavailable to mitigate.	$2.7*10^{-8}$	10,400
EPRC 4	Significant delayed release into containment (at least 6 hours after iniating event); Pre-existing containment envelope impairement; Explant release driven by steaming mitigated by vault coolers. Or, significant delayed release into containment (at least 6 hours after initiating event); Late containment failure due to steam-pressurization; Ex-plant release driven by steaming with vault coolers unavailable to mitigate.	$6.9*10^{-8}$	8,730
EPRC 5	Large delayed release into containment (> 24 hours after initiating event); Pre-existing containment envelope impairment; Ex-plant release driven by steaming with vault coolers unavailable to mitigate.	$2.0*10^{-10}$	22,300
EPRC 6	Significant delayed release into containment (>24 hours after initiating event); Pre-existing containment envelop impairment; Ex-plant release driven by steaming mitigated by vault coolers. Or,	$1.8*10^{-7}$	2,800

	Significant delayed release into containment (>24 hours after initiating event); Late containment failure due to steam-pressurization; Explant release driven by steaming vault coolers unavailable to mitigate.		
EPRC 7	Small release from containment bypass, such as HT pump gland seal failure, boiler tube rupture, ECI blowback, pipe break in D_20 feed/bleed system of LOCA2A size outside containment; Ex-plant release via direct pathway outside containment.	3.5*10-6	760
EPRC 8	Significant early release into containment due to failure of reactor shut down; Pre-existing or early consequential containment envelope impairment (containment envelope crack due to over-pressure by steam surge); Early short-term ex-plant puff-release.	$4.7*10^{-10}$	40
EPRC 9	Design basis fuel failure events (large LOCA, single channel events with containment pressurization, LOCA*ECI and LOCA*ECR, moderator heat sink available; Early ex-plant release due to containment bypass with failure of boiler SRV cool down, or depleted containment vacuum and pre-existing containment envelope impairment.	$5.9*10^{-6}$	240
EPRC 10	Design basis fuel failure events (see EPRC9); Intact containment and all containment systems available; Delayed noble gas release via EFADS (> 24 hours after initiating event).	$5.8*10^{-5}$	7
Large Off-Site Release (per unit) EPRC 1 – 6 (3)		$3.7*10^{-7}$	
Severe Off-Site Release (per unit) EPRC 1-3, 5		$1.2*10^{-7}$	

(1) The first three columns are taken from Table 2-7 of the BBRA, p. 29.
(2) The population dose estimates are taken from Table 2-11 of the BBRA, p. 36.
(3) Large and Severe Releases estimates are taken from Tables 2-2 and 2-3 of the BBRA. A Large release is defined as a release greater than 1 per cent of the core inventory of cesium-137. A Severe release is defined as a release greater than 10 percent of the core inventory of cesium-137.

Table 17 – 2003 Bruce A Risk Assessment

Release Category	Mean Frequency (occurrences per reactor year)	Mean Individual Dose (mSv)	Mean Individual Risks ($Sv.y^{-1}$)	Population Risks (Person-Sy $y^{-1)}$
EPRC 1	$1.5 * 10^{-7}$	>3000*	*	$4.9*10^{-3}$
EPRC 2	$3.6 * 10^{-7}$	>3000*	*	$1.3*10^{-2}$
EPRC 3	$6.4 * 10^{-8}$	>3000*	*	$6.7*10^{-4}$
EPRC 4	$8.6 * 10^{-8}$	>3000*	*	$7.5*10^{-4}$
EPRC 5	$2.2 * 10^{-9}$	260	$5.7*10^{-10}$	$5.0*10^{-5}$
EPRC 6	$9.1 * 10^{-7}$	3000	$2.7*10^{-6}$	$2.5*10^{-3}$
EPRC 7	$2.6 * 10^{-5}$	590	$1.5*10^{-5}$	$2.0*10^{-2}$
EPRC 8	$7.0 * 10^{-10}$	220	$1.5*10^{-10}$	$2.8*10^{-8}$
EPRC 9	$2.8 * 10^{-5}$	270	$7.6*10^{-6}$	$6.7*10^{-3}$
EPRC 10	$3.0 * 10^{-5}$	37	$1.1 * 10^{-6}$	$2.1 * 10^{-4}$
Total risk (per unit)			$3.5*10^{-5}$	$4.6*10^{-2}$
Total risk (per 4 unit station)			$1.4*10^{-4}$	$1.8*10^{-1}$

* Since EPRC 1,2,3 and 4 are predicted to result in an immediate individual dose of >3000 mSv, they are considered in the analysis to contribute to an early fatality risk. The total contribution of EPRC1 to EPRC4 to early fatality is calculated as the sum of the individual mean frequencies, or $6.6 * 10^{-7}$ per unit, or $2.7 *10^{-6}$ for four units. (1 in 1,520000 reactor years)

Table 3.5.11-5, 3-110, *Bruce A Refurbishment for Life Extension and Continued Operations Project, EA Study Report*

Table 18 – 2005 Bruce A Risk Assessment Update

Safety Goal	Consequence categories contributing to Safety Goal	Safety Limit (per reactor year unless otherwise stated)	Calculated frequency (Notes 1)	Integrated frequency of contributors (PRY) Note 2	Comparison of Integrated Frequency with limit
Severe Core Damage (SCD)	FDC1-IC FDC1-OC FDC2-IC FDC2-OC	1E-4	6.55E-8 1.16E-12 7.72E-5 3.64E-5	5.7E-5*	Meets Limit
Early Fatality (EF)	EPRC1** EPRC2** EPRC3 EPRC4	1E-5 per site year	2.61E-8 8.60E-7 1.02E-8 4.97E-8	4.5E-7*	Meets Goal
Delayed Fatality (DF)	EPRC5 EPRC6 EPRC7 EPRC8 EPRC9 EPRC10	1E-4 per site year	1.42E-9/1.85E-11 9.36E-7*/1.4E-7* 3.88E-5/1.15E-6 0.0 2.06E-5/2.7E-7 4E-5/7.4E-8	1.3E-6*	Meets Limit
Large Release (LR)	EPRC1** EPRC2** EPRC3 EPRC4 EPRC5 EPRC6	1E-5	2.61E-8 8.6E-7 1.02E-8 4.97E-8 1.42E-9 9.36E-7*	1.3E-6*	Meets Limit
Severe Release (SR)	EPRC1** EPRC2** EPRC3 EPRC5	1E-6	2.61E-8 8.6E-7 1.02E-8 1.42E-9	4.1E-7*	Meets Limit

These results are from the *Bruce A Nuclear Generating Station Probabilistic Risk Assessment*, BAPRA Update Part 1 Summary Report, P.A. Robinson, NSS Report 11575/TR/001 Issue 01, February 2005. Cited in *Review of Bruce NGSA Against Modern Safety Standards: Summary Report*, March 2006, prepared by R.A. Brown & Associates Ltd., Acquired through Access to Information.

*indicates that the frequency has removed double-accounting both within an individual consequence category and where relevant between the contributors from different consequences categories. For the Delayed Fatality goal, as a conservative simplification, the overall frequency presented is simply the sum of the risks from individual EPRC contributors.

**It is noteworthy that the release fraction for I-131 for EPRC 1 and 2 is over 50%. For Cs-137 the release fraction is 50% in the case of EPRC-1 is 52% and 76% for EPRC-2. Source: CNSC – Probabilistic Safety Assessment and Reliability Division, *Bruce A Probabilistic Risk Assessment (PAPRA) Detailed Review: Main Report*, Document File Number: 26-1-7-4-3, pg. 161.

