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Submission from Northwatch

Exposé oral

Mémoire de Northwatch

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

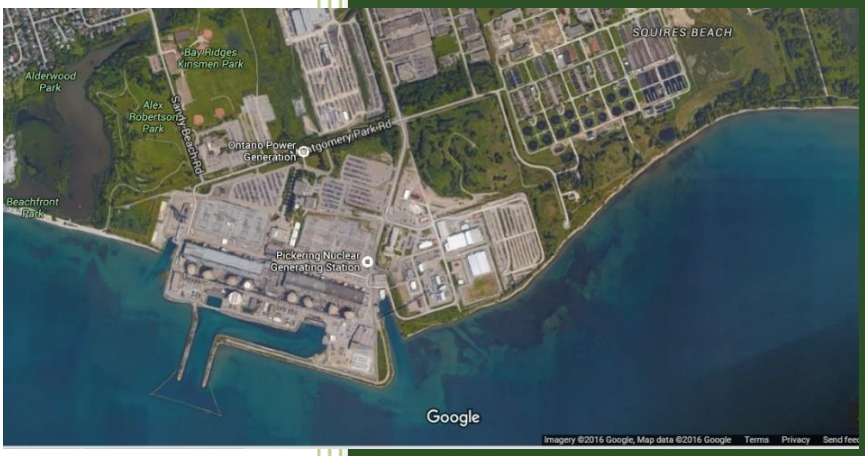
Audience publique de la Commission – Partie 2

Juin 2018

Canada

Comment on Ontario Power Generation's Application for the renewal of its Nuclear Power Reactor Operating Licence (PROL) for the Pickering Nuclear Generating Station (NGS)

Ref. 2018-H-03



Submitted to the Canadian Nuclear Safety Commission by

Northwatch

5/7/2018

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1. Context

Ontario Power Generation (OPG) has applied to the Canadian Nuclear Safety Commission (CNSC) to renew its Nuclear Power Reactor Operating Licence (PROL) for the Pickering Nuclear Generating Station (NGS) for a period of 10 years.[1]

Pickering Nuclear Generating Station (NGS) is on the North shore of Lake Ontario, in the City of Pickering, and is located 32 km northeast of downtown Toronto and 21 km southwest of Oshawa. Owned and operated by Ontario Power Generation Incorporated (OPG), the Pickering NGS consists of eight CANDU pressurized heavy water reactors and their associated facilities. Of the eight reactor units, Units 2 and 3 are in a "safe storage state", meaning they are shut down. The operating reactors have a nominal electrical output of 515 MWe (megawatt-electric) for Pickering Units 1, 4 and 516 MWe for Pickering Units 5-8. The Pickering nuclear site also contains the Pickering Waste Management Facility which is licensed separately under a Class 1B waste facility operating licence.[2]

In 2010, OPG announced that Pickering NGS would continue operation until 2020, at which time the station would shut down. On June 28, 2017, OPG informed the CNSC that all Pickering units would cease commercial operation on December 31, 2024. The current power reactor operating licence for Pickering NGS expires on August 31, 2018. OPG has requested the licence to be renewed for a period of 10 years. Currently, OPG is expressing an intention to cease commercial operation of Pickering NGS on December 31, 2024, but is requesting a licence period that would include: continued commercial operation until December 31, 2024; a stabilization phase (post-shutdown defueling and dewatering) lasting approximately 3-4 years; and the beginning of what OPG terms "safe storage". CNSC staff have accepted OPG's suppositions in their draft license and Licence Conditions Handbook, with an expectation that OPG will confirm the final shut down date for each unit by December 31, 2022. [3]

[1] CNSC Notice of Public Hearing, dated September 29, 2017, Ref. 2018-H-03
[2] CMD 18-H6, page 1
[3] CMD 18-H6, page 1

2. Northwatch's Interest

Northwatch is a public interest organization concerned with environmental protection and social development in northeastern Ontario. Founded in 1988 to provide a representative regional voice in environmental decision-making and to address regional concerns with respect to energy, waste, mining and forestry related activities and initiatives, Northwatch has a long term and consistent interest in the nuclear chain, and its serial effects and potential effects with respect to northeastern Ontario, including issues related to uranium mining, refining, nuclear power generation, and various nuclear waste management initiatives and proposals as they may relate or have the potential to affect the lands, waters and/or people of northern Ontario.

Northwatch is interested in Ontario Power Generation's proposed approach to nuclear waste management and containment over various time frames. Ontario Power Generation's proposed approach to the long term management low and intermediate level radioactive wastes generated by their operations, including refurbishment and decommissioning of their nuclear generation units, is to transfer these wastes to a facility on the eastern shore of Lake Huron for incineration, compaction and storage and – as per the intent of OPG – deep burial in a repository proposed for less than one kilometre from the shore of Lake Huron. OPG's intent with respect to the highly radioactive irradiated fuel waste generated by OPG owned and operated reactors is to transfer responsibilities for these highly radioactive and chemically toxic waste materials to a third party, namely the Nuclear Waste Management Organization, of which Ontario Power Generation is the majority shareholder. The Nuclear Waste Management Organization is currently investigating large areas of northern Ontario as possible burial locations for nuclear fuel waste.

Northwatch's key areas of focus in this licencing review are:

- OPG's management of the irradiated fuel under the PROL license, including while in the irradiated fuel bays and during transfer of the irradiated fuel from wet to dry storage,
- OPG's preparedness for the transition from preliminary decommissioning plan to actual decommissioning planning, and
- OPG's overall approach to the management of the radioactive wastes it generates, over various time frames.

Throughout OPG's operations, Northwatch is interested in how operations and operational decisions affect fuel conditions, waste volumes, and waste attributes.

3. Ontario Power Generation's Licence Application

The following comments on the Ontario Power Generation's application to renew the licence for the Pickering Nuclear Power Operating License are based on a review of the OPG Application, OPG's Commission Member Document and the CNSC staff Commission Member Document, and various related documents provided upon request by OPG or the CNSC, or from other sources. Comments with respect to the management and security of the irradiated fuel, including during transfer of the irradiated fuel from wet to dry storage, OPG's preparedness for the transition from preliminary decommissioning plan to actual decommissioning planning, and OPG's overall approach to radioactive waste and its management form the larger part of Northwatch's submission, followed by comments on a number of additional issues related to this license application.