Table 19 – 2008 Pickering B Risk Assessment

EPRC	Characteristics	Frequency (Occ/yr)

1	Fast accident progression (<6 hours), coupled with pre-existing containment envelope impairment or early consequential containment envelope failure and unavailability of containment heat removal systems	$1.1*10^{-10}$
2	Delayed accident progression (>6 hours), coupled with pre-existing containment envelope impairment and unavailability of containment heat removal systems.	$1*10^{-11}$
3	Fast accident progression, coupled with pre-existing containment envelope impairment but containment heat removal systems available	$1*10^{-11}$
4	Fast accident progression in which partial impairment of, containment systems leads to potential for enhanced release	$2.4*10^{-10}$
5a	Slow accident progression that results in late (> 24 hours) releases from containment. EPRC5A is considered to have the potential for severe core damage in more than a single unit.	$7.1*10^{-7}$
5b	Slow accident progression that results in late (>24 hours) releases from containment. EPRC5B affects a single unit only.	$2.1*10^{-8}$
6	Slow accident progression but involving a direct pathway for radioactive release that initially bypasses containment	$1*10^{-11}$
7	Delayed accident progression in which partial impairment of containment systems leads to potential for enhanced release.	$1*10^{-11}$
8	Non-severe accidents in conjunction with a pre-existing containment envelope impairment. Release is predominantly through a controlled, filtered pathway.	$1.3*10^{-6}$
9	Severe accident sequences in which the containment envelope is intact an all containment systems are available. Release is through a controlled filtered pathway.	$1.0x10^{-6}$
Large Release Frequency (per unit) EPRC 1-5, 5A, 7 (2)		$7.1*10^{-7}$

(1) This table is taken from Table 3 in the 2008 *Pickering B Risk Assessment Summary Report*, p. 45
(2) The Large Release Frequency is taken from Table 4 of the 2008 *Pickering B Risk Assessment Summary Report*, p. 46.

Table 20 – Pickering B EPRC5 Source Term

	Single Unit	Multi-unit Accident
Radionuclide	Release (Bq)	Release (Bq)
Kr-85	1.43E+15	5.72E+15
Kr-85m	1.47E+17	5.88E+17
Kr-87	2.90E+17	1.16E+18
Kr-88	4.10E+17	1.64E+18
Xe-133	1.20E+17	4.80E+17
Xe-135	1.20E+17	4.80E+17
I-131	6.13E+14	2.45E+15
I-132	9.09E+14	3.64E+15
1-133	1.29E+15	5.16E+15
I-134	1.40E+15	5.60E+15
I-135	1.20E+15	4.80E+15
Cs-134	7.59E+12	3.04E+13
Cs-136	1.12E+13	4.48E+13
Cs-137	1.77E+13	7.08E+13
Rb-86	2.11E+11	8.44E+11
Sb-127	4.46E+13	1.78E+14
Sb-129	1.54E+14	6.16E+14

Te-127	4.20E+13	1.68E+14
Te-127m	3.58E+12	1.43E+13
Te-129	1.50E+14	6.00E+14
Te-129m	2.04E+13	8.16E+13
Te-131m	7.28E+13	2.91E+14
Te-132	6.97E+14	2.79E+15
Sr-89	3.90E+12	1.56E+13
Sr-90	9.34E+10	3.74E+11
Sr-91	5.64E+12	2.26E+13
Sr-92	6.07E+12	2.43E+13
Mo-99	1.29E+13	5.16E+13
Rh-105	5.98E+12	2.39E+13
Ru-103	9.15E+12	3.66E+13
Ru-105	6.86E+12	2.74E+13
Ru-106	1.30E+12	5.20E+12
Tc-99m	1.14E+13	4.56E+13
La-140	9.65E+11	3.86E+12
La-141	9.11E+11	3.64E+12
La-142	8.77E+11	3.51E+12
Nb-95	6.17E+11	2.47E+12
Nd-147	3.40E+11	1.36E+12
Pr-143	8.18E+11	3.27E+12
Y-90	1.12E+10	4.48E+10
Y-91	5.90E+11	2.36E+12
Y-92	7.24E+11	2.90E+12
Y-93	8.26E+11	3.30E+12
Zr-95	7.19E+11	2.88E+12
Zr-97	9.25E+11	3.70E+12
Ce-141	4.86E+12	1.94E+13
Ce-143	4.91E+12	1.96E+13
Ce-144	1.74E+12	6.96E+12
Ba-139	6.65E+14	2.66E+15
Ba-140	6.49E+14	2.60E+15

Source: K.S. Dinnie (Director, Nuclear Safety Solutions) to E. Marczak (OPG), "Pickering Life Extension Project: Accidental Air and Waterborne Release for Pickering B Environmental Assessment – EPRC5, *letter*, January 19, 2007, Acquired through Freedom of Information.

Table 21 – 2008 Pickering B Assessment with Accident Categories

Release Source	Release Event	Mean Frequency (/Yr)	Individual Risk[2]		Societal Risk[1]
			Individual Dose	Individual Risk[8]	
Normal Operation	Routine	1.0	6.8E-6	3.4E-7	N/A
Design Basis	FDC3-5[8]	1.13E-3[3]	1.13E-3[3]	7.6E-8	6.6E-4

Accidents	FDC6-8	3.81E-3[4]	4.53E-5[4]	8.6E-9	7.5E-5
Severe Accidents	EPRC1 EPRC2 EPRC3 EPRC4 EPRC5A EPRC5B EPRC6 EPRC7 EPRC8 EPRC9	1.1E-10 1E-11 1E-11 2.4E-10 7.1E-7 2.1E-8 1E-11 1E-11 1.3E-6 1E-6	1.4[5] 0.42[5] 0.55[5] 0.23[5] 0.51[9] 0.013[5] 0.14[5] 0.69[5] 1.2E-3[10] 4.5E-3[5]	7.6E-12 2.08E-13 2.76E-13 2.8E-12 1.8E-9[10] 1.3E-11 7E-14 3.5E-13 7.9E-11 2.3E-10	2.1E-7 8E-9 9.9E-9 9.5E-8 3.2E-5 2.4E-7 1.8E-9 1.1E-8 7.1E-7 2E-6
Total Quantified Accident Risk (1 Unit)				8.7E-8[11]	7.7E-4[11]
Total Quantified Accident Risk (4 Units)				3.4E-7[11]	3E-3[11]
Total risk (Normal Operation + Reactor Accidents)				6.8E-7	6E-3

1. Within 100 km radius of station
2. At site boundary assumed to be about 1 km.
3. FDC3-5 Cumulative dose assumed to be 25% of EPRC9 dose.
4. FDC6-8 Cumulative dose assumed to be 1% of EPRC9 dose.
5. Individual Dose – (a) Emergency phase and Long term direct exposure dose at 1 km, plus (b) an additional 1% for ingestion.
6. Individual Risk = Annual probability of fatality to critical individual; Societal Risk = Fatalities per year within 100 km of Pickering NGS.
7. Contribution for normal operation assumed to be same as for individual risk on a relative-percentage basis.
8. Note FDC = Fuel Damage Category. Includes at-power and shutdown contribution, and inside and outside containment.
9. EPRC5A consequence is estimated to be 4*EPRC5B.
10. Individual Dose = (a) Emergency phase and Long term direct exposure dose at 1 km, plus (b) an additional 1% ingestion, plus (c) individual dose for FDC3-5.
11. Single unit total does not include EPRC5A; 4 unit total = 1*EPRC5A plus 4*(1 unit total).

Source: OPG, Pickering B Risk Assessment Summary Report, Release November 14, 2008.

Table 22 – 2011 Darlington Assessment Summary for External Events

External Event	Severe Core Damage Frequency	Large Release Frequency
Fire At-Power	1.9E-6	9.7E-8
Seismic At-Power(1)	3.7E-6	3.7E-6
Flooding At-Power	4.8E-7	4.8E-7(2)

1) Seismic results reported for events with a frequency of occurrence up to 1E-4 (recurrence interval of 10,000 years)

2) LRF for at-power internal flooding was not assessed due to the low frequency of severe core damage. LRF is bounded by SCD frequency.