3.1 Irradiated Fuel Management at the Pickering Nuclear Generating Station

Irradiated fuel – also known as spent fuel or high level nuclear waste – is a demanding legacy of Ontario's decision to use nuclear power reactors to generate electricity, and is perhaps the most demanding of the many highly hazardous radioactive materials that are created at nuclear generating stations. Fuel enters the reactor core as uranium, but exits as highly radioactive mix of hundreds of different radioactive isotopes, many of which have to be kept isolated from the environment into perpetuity.

That long journey of the irradiated fuel into eternity begins with the fissioning of the uranium inside the reactor core, and at the Pickering Nuclear Generating Station that is where trouble begins, with a history of fuel defects that have the potential to further exacerbate the already large challenge of long term management of nuclear fuel waste.[4] With the transfer of the irradiated fuel bundles into the large pools of water in the reactor station, trouble continues, with the Irradiated Fuel Bays at Pickering notable for their multiple failures and significant contribution to

[4] See Northwatch 13-H2.123 Section on fuel defects; excerpts in Appendix 3

groundwater contamination, the full extent of which Ontario Power Generation has refused to disclose.[5]

In the Pickering Nuclear Generating Station, the irradiated fuel bays are located between reactor buildings 2 and 3 in Pickering A, and between reactor buildings 6 and 7 in Pickering B. In addition, an auxiliary fuel bay, associated with Pickering A, is located southwest of Unit 4.[6]

Figure 1 from OPG CMD 18-H61 depicts "main structure" of the Pickering Nuclear Generating Station, minus the irradiated fuel bays or waste management facilities.

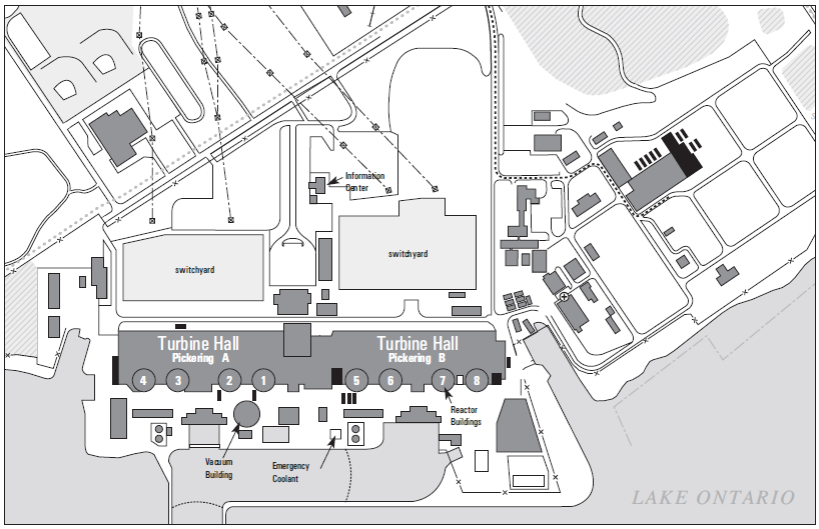


Figure 1 - Site map illustrates the main structures of the Pickering nuclear station

Irradiated Fuel Bay Performance

Despite achieving the rather puzzling summation that "the Irradiated Fuel Bays and supporting equipment are generally in good condition" in the executive summary[7] of one of the PSR safety reports, the irradiated fuel bays were overall documented to be operating sub-optimally, at best, throughout several documents, including the PSR reports. Perhaps most troubling is that the irradiated fuel pools at Pickering have been performing poorly for over a decade and even at this late date Ontario Power Generation appears lapse in their maintenance and unable to address fundamental operating issues.

Since at least as far back as 2007, there has been leakage from the irradiated fuel bays. Despite multiple instances of being directed by the CNSC to correct issues associated with the IFBs, Ontario Power Generation continues to lag in repairs and in addressing IFB issues, and continues

[5] See subsection of 3.4 on Groundwater, email from OPG to Northwatch 05-03-2018
[6] Page 118 of 641, Period Safety Review, *OPG Document No. P-REP-03680-00005 R01*
[7] PICKERING NGS PSR2 SAFETY FACTOR 2 REPORT – ACTUAL CONDITION OF STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY, March 2017, Page 6

to carry a backlog of maintenance issues related to the fuel bay structures and supporting equipment. Examples include:

- uncompleted repairs to liner cracks
- at the time of the PSR, the seismic capacity of the current spent fuel basket stacking had not been documented; OPG has advised Northwatch by email that these issues have been addressed, but provided no supporting documentation of the issues having been resolved
- issues identified with associated equipment and availability of parts; specifically, in at least one case OPG had no spare parts available for IFP supporting equipment

In addition, there is a lack of clarity around the degree to which enhancements to water makeup/cooling capability for the Irradiated Fuel Bays have been completed. While OPG's documentation includes general references to makeup water enhancements, we were unable to clearly establish that this important safety measure was actually fully in place with respect to the irradiated fuel bays in particular.

The Period Safety Review reported that there was a corrective maintenance backlog across all bays and systems, described the problems with irradiated fuel bay leakage as chronic and noted equipment deficiencies associated with all three irradiated fuel bays.[8]

In particular, the review noted that leakage from IFB-B to the collection sumps has been increasing since 2007. Reportedly, the intended strategy is to maintain the water levels in the collection sumps below groundwater level so that any leakage is inward and not outward. Northwatch questions this selection of strategies; in our view a decade-old leak warrants direct attention, rather than makeshift management.

Still not vulnerable to any accusation of putting the best foot forward, OPG is described in the same section of the PSR as having an "intention to mitigate leaks from the P058 IFB, and its collection sumps, to minimize the leak rate and to reduce the potential for environmental risk." The review indicates that these action plans are not complete; we would further question whether they are adequate.

[8] OPG Document No. P-REP-03680-00005 R01, PSR SF2, Section 4.1.4 REVIEW TASK #4 - SPENT FUEL STORAGE FACILITIES

Additional safety, maintenance and / or operational issues with the irradiated fuel bays and associated systems include:

- seismic capacity of the current spent fuel basket stacking arrangements in the Pickering IFBs not being adequately documented
- seismic capacity of the Pickering 058 IFB fuel conveyor not being adequately documented[9]

One of the results of the above noted failures is the contamination of groundwater.