Source: OPG, Darlington NGS Risk Assessment Summary Report, REP-03611-10072, May 29, 2012, pg. 96.

Table 23 – 2011 Darlington Risk Assessment

Release Category #	Description	Baseline Predicted Frequency Per Reactor Year (1)	Population Dose (person-SV) (2)	Latent Cancer Fatalities

				(3)
RC1	Very large release with potential for acute offsite radiation effects and/or widespread contamination.	4.90E-006	6.00E+004	3000
RC2	Early release in excess of safety goal "Large Release" of more than 10^{14} Becquerel of Cesium-137.	3.70E-007	1.20E+003	60
RC3	Late release in excess of safety goal "Large Release" of more than 10^{14} Becquerel of Cesium-137.	0	Not available.	
RC4	Early release in excess of safety goal "Small Release"	2.00E-009	1.10E+003	55
RC5	Late release in excess of safety goal "Small Release"	Not available.	Not available.	
RC6	Greater than normal containment leakage below Small Release limit.	Not available.	Not available.	
RC7	Normal containment leakage. Leakage across an intact containment envelope or long-term filtered release.	1.50E-006	5.40E+001	2.70
RC8	Base mat Melt-through. No release to atmosphere.	4.90E-006		

(1) These are the baseline predicted frequencies taken from Table 16 of the Darlington NGS Risk Assessment Summary Report. These are before OPG changed modeling assumptions to reduce the probability of the severe accident RC1.
(2) Based on OPG's projected 2013 population to a radius of 100km from Darlington site. Notably, the *Screening Report* indicates that the population dose for RC7 will double by 2055 because of population growth within the GTA.
(3) Latent Cancer fatalities is calculated by using a risk coefficient of 0.05 deaths per Person-Sv. This method has also been used by OPG.

Table 24 - Pickering B Release Categories 2013 (1)

Release Category #	Description	Release Frequency without external events
Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of (I-131/Cs-137)	2.9E-6
Release Category 2	Early release in excess of safety goal "Large Release" definition (greater than 10^{14} Bq of Cs-137 but less than RC1 occurring mainly within 24 hours)	N/A
Release Category 3	Delayed large release in excess of safety goal "Large Release" definition (greater than 10^{14} Bq of Cs-137 but less than RC1 occurring mainly within 24 hours)	9.7E-07
Release Category 4	Early small release in excess of safety goal "Small Release" definition (greater than 10^{15} Bq of I-131 but less than RC2 occurring mainly within 24 hours)	N/A

Release Category 5	Delayed small release in excess of safety goal "Small Release" definition (greater than 10^{15} Bq of I-131 but less than RC3 occurring mainly after 24 hours)	2.0E-7
Release Category 6	Mitigated but greater than normal containment leakage and below Small Release limit (greater than 10^{14} Bq of I-131 but less than RC5 occurring mainly after 24 hours).	N/A
Release Category 7	Normal leakage through an intact containment and filtered release occurring mainly after 24 hours.	N/A
Release Category 8	Underground release via basemat melt-through. No release to atmosphere.	N/A

1) The first two columns of this table were taken from Table 9 of the Pickering B Risk Assessment Summary Report (p. 101). Column three is taken Table 15 of the same report (p.107).
2) The Iodine Release column was calculated by multiplying the release fractions mentioned in the second column with the core inventory of Iodine-131. Iodine was chosen because it is used to determine ratings on the International Nuclear Event Scale. Because the core inventory for the Pickering B reactors was not readily available, the Pickering A inventory was used as an equivalent. See: Table 13.4-1, "Radioactive Inventory of Reactor Core", *Pickering A Risk Assessment Main Report*, 1995, p. 13-8.

Table 25 – Pickering A Release Categories 2014

Release Category	Description (1)	Frequency (2)	INES Level
Release Category 1	Large early release with potential for acute offsite radiation effects and/or widespread contamination (greater than 3% core inventory of I-131/Cs-137)	4.69E-6	7
Release Category 2	Release in excess of 10^{14} Bq of Cs-137 but less than RC1 occurring within 24 hours.	N/A	6?
Release Category 3	Release in excess of 10^{14} Bq of Cs-137 but less than RC1 occurring after 24 hours.	3.45-8	6

1) The first and second columns are taken from Table 7 of the Pickering A Risk Assessment. The summed Large Release Frequency is 4.72E-6.
2) The third column is taken from Table 12 of the 2014 Pickering A Risk Assessment. These frequency estimates exclude external events.

Table 26 – 2013 Bruce A at-Power Internal Events Level 2 Release Category Results

Release Category (RC)	Frequency	Frequency with EME Credit	Description
RC0	2.9E-6	6.32E-7	Early very large release - > ~3% core inventory of I-131 occurring mainly after 24 hours.
RC1	2.45E-7	4.25E-8	Late very large release -> ~3% core inventory of I-131 occurring mainly after 24 hours.
RC2	6.72E-6	7.91E-7	Early RD-152 Large Release – Mixture of fission products containing > 10^{14} Bq of Cs-137 but < ~3% core inventory of I-131 occurring mainly within 24 hours
RC3	1.21E-12	1.05E-13	Late RD-152 Large Release – Mixture of

			fission products containing > 10^{14} Bq of Cs-137 but < ~3% core inventory of I-131 occurring mainly after 24 hours.
RC4	7.68E-8	7.65E-9	Early RD-152 Small Release – Mixture of fission products containing > 1015 Bq of 1-131 but < 10^{14} Bq of Cs-137 occurring mainly within 24 hours.
RC5	2.03E-12	4.97E-14	Late RD-152 Small Release – Mixture of fission products containing >10^{15} Bq of I-131 but < 1014 Bq of Cs-137 occurring mainly after 24 hours.
RC6	1.47E-6	2.97E-7	Mitigated release – Mixture of fission products containing > 10^{14} Bq of I-131 but < 1015 Bq of I-131 occurring mainly after 24 hours.
RC7	6.52E-6	1.93E-6	CET Success Path – Slow release containing < 10^{14} Bq of I-131.
RC 8	2.19E-6	3.67E-7	Basemat Melt-through – Penetration of FMD concrete basemat due to CCI
Large Release Frequency Total	9.87E-6	3.67E-7	Sum of RC0 to RC3
Small Release Frequency Total	9.95E-6	1.47E-6	Sum of RC0 to RC5.

Source: Attachment A – Bruce A and Bruce B Internal Events Level 2 Release Category Results, F. Saunders (Bruce Power) to S-P Stensil (Greenpeace), "Greenpeace Information Request," *letter*, February 13, 2015.

Table 27 - Bruce B at-Power Internal Events Level 2 Release Category Results

Release Category	Frequency	Frequency with EME Credit	Description
Release Category 0	4.71E-06	5.9E-7	Early very large release - > ~3% core inventory of 1-131 occurring mainly after 24 hours.
Release Category 1	4.96E-07	6.2E-8	Late very large release -> ~3% core inventory of I-131 occurring mainly after 24 hours.
Release Category 2	2.70E-07	3.61E-8	Early RD-152 Large Release – Mixture of fission products containing > 10^{14} Bq of Cs-137 but < ~3% core inventory of I-131 occurring mainly within 24 hours
Release Category 3	1.43E-08	1.99-9	Late RD-152 Large Release – Mixture of fission products containing > 10^{14} Bq of Cs-137 but < ~3% core inventory of I-131 occurring mainly after 24 hours.
Release Category 4	1.74E-7	2.05E-8	Early RD-152 Small Release – Mixture of fission products containing > 1015 Bq of 1-131 but < 10^{14} Bq of Cs-137 occurring mainly within 24 hours.
Release Category 5	0	0	Late RD-152 Small Release – Mixture of fission products containing >10^{15} Bq of I-131 but < 1014 Bq of Cs-137 occurring mainly after 24 hours.
Release Category 6	5.74E-6	1.38E-6	Mitigated release – Mixture of fission products containing > 10^{14} Bq of I-131 but < 1015 Bq of I-131 occurring mainly after 24 hours.