As noted in the CNSC staff's "Environmental Assessment Report"[10], groundwater samples from 140 sampling points that were collected and analyzed for tritium in 2016 showed that "in many cases, concentrations have remained nearly constant or decreased ... In a few cases, tritium concentrations increased unexpectedly over recent years." Northwatch would prefer to have a more quantified summary of results in order to better understand the comparative ratios between the "many" and the "few", particularly given that the "many" included both the constant levels and the decreased levels. However, the information provided by CNSC staff, despite its presumably purposeful vagaries, is sufficient to signal that there is a serious problem - groundwater being contaminated by tritium (and potentially other radionuclides) - and the problem is at best not being resolved, and quite possibly is worsening.

In more than one instance the CNSC staff or the OPG documents emphasize that there is no off-site migration of tritium impacts. The Commission is encouraged to consider three factors:

- the site is relatively large, meaning that the groundwater contamination can be of considerable extent even while on-site
- there are indications of tritium in the perimeter groundwater wells, so the claims of no off-site migration of tritium is difficult to accept[11]
- in this age of impending closure and eventual decommissioning, if OPG is ever successful in its bid for a license to abandon the site, there will be no "off-site" rationale available

[9] OPG Document No. P-REP-03680-00005 R01, PSR SF2, Section 4.1.4 REVIEW TASK #4 - SPENT FUEL STORAGE FACILITIES
[10] Environmental Assessment Report: Ontario Power Generation Inc. Pickering Nuclear Generating Station – PROL 48.00/2018 Licence Renewal, CNSC, March 2018
[11] For example, as reported in ONTARIO POWER GENERATION Environmental Emissions Data for Pickering Nuclear Q3 2017

Irradiated Fuel Bay Capacity

The Period Safety Review flags additional issues around storage capacity in the irradiated fuel bays at the Pickering Nuclear Generating Station. According to the PSR, "the irradiated fuel bays are designed to have a storage capacity for all the irradiated fuel accumulating over approximately 12 station-years."

The Nuclear Waste Management Organization estimates typical annual production at the Pickering station to be 21,700 bundles per year; actual average production rate between 2013 and 2017 was 17,295 bundles per year. Using an approximate median of 20,000 bundles per year, the capacity statement in the PSR would mean that the design storage capacity is 240,000 bundles. In contrast to that, the 2018 license application states that the maximum quantity of irradiated fuel in the reactor cores are 9,360 bundles in Pickering A, Units 1 and 4 and 18,240 bundles in Pickering B, Units 5 through 8 (for a total of 27,600; assuming an 18 month residency, throughput over 12 years would be 220,800). According to the Nuclear Waste Management Organization's most recent fuel waste projection, there were 399,703 irradiated fuel bundles in the Pickering irradiated fuel bays as of June 2017.

Year	Fuel Waste in IFBs	Fuel Waste in DSCs	Total Fuel Waste
2017	399,703	337,114	736,817
2016	399,655	319,266	718,921
2015	400,440	300,977	701,417
2014	403,303	280,726	684,029
2013	406,315	261,324	667,639
Source: Nuclear Waste Management Organization's annual "Nuclear Fuel Waste Projections in Canada" updates for 2013 through 2017.			

The PSR goes on to state that "there is sufficient bay space available provided movement to dry storage is performed in a timely manner".

As was conveyed to the Commission during the 2017 license review for the Pickering Waste Management Facility, Northwatch has concerns about the timeliness of OPG's transfer of irradiated fuel from wet to dry storage at the Pickering station, and about OPG's level of effort in this area.

As discussed during the PWMF license review, the Pickering waste processing facility (to process waste from wet to dry storage) is limited to a processing rate of 50 Dry Storage

Containers per year. With 384 bundles per dry storage container, this results in a maximum of 19,200 bundles being processed per year, i.e. the processing rate is below what the NWMO describes as the typical fuel waste production rate of 21,700 bundles per year, and only slightly more than with Pickering's average production rate over the last five years of 17,295 bundles per year (processing rates ranged from 84 to 93% of processing capacity over the last five years).

If the processing rate were to keep with production until shutdown, the backlog of fuel bundles in wet storage would require twenty years to process at the current rate of processing 50 containers per year. However, OPG does have plans to replace the processing facility with a new facility that will have double the capacity, but does not plan to begin construction of that new processing building until 2024. On the face of it appears that the construction schedule (and construction date of 2024) is divorced from any sense of urgency in terms of moving the irradiated fuel from wet to dry storage. This is consistent with what appears to be a system-wide malaise in this regard. Northwatch did request that the CNSC direct OPG to re-examine their processing schedule and construction timeline for the DSC processing building replacement to identify opportunities to accelerate the removal of the irradiated fuel from wet storage as a license condition for the PWMF, but the CNSC also appears to be unconvinced of the need to act expediently on the matter of improving security for the irradiated fuel currently in wet storage at the Pickering NGS.

Year	Fuel Waste in IFBs	Transfer to DSC	Actual Production	% of Processing Capacity
2017	399,703	17,848	17,896	93
2016	399,655	18,289	17,504	91
2015	400,440	20,251	17,388	90
2014	403,303	19,402	16,390	85
2013	406,315	17,889	17,296	90
Source: Nuclear Waste Management Organization's annual "Nuclear Fuel Waste Projections in Canada" updates for 2013 through 2017. Processing capacity at Pickering is 19,200 bundles per year.				

From the numbers available, as presented above, Northwatch has been unable to conclude that there will be sufficient capacity in the irradiated fuel bay going forward, even under "normal" operating conditions.

Three different scenarios elevate the question of irradiated fuel bay capacity to an even higher level of urgency. Those scenarios are:

- Impingement on fuel bay capacity

- Upset conditions which require rapid emptying of reactor core
- Upset conditions which require return to the irradiated fuel bay the contents of one or multiple dry storage containers

According to a Period Safety Review report the first scenario – impingement of fuel bay capacity – has already occurred and is ongoing at present. As reported:

> *Recent field walkdowns have identified unusable space in each of the bays. Unusable bay space is defined as basket/module spaces in each bay that are inaccessible, damaged, filled with non-fuel material, filled with scrap fuel and/or non-fuel matter, and any space that cannot be occupied by used intact irradiated fuel. According to an assessment performed following the walkdowns[12], the number of bundles that cannot be optimally stored represent the amount of fuel stored in approximately one reactor in each of IFB-B and AIFB, and approximately three reactors for the IFB-A. As per the Bay Storage Assessment at End of Life,[13] given the unavailable space in the bays, and DSC and ITB transfer rates, there are challenges to meeting the Bay Storage requirements for EOL core defueling.[14]*

In addition to the concerns noted above about the impacts the limited capacity in the fuel bays may have on end-of-life core defueling, more immediately this limited capacity caused by impingement on usable space in the fuel bays by unspecified clutter raises direct concern about the ability of PNGS to respond to situations where there is an emergency need – caused by an accident or some malfunction – to empty the reactor core of fuel. Similarly, it raises a direct concern about the ability of PNGS to respond to situations where there is an emergency need – caused by an accident or some malfunction – to empty one or more dry storage containers of irradiated fuel.

Northwatch appreciates that we do not have all of the information related to this situation; in fact, we are frustrated and made impatient by this brief section of one portion of the Period Safety Review report being the sole source of information available about this significant concern.

REQUEST: The Commission should require a detailed report on the circumstance of significant portions of the irradiated fuel bays being unusable, including a history and timeline, a detailed description of the cause of this reduced capacity (i.e. the reason that the spaces are unavable, such as being damaged, filled with non-fuel material, filled with scrap fuel and/or non-fuel matter, or other causes), and an action plan and timeline for the remedying of this impingement.

[12] (P-REP-34400-00002) [66]
[13] (P-REP-34400-00003) [67]
[14] ***122*** *of* ***641*** *OPG Document No. P-REP-03680-00005 R01*

Irradiated Fuel Transfers

In general, the Periodic Safety Review raised a number of concerns about the performance of the irradiated fuel bays and of their associated equipment and systems; taken as a whole, the PSR leaves Northwatch – and we would presume the Commission as well – with serious questions about the robustness of OPG's operations at Pickering, including and particularly in relationship to the management of the irradiated fuel.

For example, the PSR safety report that examines spent fuel handling outlines the effect of aging on a number of system components, including:

- The equipment used to latch, lift, transport and deposit irradiated fuel baskets / modules has read the end of its life and requires a major overhaul to "fix issues encountered on a regular basis"[15]; a plan to replace the equipment was noted, with a general timeline of 2018, which was some time out from the time of the issue being identified
- There are age related maintenance issues associated with the transport truck
- There were numerous aging related issues identified related to the conveyer, the unloader pulley, and other equipment, as well as issues around the availability of replacement parts and to maintenance backlogs

In Northwatch's review of the Pickering Waste Management licence application in 2017, we raised with the Commission safety concerns related to the transfer of irradiated fuel waste.[16] The first of these, a concern about the hazard associated with the drop of a dry storage container (DSC) appears even larger, given the deficiencies itemized in the Period Safety Review with respect to maintenance and equipment reliability associated with the irradiated fuel bay. While the PSR did not directly identify this as a concern, the relationship between the issues identified and the security of the fuel transfers (or lack thereof) is evident.

Ontario Power Generation's 2016 PWMF license renewal application[17] stated that the total mass of each DSC was approximately 60 Mg empty and approximately 70 Mg when loaded with 384 spent fuel bundles. Such a heavy load, if dropped, could cause considerable damage to the spent

[15] 4.1.4.5 SPENT FUEL HANDLING, 123 of 641 OPG Document No. P-REP-03680-00005 R01
[16] 17-H5.13 Submission from Northwatch
[17] Section 1.5.1 of Attachment 3 to the PWMF licence application, 2016

fuel bundles in the storage racks and/or to the spent fuel pool itself. Spent fuel bundles could be damaged from direct impact by the dropped DSC or indirectly through overheating if the dropped DSC causes water inventory to be lost. A 2015 submission to the CNSC by Beyond on the application to renew the reactor operating license for the Darlington Nuclear Generating Station discussed in some depth and detail the risks associated with have loads dropped into waste storage pools.

Ontario Power Generation's (OPG's) 2015 Interim Status Report on Darlington, Pickering and Western Waste Management Facilities (W-REP-00531-00009-R000) dated May 27, 2015, identified four events during the reporting period that it classified as having "*Maximum Reasonable Potential for Harm*." One event involved a mobile crane incident and a second event involved a dropped load. This operating experience is consistent with that provided in a report (NUREG-1774)4 issued by the NRC in July 2003 about the experience between 1968 and 2002 at U.S. nuclear plant with crane failures. Twenty-eight percent of the failures involved cranes used to move fuel bundles.

Dropping a DSC into a spent fuel storage pool at Pickering is a credible event with adverse consequences. In our 2017 submission Northwatch did not contend that the DSC drop risk was unduly elevated, but advised the Commission that we were are unable to conclude that this hazard is being adequately managed. In light of the newer information about performance issues at the PNGS, this concern becomes more elevated.

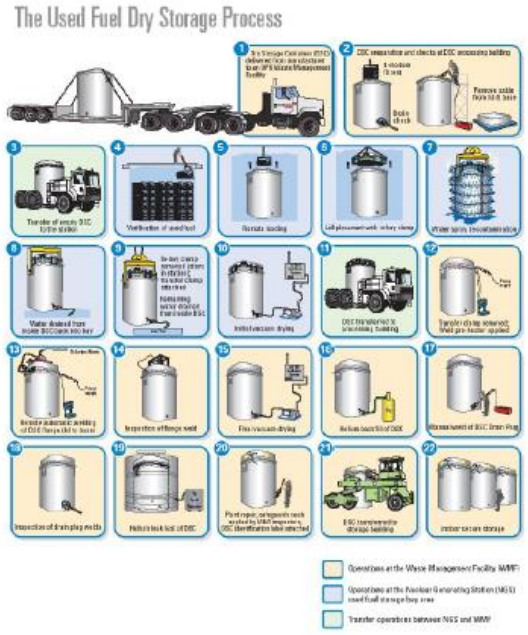
REQUEST: Require a third-party investigation of the degree to which OPG's maintenance back log and overall underperformance with regard to systems, equipment associated with the Irradiated Fuel Bays and irradiated fuel might potentially increase the risk of fuel drop due to aging or maintenance related equipment failure.