Release Category 7	4.08E-6	1.33E-6	CET Success Path – Slow release containing < 10^{14} Bq of I-131.
Release Category 8	4.94E-6	6.2E-7	Basemat Melt-through – Penetration of FMD concrete basemat due to CCI
Large Release Frequency Total	5.49E-6	6.93E-7	Sum of RC0 to RC3
Small Release Frequency Total	5.67E-6	7.14E-7	Sum of RC0 to RC5.

Source: Attachment A – Bruce A and Bruce B Internal Events Level 2 Release Category Results, F. Saunders (Bruce Power) to S-P Stensil (Greenpeace), "Greenpeace Information Request," *letter*, February 13, 2015.

Table 28 – Variations in Darlington Large Release Frequency

	DARA 2012 (1)			DARA 2015 (2)	
Release Category	**Baseline Predicted Frequency**	**Enhanced Model with SIOs**	**Enhanced Model without SIOs**	**Baseline Predicted Frequency with EMEs**	**With EME and SIOs (3)**
D-RC1 (A level 7 INES accident with more the 3% of I-131 to the environment)	4.9E-06	5.1E-08	7.8E-07	5.0E-07	OPG would not provide. Greenpeace Estimate: 2E-7
D-RC2 (A level 6 INES accident with releases equivalent to the CNSC's severe accident study)	3.7E-07	3.6E-07	5.2E-07	5.2E-07	OPG would not provide. Greenpeace Estimate: 2E-7
D-RC3	0	0	0	0	0
Summed Frequency of Large Releases Categories	5.27E-06	4.11E-07	1.3.6	1E-6	4E-7 (4)

(1) The DARA 2012 numbers were taken from Table 16 *Darlington Risk Assessment Summary Report*, p. 104.
(2) The DARA 2015 numbers were taken from Table 17 of the 2015 Darlington Risk Assessment Summary Report, p. 110. It should be noted that Greenpeace requested DARA frequency estimates without credit for Emergency Mitigating Equipment, but OPG refused.
(3) Greenpeace requested OPG provide Release Category estimates without credit for both EMEs and SIOs. OPG responded that: "In the Level 2 Internal Events for At-Power PSA the case with no EME or SIOs is only a sensitivity case. As such, the results of this sensitivity case were not derived on an individual release category basis. The LRF without EME or SIOs is 1.5E-6 occurrences per reactor year." (Memorandum to Greenpeace, "Response to Request from Greenpeace for Information from Darlington NGS Probabilistic Safety Assessment" September 10, 2015, N-CORR-03611-0562767 LOF) This implies that EMEs impact on large release frequency is approximately 0.5E-6 (1.5E-6 without EMEs compared to 1E-6).
(4) Table 13 of the 2015 indicates that the summed LRF with EMEs and SIOs is 4E-7. Based on this Greenpeace estimates the RC1 and RC 2 would be equal to 2E-7 each.

Attachment 2

GREENPEACE

June 12, 2018

Matthew Torigian
Deputy Minister of Community Safety
Ministry of Community Safety and
Correctional Services
25 Grosvenor Street 11th Floor
Toronto, Ontario
M7A 1Y6

Re: Ensuring the impartiality of the public service in regard to nuclear emergency planning

Dear Deputy Minister Torigian,

I write to seek clarification on the steps the Ministry has taken to ensure the public service is competent and free from conflict of interest in carrying out its responsibility to protect public safety in the event of a nuclear emergency.

Over the past several years Greenpeace has become increasingly concerned that the Ontario public service's responsibility to uphold the public interest – and public safety – may have been compromised by its reliance on reactor operators for policy advice. The Auditor General of Ontario echoed Greenpeace's concern in her 2017 report, which noted that in 2015 a staff member was paid directly by a nuclear power company while being working at the Ministry. The Auditor observed that this type of arrangement could pose a risk to the Ministry's objectivity. Greenpeace agrees.

I'm contacting you now because it has come to Greenpeace's attention that the Ministry has continued to rely on staff from nuclear companies to carry out its functions.

In the document attached to this letter I highlight several examples of how the Ministry's reliance on Ontario Power Generation (OPG) staff may have compromised ethical and professional behaviour of the public service. I am concerned that this ongoing reliance on nuclear industry staff may have compromised the neutrality of the public service.

As you know, the purpose of *Public Service of Ontario Act* (herein *Public Services Act*) is to ensure the public service is effective, non-partisan, professional, ethical and competent. Upholding these values is needed so that both Ontarians and Ministers can trust and have confidence in the policies, proposals and programs overseen by the public service.

The *Public Service Act* requires public servants to take steps to avoid any conflict of interest between their professional duties and their private affairs. Staff seconded from nuclear companies are in a clear conflict of interest. While the public service is mandated to advance the public interest, nuclear companies are motivated by profit. Given that nuclear companies pay

for emergency response measures, industry staff may not support strengthening public safety if it leads to increased costs for reactor operators. I have seen no evidence that the Ministry has reflected on the impact its reliance on nuclear operators may have on public safety and public trust.

For this reason, I ask you to provide clarity on what steps have been taken to ensure the ethical and neutral operation of the public service in regard to its responsibility to oversee the adequacy of nuclear emergency response. This will also help clarify whether the Ministry has sought to respect the objectives of the *Public Services Act.*

I thus respectfully request responses to the following questions:

- Please provide a list of all staff loaned or seconded to the Ministry of Community Safety to assist with the oversight of nuclear emergency response since the 2011 Fukushima disaster. Please include their responsibilities and the period during which they assisted the Ministry.
- For each staff member seconded or loaned from a nuclear company, such as OPG, please state whether the Ministry sought advice from the Conflict of Interest Commissioner regarding the ethical acceptability and potential conflicts of interest. If advice was not requested from the Conflict of Interest Commissioner, were there other formal processes used to evaluate the ethical acceptability of these secondments?
- Has the Ministry established any policies or procedures to ensure arrangements with nuclear companies do not impede the Ministry's ability to objectively assess nuclear risks and provide unbiased analysis to the Minister and the public? Please indicate whether these documents publicly available.
- The Ministry appears to have an ongoing and informal reliance on OPG, which is a Crown corporation, for technical and staffing support. Has the Ministry established any guidelines or procedures to ensure OPG's business interests do not unduly influence government operations, advice to the Minister or relationships with public stakeholders?
- Has the Ministry assessed the staffing needs and financial support required to implement the latest Provincial Nuclear Emergency Response Plan (PNERP) as well as any Canadian Nuclear Safety Commission requirements that may impact Ministry operations?

Thank you for your attention. Greenpeace makes these requests in the hope that they will help clarify what actions the Ministry has taken to ensure the integrity of its oversight of nuclear emergency response.

In the event that there has been insufficient consideration of these issues, Greenpeace will support and encourage policies and actions to strengthen the independence and competency of the public service.

Truly,

Shawn-Patrick Stensil
Senior Energy Analyst
Greenpeace Canada
33 Cecil St.,
Toronto, Ontario
M5T 1N1

CC:

Sidney B. Linden, Conflict of Interest Commission
Bonnie Lysyk, Auditor General of Ontario
Brian Beamish, Information and Privacy Commissioner
J. David Wake, The Office of the Integrity Commissioner
Marie-France Lalonde, MPP, Ottawa-Orléans
The Honourable Andrea Horvath, Leader of the Opposition
Mike Schreiner, MPP Guelph, Leader of the Green Party of Ontario

Summary of Concerns

Since the 2011 the Fukushima accident began, Greenpeace has been raising concerns related to the adequacy of Ontario's Provincial Nuclear Emergency Response Plan (PNERP). We have attempted to encourage the modernization of the PNERP and have put a significant amount of effort into developing and proposing constructive proposals for improving public safety.