A second issue Northwatch raised with the Commission in 2017 related to the potential for sabotage of the irradiated fuel in dry storage containers as it transferred from the irradiated fuel bays to the processing building. This issue is equally pertinent to the review of the license application for the PNGS.

Once out of the spent fuel pool, the primary hazard associated with a DSC loaded with irradiated fuel bundles is an act of malice that breaches the integrity of the container(s) and releases radioactivity.

Figure 1 is OPG's illustration showing the steps involved in placing a loaded DSC into a storage building. Step 11 transports the DSC from the refueling bay to the processing building. The lid is held on the DSC base with a transfer clamp during this movement. Steps 12 through 20 are performed in the processing building. The lid is welded to the DSC base in Step 13. The DSC drain plug is welded shut in Step 17.

Figure 1



Source: Figure 5 from Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016

Figure 2

Source: Figure 1 from Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016

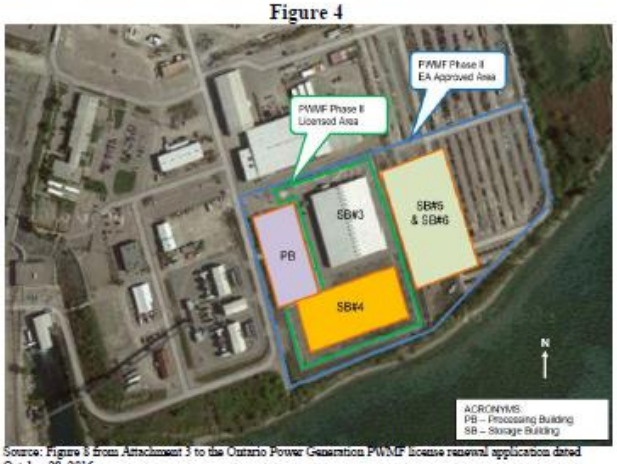
Figure 2 shows an aerial view of the Pickering site. The eight reactor units and the PWMF Phase I Licensed Area are on the left side within a protected area featuring access control and

The sealed DSC is transported to a storage building in Step 21.

Figure 3

Source: Figure 2 from Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016

Figure 4



Source: Figure 3 from Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016

other security measures. The PWMF Phase II Licensed Area is on the right side within a second, separate protected area as described in section 2.12.1 of Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016.

Figure 3 shows the PWMF Phase I Licensed Area. The structure labeled (2) in the picture is the current processing building where Steps 12 through 20 are performed.

Figure 4 shows the PWMF Phase II area indicating where the proposed new processing building will be located.

Currently, all DSC transfers outside of protected areas (i.e., moving across the unprotected area between the protected area around the PWMF Phase I Licensed Area and the protected area around the PWMF Phase II Licensed Area) are made after the DSC is sealed. The lid and the drain plug are welded in place.

Under the proposed plan, DSCs will be transported across unprotected areas before being sealed. Given that it would be easier to remove a transfer clamp holding a lid onto a DSC base or tamper with the unsecured drain plug on a DSC than to breach a sealed DSC, the proposed plan introduces a sabotage vulnerability, unless additional security measures are employed during DSC journeys between protected areas.

Section 1.5.7 of Attachment 3 to the Ontario Power Generation PWMF license renewal application dated October 28, 2016, stated that a "security escort will continue to be used for each transfer" of a DSC. The nature of this security escort is not described. Testing or other qualification standards applied to this security escort are not described either. As with the DSC drop safety hazard, we did not contend that the DC drop risk was unduly elevated (although our level of concern has been re-sparked by PSR findings), but we remain unable to conclude that this hazard is being adequately managed.

REQUEST: Undertake a specific review of the exposure of irradiated fuel to the risk of malevolent acts or acts of sabotage during transfer in an unsealed condition between protected zones.

3.2 Decommissioning Pickering

Northwatch retained Edinburgh Energy and Environment Consultancy to undertake an evaluation of Ontario Power Generation's (OPG's) state of readiness for the transition from preliminary decommissioning planning to actual decommissioning planning and eventual implementation of decommissioning plans, including identification of appropriate information measures and monitoring regimes. That report, in its entirety, is found as Appendix 1 to this submission. Northwatch adopts its findings and recommendations, and summarizes those here in the body of Northwatch's submission.

Decommissioning Planning Background

PNGS is the fourth oldest nuclear station in North America and one of the largest. It was originally designed to operate for 30 years, but it is now 47 years old. It is surrounded by more people (2.2 million within 30 km) than any other nuclear station on the continent. Pickering's operating costs per kWh, exclusive of fuel costs, are higher than those of any other nuclear station in North America.[18] It is probably one of the single largest sources of atmospheric tritium in the world. The consequences of a serious accident at Pickering would be much more severe due to its location in a dense urban area compared to what occurred in Fukushima, which is in a largely rural location. PNGS has had a checkered operational history with numerous performance issues. In 1997, four Pickering A reactors were shut down for repairs after a scathing safety review. In the end, only two units were eventually re-started (Units 1 and 4) with the other two "A" reactors mothballed.[19]

OPG now says that it wants the Pickering Plant to continue operating until 2024. This is a reversal of its earlier position that the plant should close no later than 2020. There is no question that the earlier deadline makes much more sense for both performance and safety reasons.

The current plan is to operate PNGS until the end of 2024. The licence term between 2024 and 2028 is intended to allow for activities such as removal of fuel and water.

[18] Clean Air Alliance 7th March 2016 http://www.cleanairalliance.org/pickering-highest-cost-nuclear-plant-in-north-america/
[19] See for example http://www.cleanairalliance.org/fukushima/

This section of Northwatch's submission will focus on post closure decommissioning, with the aim of evaluating OPG's preparedness for the transition from preliminary decommissioning planning to actual decommissioning planning and eventual implementation of decommissioning plans.

OPG's Preliminary Decommissioning Plan

The PDP says the plan "is an ongoing process" which "will evolve over time". Its objective is to demonstrate the technical and financial feasibility of decommissioning PNGS. The scope of the PDP does not include decommissioning the Pickering Waste Management Facility (PWMF). There is a separate PDP for this because it is licensed separately.

The licence application explains that PNGS plans to continue commercial operation and shut down all units by December 31, 2024. The Preliminary Decommissioning Plan assumes that PNGS A and PNGS B will be shut down in 2022 and 2024 respectively, and a deferred decommissioning strategy has been selected.

After the units in PNGS are permanently shut down, OPG will defuel and dewater (remove the tritiated heavy water) the reactors and make all the necessary modifications to the Structures, Systems and Components (SSCs) to prepare for the subsequent Safe Storage Stage. Service systems no longer required to support the operation of the station will be removed. The aim is to safely transition from electricity generation to a Safe Storage State (SSS).Activities which are required to place the units in the safe storage state are described in the Stabilization Activity Plan (SAP).

Defuelling will be completed using existing fueling machines and is expected to take a minimum of 6 months per unit to complete. All fuel removed from the units will be transferred to their respective Irradiated Fuel Bays (IFBs) for storage and monitoring.

Dewatering involves draining the heavy water from the moderator system and then flushing with light water flush to reduce residual contamination. The heat transport system will be drained with

residual heavy water removed using a vacuum dry process. Heavy water removed from the reactor systems will be placed in a storage facility.

For planning purposes, it is assumed that dismantling of the station won't start until 30 years after the start of Safe Storage. During this Safe Storage phase, the station will be monitored and maintained as deemed necessary while the radiation levels in the reactor systems decay. A Storage and Surveillance Plan (SSP) will be prepared to detail arrangements and activities that will be conducted in support of Safe Storage.

Work that will need to be carried out during the Safe Storage phase includes continuing to monitor spent fuel in the IFBs and transferring it to dry storage casks after a 10-year storage period; (the Pickering Waste Management Facility (PWMF) will need to continue receiving, packaging, processing and storing dry storage containers) storing upwards of 3,000 Mg of tritiated heavy water; spent resin storage and handling systems; removing intermediate level transitional waste generated prior to the stations entering Storage with Surveillance will also continue into Safe Storage.

Obviously the IFBs will remain in operation through the first part of the Safe Storage period until all the used fuel has been transferred to PWMF. Once all of the fuel (including all damaged fuel) has been removed from the IFBs, various work can be carried out such as draining the IFBs and disposing of the water in accordance with the applicable regulatory requirements; and removing ion exchange resins for disposal.

The PDP highlights the fact that a used fuel disposal facility will not be available until 2043 at the earliest.

Planning for Dismantling & Demolition and Site Restoration

Towards the end of the Safe Storage stage, OPG will make detailed preparations for the dismantling of the remaining systems, structures, and the disposal of the waste. A transition plan will be developed for the orderly progression from Safe Storage to Dismantling & Demolition operations.

Dismantling & Demolition operations will be designed to accomplish the required tasks while maintaining all doses ALARA. The procedures will also address the continued protection of the health, safety, security of workers, the public and the environment.

This planning stage will include preparing plans for decontamination, dismantling and demolition, and disposal activities; preparing detailed procedures for the decontamination of Structures, Systems and Components (SSCs) and procurement of decontamination equipment, which may include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices, components for the scarification and spalling of concrete surfaces, chemical applicators, etc.; evaluating the options for the disposal of large radioactive components such as steam generators, calandria, etc.; developing and revising the emission monitoring program; developing a waste management plan; determining the transport and disposal container requirements for radioactive materials and hazardous wastes including the requirements for shielding and stabilization of the waste; assessing decontamination methods such as chemical cleaning, electro polishing, mechanical abrasion or melting which may be used to decontaminate scrap metal.

The PDP says that international experience suggests that scoping and characterization surveys should be performed as early as possible, prior to the start of Dismantling & Demolition.

Acceptable site radiological release criteria or clearance levels for decommissioning waste will be developed prior to Dismantling & Demolition.

Other work required to prepare for dismantling includes: completing a comprehensive site characterization survey to determine extent of site contamination and conducting radiation surveys of work areas and major components.

Detailed Decommissioning Plan

A Detailed Decommissioning Plan is expected to be ready approximately five years prior to the commencement of the Dismantling & Demolition operations – so not until around 2050. The DDP will present a complete description and schedule of work and an estimate of expected costs.

Nor will we know, until the DDP is published, the criteria (clearance levels) that will be used to determine if material is suitable for uncontrolled release from the site and the clearance levels that will be used to determine if the site itself is suitable for release from further regulatory control. An acceptable site radiological release criteria or clearance levels for decommissioning waste should be discussed and decided upon much sooner than that.

Decommissioning Planning Summary

The PDP assumes that PNGS A will close in 2022 and PNGS B will close in 2024, but no commitments are made. If the operating licence is granted, both dates could be much closer to 2028.

Despite the fact that IAEA Guidelines stipulate that the preferred decommissioning strategy should be immediate dismantling, however, the IAEA's preferred option assumes a waste "disposal" option is available, and in this instance it is not. OPG has chosen to delay dismantling by 30 years. (See Annex A for more on this)

Spent Fuel will continue to be stored in the Irradiated Fuel Bays for ten years and then transferred to the Pickering Waste Management Facility for dry storage, where its adjacency and exposure to Lake Ontario leave it vulnerable to malicious attack. Eventually the spent fuel is expected – by OPG - to be moved off-site to a used fuel facility at some as yet undecided location. This disposal facility is not expected to be available until 2043 at the earliest, and, of course, there is no guarantee it will ever be available.

Decontamination, Dismantling & Demolition, and disposal activities will be planned towards the end of the 30 year Safe Storage period. The techniques mentioned could very likely lead to further dilution and dispersal of radioactive waste, as opposed to concentration and containment. Techniques for "decontamination" could include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices. Decommissioning is likely to generate large volumes of lower level radioactive wastes which could mean a high likelihood of pressure from the industry to introduce unacceptable waste management techniques, such as increasing the amount of wastes going to landfill.

There could also be pressure to lower standards for site remediation, in an attempt to reduce the volumes of waste generated and their associated disposal costs, and to release vacant land onto the market sooner than might otherwise be possible With significant quantities of potentially valuable metals arising from decommissioning, there could also be pressure to allow more recycling which would result in increases in discharges of liquid radioactive waste into the environment, as a consequence of the decontamination processes for metals.

The dilution and dispersal of radioactive contamination throughout the environment could result in increasing public exposures adding to the burden of radiological risk that is carried by society.