Greenpeace is very concerned that the value of our efforts may have been compromised by what we believe to be an effective lack of separation between nuclear companies, in particular Ontario Power Generation (OPG), and the Ministry of Community Safety and Correctional Services (henceforth referred to as "the Ministry").

The Ministry has a significant responsibility: protecting public safety. The government needs an impartial public service to ensure it receives advice that is informed by the public interest, objective and independent. Impartiality also encourages public confidence and trust in government oversight and ensures that public concerns receive fair and objective treatment no matter their political views.

The Ontario government is also OPG's sole shareholder. OPG's operations at the Pickering and Darlington nuclear stations are a public safety risk and require the Ministry to prepare emergency response plans. As OPG pays for offsite nuclear emergency measures around its stations, it has a financial interest in limiting their expansion.

Notably, unlike Bruce Power, OPG does not appear on the Office of the Integrity Commissioner's Lobbyist Registry. Greenpeace is concerned that OPG's status as a Crown Corporation may have led government authorities to treat OPG as an extension of the public service instead of like private company. This raises questions whether the views of Greenpeace and other civil society interveners have been treated fairly by the public service. Given OPG's business interests, it may also raise questions regarding the objectivity and independence of advice provided to government.

It is a stated purpose per section 1(1) of the *Public Service Act* "To ensure that the public service of Ontario is non-partisan, professional, ethical and competent." This document aims to provide several examples of government activities that may have contravened at least the spirit of the *Public Service Act*. The majority of the examples relate to the Ministry's direct or informal reliance on OPG in developing or advising on policy related to nuclear emergency planning in the Province of Ontario.

That said, ethical behaviour within the public service requires reflecting upon the impact of decisions, especially where the public interest objectives of the government may be influenced by private interests. Greenpeace wishes to better understand what, if any, processes are in place to safeguard or mitigate the potential for OPG's private business interests to impact government decision-making and the relationship between the Ministry and non-industry actors such as Greenpeace.

Direct Reliance on OPG staff

The Auditor General of Ontario's 2017 report observed that the Ministry's responsibility for nuclear emergency response requires it to have expert staff able to provide the government "…with independent and objective advice." However, the Auditor conversely noted that the Ministry had failed to fill key positions and relied instead on a "…network of retired nuclear power company staff and a nuclear consulting group." In 2015, the Ministry even relied on staff paid directly by a nuclear company.[1]

The Auditor concluded that: "This type of arrangement could pose a risk to EMO's [Emergency Management Ontario] objectivity" and recommended the Ministry "use independent nuclear expertise at all times to assess nuclear risks, plans and response strategies." In response, the Ministry agreed with the Auditor's concerns and recognized "…the need for independence and clarity in its arrangements with the nuclear power companies."[2]

Despite this, it has come to Greenpeace's attention that the Ministry has continued to rely on nuclear company staff to carry out its responsibilities for nuclear emergency response. According to his LinkedIn profile, OPG employee Jim Coles has apparently been "On loan from OPG to support [the] development of the Provincial Nuclear Emergency Plan" since July 2017. Mr. Coles was OPG's Director of Emergency Management and Fire Protection from 2012 to 2015.

As OPG's Director of Emergency Management and Fire Protection, Mr. Coles chaired the committee in 2013 that developed Canadian Standards Association Group standard N1600, *General requirements for nuclear emergency management programs.* Notably, CSA standards are developed using a consensus-based process among industry stakeholders and government agencies. This means that OPG or Bruce Power can block the adoption of any proposed standards that may conflict with their financial interests. The standard was also developed without public consultation. Notably, the standard subsequently became a standard against the PNERP was re-assessed and updated.

Thus, OPG has had privileged access to influence the scope of revisions to PNERP through Mr. Coles. Outside of government OPG has been able to influence CSA Standard N1600 in 2013 and now inside the Ministry through Mr. Coles' apparent secondment to assist with the development of the 2017 PNERP. Greenpeace encourages the Ministry to clarify Mr. Coles present role and responsibilities in government as well as what procedures have been put in place to mitigate the potential influence of his employer.

Informal Reliance on OPG staff

Through documentation obtained through Freedom of Information legislation, Greenpeace has noted that Ministry staff have shown a tendency to informally rely on OPG staff for advice on technical matters. This is an indication that the Ministry lacks sufficient staff with technical expertise to make technical assessments independently.

[1] Auditor General of Ontario, Annual Report, Chapter 3, Section 3.04 – Emergency Management in Ontario, December 2017, pg. 253.
[2] Ibid., pg. 254,

The glaring example which best illustrates this informal reliance on OPG staff occurred after Greenpeace, the Canadian Environmental Law Association (CELA) and Durham Nuclear Awareness (DNA) met with Madeleine Meilleur, the Minister of Public Safety and Correctional Services, in August 2013. The meeting was initiated due to concerns the organizations raised during Canadian Nuclear Safety Commission (CNSC) hearings on OPG's application to continue operating the Pickering nuclear station in May 2013. The Ministry's inadequate oversight of nuclear emergency preparedness was a focus of discussion during these hearings.

Also raised at the hearing, were findings from OPG's most recent risk assessment for the Pickering nuclear station. This assessment found that an accident leading to a large radiation release was much more likely than previously thought. Indeed, in the 1990s the Royal Society of Canada (RSC) recommended that the government put in place "…detailed emergency planning should be done for accidents resulting from a credible series of events which could occur with a probability of approximately 10^{-7} /reactor year."[3] Risks assessments at the time showed accidents meeting this criteria did not lead to large radioactive releases. However, the risk assessment published by OPG in 2013 found major accidents would meet the criteria proposed by the Royal Society of Canada for detailed planning.

Unfortunately, Greenpeace has found no evidence showing that Ministry has independently reviewed the significance of the aforementioned risk studies before or after our meeting with the Minister. On the contrary, correspondence obtained through Freedom of Information shows that, in response to a request from the Minister, Ministry staff asked OPG to provide their analysis of the issue (see Attachment 2). Based this, Greenpeace is deeply concerned that the issues it has raised with the Minister have in effect been dealt with by OPG. In Greenpeace's view, this exemplifies how the lack of independent expertise within the Ministry has lead to possible unfair treatment of stakeholders by the public service.

Notably, Minister Meilleur committed to hold a public consultation on nuclear emergency response during the August 2013 meeting. However, this public consultation did not occur until May 2017. According to other documents acquired through Freedom of Information, the Ministry continued to consult behind closed doors with OPG and other industry stakeholders on possible changes to the PNERP throughout this period.

OPG's Organizational Interests in the PNERP Consultation

Greenpeace is concerned that OPG's private interests may have influenced the timing and scope of Ministry's 2017 public consultation on nuclear emergency preparedness.

As noted, Minister Meilleur committed to hold a public review on nuclear emergency response in 2013, but the consultation did not occur until 2017. The adequacy of the province's emergency preparedness was also a focus of the CNSC's review of OPG's application for five-year operational license for the Pickering nuclear station. This licence expires in July 2018 and will be reviewed this summer.

[3] I W.R. Bruce et al, *Report to the Ministry of the Environment and Energy concerning two technical matters in the Provincial Nuclear Emergency Plan,* Royal Society of Canada & Canadian Academy of Engineering, November 1996, pg. 33.