High levels of tritium are likely to continue being released into the atmosphere even after the reactors' closure, including potentially from the concrete structures. There is no acknowledgement of this in the PDP.

Recommended Alternate Approach

Towards a Democratically Accountable Decommissioning Plan

1. A democratically accountable decommissioning plan requires a plan for meaningful interaction with stakeholders and in particular the local population.
2. The first thing which a decommissioning plan developed by meaningful interaction with stakeholders is likely to decide is that a commitment should be made not to use decommissioning as an excuse to increase discharges of radioactivity into the environment.
3. Secondly stakeholders would need a clear indication of the inventory of radioactive waste, including spent fuel, firstly assuming PNGS is closed in 2018 as originally planned compared to an estimated inventory assuming PNGS continues to operate until 2024. OPG's application to operate PNGS longer that originally stated when there is no facility yet available to accept the spent fuel raises ethical questions which demand further discussion. For instance, although the UK Government's Committee on Radioactive Waste Management (CoRWM) recommended geological disposal as the best available option it made clear that its "…*recommendations are directed to existing and committed waste arisings … the political and ethical issues raised by the creation of more wastes are quite different from those relating to committed – and therefore unavoidable –wastes*". [20] And in September 2007 CoRWM said: "*To justify creating new spent*

[20] Managing our Radioactive Waste Safely, CoRWM, July 2006. Para 26
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/294118/700_-_CoRWM_July_2006_Recommendations_to_Government_pdf.pdf

fuel from an ethical point of view, there must be a management solution that is ethically sound, not just least bad. … In short, a solution that is ethically acceptable for dealing with existing spent fuel is not necessarily a solution that would be ethically acceptable for dealing with new or changed materials."[21]

4. In order to draw up a full inventory of radioactive waste there will need to be a complete scoping and site characterisation carried out. The PDP agrees that this should be performed as early as possible.

5. There should be a wide public debate about clearance levels before further plans are made for dismantling & demolition and site restoration. Options for controlled contaminated metals smelting as a means of volume reduction, and controlled reuse (e.g. within the radioactive waste management industry) could be discussed.

6. Similarly there should be a discussion about clearance levels for soil and methods of site remediation.

7. A plan for monitoring before, during and after decommissioning and dismantling will need to be agreed and implemented.

8. To meet the environmental principles detailed above further production of nuclear waste should be stopped as soon as possible. Practically speaking this means no new reactors and no refurbishments.

9. Existing waste should be concentrated and contained rather than diluted and dispersed. Stakeholders might want to know, for instance, if it is really necessary to flush the moderator system with light water – thus creating more tritiated water which will need to be managed.

10. Existing waste should be managed as close to the site of production as possible. Practically speaking this would involve storage of waste, in facilities which can contain the waste on the site where it is produced. It means no incineration of waste and no decontamination which involves discharges into the environment and no depositing of waste on landfills.

11. Particular attention will need to be paid to tritium emissions. The reactors are likely to continue emitting large quantities of tritium even after they have been closed down.

REQUEST: Subject OPG's decommissioning planning process to a strategic environmental assessment under the (currently under revision) federal environmental impact assessment laws to assess various options using a science and evidence based method that is transparent and participatory.

[21] Re-iteration of CoRWM's Position on Nuclear New Build, Gordon Mackerron September 2007. Page 3 http://webarchive.nationalarchives.gov.uk/20130717140311/http://corwm.decc.gov.uk/assets/corwm/pre-nov%202007%20doc%20archive/doc%20archive/tier%202%20(7)%20-%20implementation/tier%203%20-%20implementation%20advice/2162%202%20-%20corwm%20position%20on%20new%20build%20reiterated.pdf

3.3 OPG's Approach to Radioactive Waste Management

Radioactive Waste Management in OPG's Licence Application

Two sections of Ontario Power Generation's application for a ten year license extension address radioactive wastes, albeit both in a limited and superficial way: the first is a one page generalized discussion under a section titled "The Case for Continued Safe Operation of the Pickering NGS" in the main body of the application, and the second is in the discussion of Safety Control Areas. Some additional information is included in the Supplementary filing from OPG.

Ontario Power Generation's claims do not coincide with Northwatch's own experience of OPG when seeking information, such as one found in the license application. OPG self-describes as follows:

> Other activities that protect the public and workers from exposure to radiation are the careful packaging and transport of radioactive materials, and the safe management of radioactive waste. OPG is transparent about these activities, providing information to local communities and the public on station performance so that interested or concerned individuals can verify for themselves that levels remain low.[22]

This has not been Northwatch's experience. In every license review over the last several years Northwatch has requested and been refused information which Northwatch had carefully identified as being pertinent to the area of their review. In this most recent instance, the case of the PNGS PROL extension application, OPG did convene a helpful stakeholders meeting and did respond to several information requests, but rejected others, including requests for groundwater monitoring results and followup on inspection results, both of which did not include any information related to security (Northwatch accepts that there may be some information that is not released into the public realm for security reasons, but is of the view that in almost every instance of this at least partial information can be provided).

Section 2.4.5, the first section on waste management in the application document, is of pamphlet style simplicity, providing minimal information about the waste, its volumes, characteristics or management requirements, and no information about the hazards associated with radioactive wastes. While there is no mention of hazards associated with radioactive wastes, the section does

[22] POWER REACTOR OPERATING LICENCE WRITTEN SUBMISSION 2018, page 44

go on to identify cleaning agents, grease, oil, waste fuels and acids, as well as batteries as hazardous.

Adequacy of Information Provided

The General Nuclear Safety and Control Regulation Requirement (herein "General Regulations") sets out in Section 3 that:

1) *An application for a licence shall contain the following information: […]*
   (j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed, or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;

In the license application matrix provided as part of their application, OPG indicates that the required information can be found in Section 2.11 (of the application), Appendix A, and Enclosure 1. Northwatch examined each of these documents, and did not find the required information.