According to documents obtained through Freedom of Information, OPG was concerned any further delay in updating Ontario's nuclear emergency response plans before the CNSC's relicensing hearings could lead to regulatory sanction by the Commission. In an internal document detailing risks to its licence application, OPG observed:

> There is a tight schedule for the Province to have the updated PNERP approved by Cabinet by the end of 2017, before the Spring 2018 election and Part 1 Hearing. There is a risk that, if the PNERP is not updated and approved in time by the current Cabinet, it will be significantly delayed beyond the 2018 PNGS licence expiry date and will raise questions about the robustness of off-site emergency preparedness around Pickering. These issues could threaten Pickering relicensing and result in hold points and/or a shorter licence term <10 years.[4]

To mitigate these risks, the document states that OPG was "…engaged at senior levels to provide appropriate support and consultation."[5] As earlier noted, OPG's former Director of Emergency Management and Fire Protection is currently "on loan" to the Ministry to assist with revisions to the PNERP. Mr. Coles secondment may be one of the actions taken to reduce the risk of regulatory sanction by the Commission.

Also of significance is that the City of Toronto requested the government extend the public consultation period "to September 30, 2017 in order to allow municipalities and citizens to provide meaningful input."[6] Although the province provided a two week extension to the consultation, it meant that Toronto Council was unable to consider emergency planning issues due to council holidays over the summer break.

OPG's internal enterprise risk assessments also indicate it was concerned by the cost implications of the province deciding to put in place emergency plans to address more severe accidents. Since Fukushima, Greenpeace and other organizations have argued from a public safety perspective that it would be prudent to prepare accidents leading to large radioactive releases.

In a document entitled *Failure to Obtain a Longer Term Licence Renewal for Pickering,* OPG describe the cost impacts on the company if the government decided to strengthen public safety:

> In 2016, the CNSC advised the OFMEM to consider more severe accidents in the update to the PNERP, which may result in potential changes to the planning basis. These changes may include new protective requirements and expansion of the emergency plan requirements for Pickering. New protective requirements may result in the need for modifications to Pickering that could have cost implications for operating the station to 2024. Changes to the emergency plan requirements may entail expanding the evacuation zone and potassium iodide pill distribution. This may impact the public's

[4] OPG, Risk Registry – Pickering Relicensing 2018, May 31, 2017, FOI # 17-048, pg. 393.
[5] Ibid.
[6] MM31.31, Request for Extension of the Government of Ontario's deadline for comments on its Discussion Paper on nuclear emergency preparedness - by Councillor Neethan Shan, seconded by Councillor Paul Ainslie, July 4, 2017.

perception of nuclear and could affect Pickering's longer term license application.[7]

In Greenpeace's view, the aforementioned extracts from OPG's planning and enterprise risk documents show the company had clear motivations to both limit public consultation and to prevent the government from preparing for more severe nuclear accidents. In Greenpeace's view, OPG has a clear private interest in minimizing public safety.

Considering that OPG's private interests conflict with Ministry's public safety mandate, Greenpeace requests clarification on what steps were taken to safeguard Ministry objectivity of government operations before and during the 2017 PNERP public consultations.

Ensuring the Competence of the Civil Service: Adequate Funding

Over the past decade, it has become apparent to Greenpeace that the Ministry is understaffed and neither able to fulfill new planning requirements put in place since Fukushima nor the public's expectation for transparency and open government.

Greenpeace is concerned that the Ministry may be made more vulnerable to the influence of OPG and other private interests due to a failure to both maintain sufficient independent expertise and anticipate future staffing needs. This speaks to whether the Ministry has made adequate effort to ensure the public service is "competent" as statutorily required under Section 1(1) of the *Public Services Act.*

As the Auditor General observed in her 2017 report, the government expects nuclear power companies to cover the full cost of managing its nuclear emergency management program. In 2015, the Ministry received $750,000 from reactor operators. The Auditor observed that the Ministry could provide no basis demonstrating how this amount was determined.[8]

Notably, Cabinet Documents from 1987 show that the government of the day estimated the cost of nuclear emergency response to be approximately $396,600 annually.[9] When adjusted for inflation, this equals approximately $730,000 in 2015 dollars – effectively the same amount cited by the Auditor.

This indicates that the Ministry may have simply lost track since the Chernobyl disaster of the basis for its resource requirements. It also suggests that the Ministry has not been regularly forecasting its staffing needs and adjusting its funding requests from reactor operators.

Requirements for nuclear emergency response have changed significantly since the 1986 Chernobyl disaster. For example, the province is now expected to participate regularly in emergency exercises at each of Ontario's nuclear stations. Public expectations regarding transparency, public consultation and open government have also evolved. For example, the

[7] Freedom of Information Request 17-048, pg. 403

[8] Auditor General of Ontario, Annual Report, Chapter 3, Section 3.04 – Emergency Management in Ontario, December 2017, pg. 253.

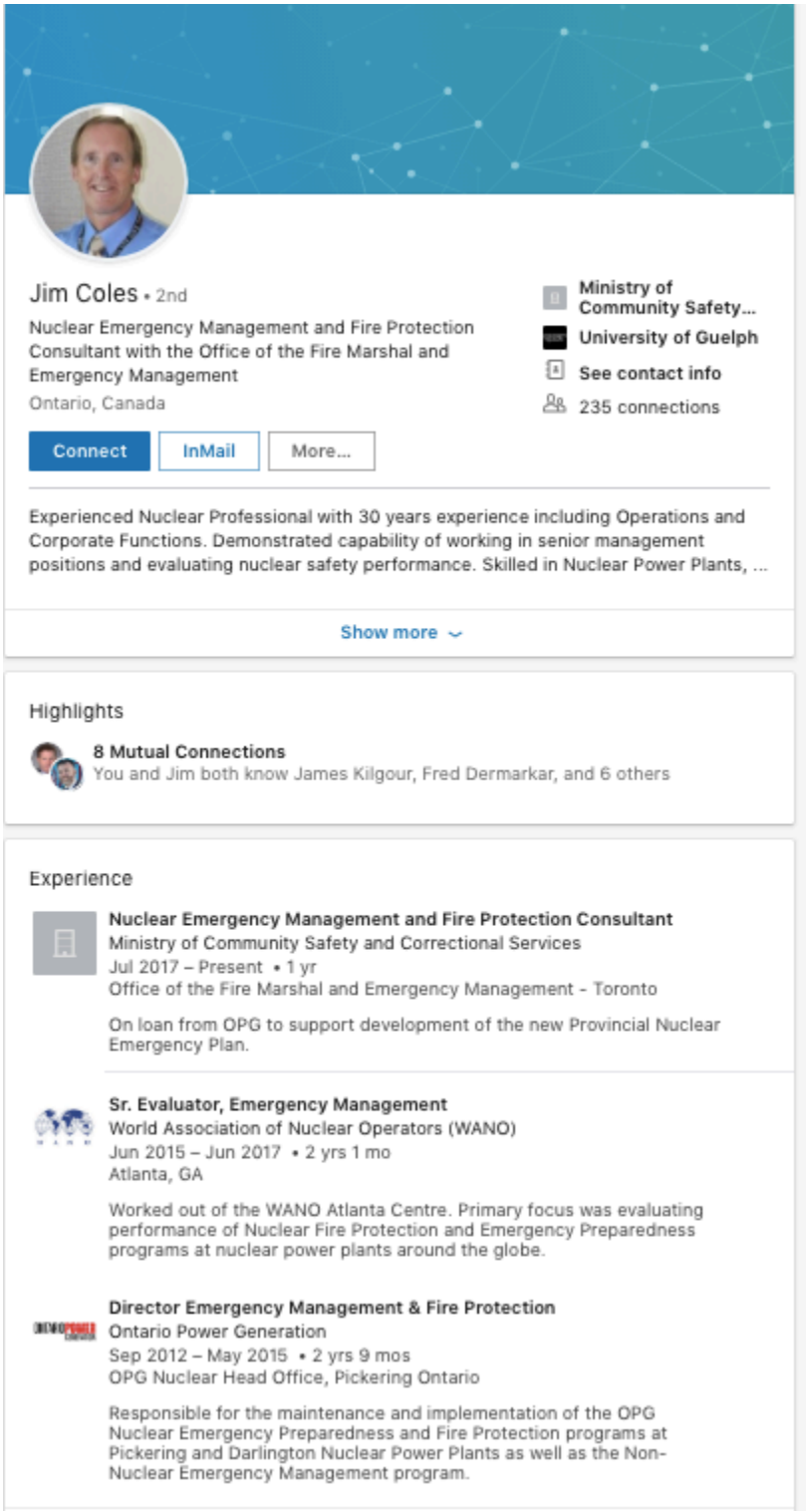
[9] Solicitor General, *Cabinet Submission – Chernobyl Accident Report, Annex C – Resources for Nuclear Emergency Planning*, February 19, 1987, pg. 8.

2017 PNERP has new calls for regular public consultation and government transparency. These all have impacts on staffing requirements.

In Greenpeace's view, the Ministry increases the likelihood that OPG's private interests may inappropriately taint government decision-making by failing to anticipate and resource its staffing needs. Doing so results in the Ministry's over reliance on direct support from nuclear companies. This not only undermines the Ministry's independence, but the competency of the public service.

Attachment 1

Below is a screenshot of Jim Coles LinkedIn Profile. Last Accessed June 12, 2018.



Jim Coles • 2nd

Nuclear Emergency Management and Fire Protection Consultant with the Office of the Fire Marshal and Emergency Management

Ontario, Canada

Ministry of Community Safety...

University of Guelph

See contact info

235 connections

Connect | InMail | More...

Experienced Nuclear Professional with 30 years experience including Operations and Corporate Functions. Demonstrated capability of working in senior management positions and evaluating nuclear safety performance. Skilled in Nuclear Power Plants, ...

Show more

Highlights

8 Mutual Connections

You and Jim both know James Kilgour, Fred Dermarkar, and 6 others

Experience

Nuclear Emergency Management and Fire Protection Consultant

Ministry of Community Safety and Correctional Services

Jul 2017 – Present • 1 yr

Office of the Fire Marshal and Emergency Management - Toronto

On loan from OPG to support development of the new Provincial Nuclear Emergency Plan.

Sr. Evaluator, Emergency Management

World Association of Nuclear Operators (WANO)

Jun 2015 – Jun 2017 • 2 yrs 1 mo

Atlanta, GA

Worked out of the WANO Atlanta Centre. Primary focus was evaluating performance of Nuclear Fire Protection and Emergency Preparedness programs at nuclear power plants around the globe.

Director Emergency Management & Fire Protection

Ontario Power Generation

Sep 2012 – May 2015 • 2 yrs 9 mos

OPG Nuclear Head Office, Pickering Ontario

Responsible for the maintenance and implementation of the OPG Nuclear Emergency Preparedness and Fire Protection programs at Pickering and Darlington Nuclear Power Plants as well as the Non-Nuclear Emergency Management program.

Attachment 2

The screenshot below shows correspondence between Ministry staff and OPG. In August 2013, Greenpeace, the Canadian Environmental Law Association (CELA) and Durham Nuclear Awareness (DNA) met with the Madeleine Meilleur, the Minister of Public Safety and Correctional Services. Following the meeting Ministry staff asked OPG to clarify the concerns we raised with the Minister instead of carrying out its own independent assessment.

From: LAWRENCE Paul -NUCLEAR
Sent: Tuesday, September 17, 2013 1:53 PM
To: 'dave.nodwell@ontario.ca'
Cc: KHAWAJA Ghulam -NUCLEAR; COLES Jim -NUCLEAR; GREGORIS Carol -NUCLEAR; LORENCEZ Carlos -NUCLEAR; BURGER Dave -NUCLEAR; ELLIOTT Mark -NUCLEAR; MANLEY Robin -NUCLEAR; DERMARKAR Fred -NUCLEAR
Subject: RE: Urgent: EMO RESPONSE REQUESTED: CELA/GP
Attachments: Pickering NGS B Probabilistic Risk Assessment.pdf

Importance: High

Mr. Nodwell:
The attached file provides background on the recently completed Pickering NGS-B PRA and its part in the relicensing of Pickering.

If this doesn't meet your needs, please contact me by E-mail or by phone at 289-314-6734. Please note that I it may not be easy to contact by phone over the next couple of days as I will be in Ottawa at meetings with the CNSC.

Paul Lawrence
Manager – PRA Department
Ontario Power Generation

From: Nodwell, Dave (MCSCS) [mailto:Dave.Nodwell@ontario.ca]
Sent: Friday, September 06, 2013 3:20 PM
To: KOZAK Deborah -NUCLEAR; COLES Jim -NUCLEAR; BELL Rick -NUCLEAR
Cc: Bleyer, Kathy (MCSCS)
Subject: CELA/GP

Hi folks – I am hoping one of you may be able to help me out. At the Pickering re-licencing hearing Greenpeace referenced that OPG had developed two severe accidents scenarios that had a high likelihood of occurring (or words to that effect). Could you shed some light on this for me? Kathy and I are not aware of what this is referencing.

Unfortunately, it was raised with our Minister by CELA recently and I have been tasked with getting an explanation.

Many thanks

Dave Nodwell
Manager, Planning and Exercises
Office of the Fire Marshal and Emergency Management
Office: 416 212 3464
BB: 647-278-8844

Attachment 3

GREENPEACE

June 1, 2018

Minister of the Environment and Climate Change
200 Scacre-Coeur Boulevard, 2nd Floor
Gatineau, Quebec
K1A 0H3

Re: Comments on the Consultation Paper on Approach to Revising the Project List

To whom it may concern,

Thank you for the opportunity to comment on the government's *Consultation Paper on Approach to Revising the Project List: A New Impact Assessment System*.

The government has proposed the *Impact Assessment Act* ("IAA") to replace the 2012 version of the *Canadian Environmental Assessment Act* (CEAA 2012). In Greenpeace's view, *CEAA 2012* was a step backward in environmental protection. The projects designated for environmental assessments under *CEAA 2012* are insufficient. Significant projects were excluded that could harm our progress towards sustainability. It should not be considered an appropriate baseline for the *IAA*

The *Consultation Paper* proposes an approach for determining what projects will be considered under *IAA.* Greenpeace is concerned by that the proposed approach is insufficiently clear and too narrow to encourage government authorities to take actions that encourage Canada's transition toward sustainable development. In short, the proposed approach is inadequate to compensate for the erosion of environmental protection caused by *CEAA 2012*.

In this submission, we focus on nuclear projects that should be included in an updated project list. Specifically, any approach to designating projects should ensure that the following projects are assessed:

- All new reactor construction projects, including proposals to build experimental Small Modular Reactors (SMR);
- Reactor life-extension proposals, which were excluded from reviews under *CEAA 2012;* and,
- Reactor decommissioning plans and waste management strategies.

For broader comments on the *Consultation Paper,* please note that Greenpeace Canada supports the comments filed by the Canadian Environmental Law Association (CELA).

Factors for assessing a project's contribution to sustainability

The *Consultation Paper* states that under the *IAA* will focus on whether a project's adverse effects are in the public interest. This public interest determination will be guided by a "project's contribution to sustainability".

If properly implemented, this could be a significant advancement from how environmental assessments of nuclear projects were carried out under *CEAA 2012* and 1992. Unlike other industries, nuclear projects have not undergone sustainability assessments under *CEAA 2012* and 1992. As discussed in previous submissions on the propose *IAA*, environmental reviews of nuclear projects have always focused strictly on the effects of projects instead of their contribution to sustainability. The *Consultation Paper* states it wishes to move away from this approach.

However, the government should consider that the strict focus on effects in reviews of nuclear projects was occurring even before CEAA 2012. This was due to the influence of the Canadian Nuclear Safety Commission (CNSC), which has admitted it lacks the knowledge and understanding of sustainability.[1]

For example, even the Joint Review Panel that assessed Ontario Power Generation's (OPG) proposal to build up to four new nuclear reactors at the Darlington nuclear station did not undertake a sustainability assessment. The panel acknowledged that such an assessment would put "…greater emphasis on the legacy in terms of waste legacy and nuclear liability. To achieve this, an environmental assessment would need a framework that looks at the sustainability of a project starting with the preparation of the EIS Guidelines, at minimum."[2]

It goes without saying that a more meaningful consideration of long-lived radioactive waste and the transfer of accident liability to Canadians would have impacted the conclusions and recommendations of the Darlington environmental assessment. This failure of government authorities to apply sustainability assessments to nuclear projects even under *CEAA 1992* shows why the government's updated project list must provide clear directions to government authorities related to nuclear projects.

The *Consultation Paper* lists five factors for qualifying projects within federal jurisdiction for impact assessments. These factors are: magnitude, geographic extent, timing, frequency, duration and reversibility.

Nuclear projects cause significant adverse effects in terms of their duration and reversibility. The two most obvious examples are radioactive waste and reactor accidents. Radioactive waste is long-lived and effectively irreversible. The environmental and social impacts of a nuclear accident similar to Chernobyl or Fukushima are also long-lived and irreversible.

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[1] Canadian Environmental Assessment Agency, Deep Geological Repository for low and intermediate level radioactive waste project, Joint Review Panel, Transcripts, Thursday, October 3, 2013, Volume 15, pgs. 182 - 185.

[2] Joint Review Panel Environmental Assessment Report: Darlington New Nuclear Power Plant Project, June 2011, Pg. 140.

As seen with the Joint Review Panel review of OPG's proposal to build new reactors at Darlington, the impact nuclear waste or reactor accidents on Canada's shift to sustainability have not been assessed in Canadian environmental reviews. This requires the government to state clearly that such impacts be assessed under the IAA and its supporting regulations.

Government authorities – specifically the Canadian Nuclear Safety Commission - have used two inappropriate reasons to exclude accidents and radioactive waste from environmental reviews: the asserted low probability of nuclear accidents and the existence of policies for the management of radioactive waste.

In a ruling on whether CEAA was correctly applied to the proposal to build new reactors at Darlington, Justice Russell found that excluding major accidents from environmental reviews deprives the public and decision-makers of information needed to assess the desirability of a project. He observed:

> "On policy grounds, it is logical that such scenarios [such as Fukushima or Chernobyl] should be considered by political decision-makers, because once again they seem to engage mainly question of "society's chosen level of protection against risk" that will be difficult for a specialized regulatory to assess with legitimacy."[3]

Frequency is included as a factor to be considered in determining projects under the IAA. Greenpeace requests the government clarify that a precautionary approach be used to the application of frequency if foreseeable consequences may be irreversible or of long duration.

The existence of the *Nuclear Liability and Compensation Act*, which transfers the financial risks of nuclear accidents from reactor operators and suppliers to Canadians, shows that the impacts of nuclear accidents are within federal jurisdiction. Considering that Canadians shoulder the risk of nuclear accidents, the federal government should ensure the public is provided full information on the potential impact of such accidents before projects are allowed to proceed.

Recommendation: The federal government's approach to determining projects under the *IAA* should state that any reactor project covered by the *Nuclear Liability and Compensation Act* will undergo an assessment under the *IAA.*

As noted, government authorities have also cited the existence of policies to justify ignoring the potential environmental and social impacts of radioactive waste production from environmental reviews.

Durham Region, which hosts ten reactors at the Darlington and Pickering nuclear stations, has stated that the current environmental assessment process has not properly assessed the impacts of radioactive wastes. Durham Region contends that the exclusion

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[3] Greenpeace Canada v. Canada (Attorney General), 2014 FC 463 (CanLII), Paragraph 331

or radioactive waste assessment from environmental reviews has lead to an unacceptable situation where reactor operators and the federal government have been allowed to postpone decisions on the long-term management of radioactive waste.

As noted, reactor operation creates radioactive waste. Nuclear waste is an adverse effect in that is both long in duration – arguably permanent for some types of waste – and irreversible. Thus, the government should make clear in its regulations that any project proposal that may create long-lived radioactive wastes will undergo a review under the *IAA.*

In line with this, Durham Region has asked the government to ensure that: "Approval of a nuclear project should require a proponent to have a nuclear waste disposal solution available before the new/refurbished nuclear reactors are permitted to operate."[4] Durham Region's recommendation is aligned with a key objective of sustainability assessment; that is, to discourage decisions that will result in the transfer of adverse effects or risks to future generations.[5]

Recommendation: The federal government's approach to determining projects should state that any reactor project that creates long-lived radioactive wastes will undergo an assessment under the IAA. This includes both proposals to extend the operational lives of existing stations and the construction of new reactors, including prototype Small Modular Reactors (SMR).

Decommissioning and Waste Management

The government should ensure the *IAA's* supporting regulations appropriately compensate for the historic failure of government policies to openly consider the adverse effects of radioactive waste production. This includes new strategic impact assessments of decommissioning and radioactive management plans.

Nuclear stations were built in Canada without environmental reviews. They were built and allowed to operate based on the promise that the radioactive wastes produced by the station would be sent to other off-site waste management facilities. The station's community acceptance – what we now call "social licence" - has been based on this promise.

After several decades, it has become evident to some reactor host communities that radioactive waste may remain on-site for extended period of time if not permanently. For example, the Pickering nuclear is set to close, but there is still no approved off-site plan for the long-term management the long-lived radioactive wastes produced by the station.

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[4] Garry Cubitt (Chief Administrative Officer, Durham Region) to Kevin Blair (Major Projects Management Office, Natural Resources Canada), "Environmental and Regulatory Reviews Discussion Paper," August 28, 2017.

[5] Gibson, R.B. (2006). Sustainability assessment: Basic components of a practical approach. Impact Assessment and Project Appraisal 24(3): 170-182.

In light of this, Durham Region has requested to be financially compensated for the long-term storage of radioactive wastes at the Pickering and Darlington nuclear stations.[6] From the perspective of environmental protection, the foreseeable possibility that reactor sites may unintentionally evolve into long-term radioactive waste storage facilities raises questions of whether such plans should be proactively assessed under the *IAA.*

Citing the lack of clarity related to reactor decommissioning under the updated *IAA*, Durham Region has asked the Canadian Nuclear Safety Commission (CNSC) "….to commit that the Region of Durham will be formally notified of and engaged in the decision-making process with respect to conducting an EA for PNGS decommissioning since our community will be directly affected for decades by the decommissioning process."[7] Greenpeace supports the inclusion of reactor decommissioning on the project list.

In summary, Greenpeace urges the government to ensure that its approach to determining projects under the IAA considers the historic weaknesses in the government's oversight of radioactive waste production. Without clear direction from the federal government, decommissioned nuclear stations may inadvertently become long-term radioactive waste storage facilities without appropriate reviews of how to mitigate potential adverse effects. It is thus imperative that strategic impact assessments of decommissioning be included on the *IAA's* project list.

Recommendation: The federal government's approach to determining projects under the *IAA* should include the decommissioning plans of existing nuclear stations, including contingency plans for long-term waste management at the site.

Conclusion

Thank you for this opportunity to comment on the government's *Consultation Paper* on the government's approach to revising the project list under the proposed *Impact Assessment Act*. Please don't hesitate to contact me if you require any clarifications.

Truly,

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[6] Durham Region, *Submission from the Regional Municipality of Durham regarding the application of Ontario Power Generation (OPG) to renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station (PNGS) from September 1, 2018 to August 31, 2028*, May 7, 2018, pg. 14.
[7] Ibid, pg. 16.