The most promising of these, Section 2.11, discussed waste issues in the context of the Safety Control Area on Waste Management. The section included several waste related topics, albeit quite superficially. Those topics include:

- Waste Minimization, Segregation and Characterization
- Waste Storage and Processing
- Interim Dry Storage of Irradiated Fuel
- Decommissioning Plans
- Preparation for Management of Waste from Transition to Safe Storage State
- Applicable OPG Documents

Nowhere in these sections are volumes of radioactive wastes that will be generated through continued operation described. There is an extremely generalized description of waste reduction efforts for low level radioactive wastes, an extremely generally stated list of wastes to be shipped to the Western Waste Management Facility, and an extremely brief and general statement of the objective of interim dry storage of irradiated fuel. There is no reference to intermediate level

wastes, and there are no statement of the volume of any of the categories of radioactive wastes that will result for "the activity to be licensed", i.e. continued operation.

Appendix A and Enclosure 1 similarly do not contain any reference to intermediate level wastes, and there are no statement of the volume of any of the categories of radioactive wastes that will result for "the activity to be licensed", i.e. continued operation.

These minimalist description clearly do not make the requirements of the regulation – cited above - to "name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed, or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste".

Management of Nuclear Fuel Waste

As Northwatch observed during the review for the Pickering Nuclear Generating Station PROL in 2013 and again during the review of the Pickering Waste Management Facility license review in 2017, Ontario Power Generation regards dry storage on-site of irradiated fuel (high level radioactive waste) as an interim measure, and intimates via their assertions in the preliminary decommissioning plan that the irradiated fuel waste will be transferred off-site.[23]

The assumption of off-site transfer relies on the perpetuation of the illusion that a convincing technical case has been made for geological disposal, and the ability of a geological repository – even as part of a multi-barrier approach – to effectively isolate and contain the wastes for a sufficient period of time. In point of fact, there is currently no operating geological repository for used fuel, and for more than 30 years several countries have been depicting themselves at various times as being on the brink of operating a geological repository for used fuel, and yet none have, despite decades of effort and extremely large sums of public funding.[24] Canada, for one, is now further away from "opening day" of a geological repository than the nuclear industry considered it to be twenty years ago. The U.S. equally so.

[23] OPG CMD 17-H5.1 Submission from Ontario Power Generation Inc. re. PWMF, pages 85-96

[24] "Wasting the Future", Australia, 2006 http://www.energyscience.org.au/FS08%20Radioactive%20Waste.pdf

As outlined in several international reports, there are a host of technical deficiencies of the geological disposal concept, and numerous unresolved technical issues, including the longevity of the containers, the availability of rock formations of the size and quality required, and the reliability of all of the computer predictions being made, to name a few.[25]

In addition to not having made the technical case for the geological "disposal" of used nuclear fuel, neither the OPG nor their alternate *persona* the NWMO have made the social case for geological disposal.

This was a matter of great significance during the 10 year federal review of Atomic Energy of Canada Limited's geological disposal concept. In the end, the Panel concluded that broad public support was necessary in Canada to ensure the acceptability of a concept for managing nuclear fuel wastes and that the AECL concept for deep geological disposal had not been demonstrated to have broad public support, and the concept did not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel wastes.[26]

In Canada, there are many indications that social acceptability will continue to elude nuclear fuel waste repository proponents, as has been the subject of several academic papers.[27] While the NWMO is currently engaged in a siting process through which they intend to contract a community to become the recipient of geological repository for nuclear fuel waste – or more probably to contract to have an area outside their municipal boundaries become the recipient - the process is still in the preliminary stages (Step 3 of 9) and the outcomes are wholly unknown. To rely on such a conceptual notion as the NWMO's "Adaptive Phased Management" approach for the long term management of the nuclear fuel wastes currently in "interim storage" at the Pickering Waste Management Facility is equivalent to saying that no plan is needed whatsoever.

Ontario Power Generation acknowledges in their Preliminary Decommissioning Plan for the Pickering Waste Management Facility that there are numerous potential consequences of program failure for the NWMO, and OPG indicates that "strategies for managing such scenarios"

[25] "Rock Solid? A scientific review of geological disposal of high-level radioactive waste", Dr. Helen Wallace, GeneWatch UK, September 2010, as foundo online at http://www.greenpeace.org/raw/content/eu-unit/press-centre/reports/rock-solid-a-scientific-review.pdf

[26] Seaborn Panel Report for Nuclear Fuel Waste Management and Disposal Concept, 1998, as found online at http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=0B83BD43-1&xml=0B83BD43-93AA-4652-9929-3DD8DA4DE486&toc=show

[27] For example, see ""Nuclear Waste Management in Canada: Critical Issues, Critical Perspectives", Darrin Durant and Genevieve Fuji Johnson, 2010, details at http://www.ubcpress.ubc.ca/search/title_book.asp?BookID=299172872

will be developed in the future. Northwatch supports the development of contingency planning for the long term management of radioactive wastes. One option to be considered is extended on-site storage; see Appendix 2 for an outline of this approach.

In particular, Northwatch supports the undertaking of a strategic environmental assessment under the (currently under revision) federal environmental impact assessment laws to assess various options for the long term management of radioactive wastes in an evidence and science-based method that is participatory and transparent.

REQUEST: Subject OPG's long term management of radioactive wastes to a strategic environmental assessment under the (currently under revision) federal environmental impact assessment laws to assess various options using a science and evidence based method that is transparent and participatory.

3.4 Additional issues

Licence Period

Ontario Power Generation has applied for a ten year licence, and has "informed" the Canadian Nuclear Safety Commission of their intent to run the reactors for an additional four years, now up until 2014.

The current licence authorizes OPG to operate Pickering NGS fuel channels up to 247,000 Equivalent Full Power Hours (EFPH). OPG is seeking Commission approval to operate Pickering Units 5-8 up to 295,000 EFPH.[28] In 2013, OPG sought and was granted permission to operate Pickering units 5-8 beyond the assumed fuel channel design life of 210,000 Effective Full Power Hours (EFPH) during the next license period for what OPG termed "the incremental life extension" from approximately 2015 (210k EFPH) to approximately 2020 (247k EFPH).[29] The EFPH creep has been from 210,000 to 247,000 and now to 295,000. Where next?

As witnessed by the fuel defects that were a focus of discussion in the 2013 license review and the performance issues with the irradiated fuel bay in the current license review, aging is having significant effect on the operations at Pickering. This has serious safety considerations. Visually, it provokes the image of an elastic band being stretched – and stretched again - until it snaps.

In addition to all of the safety concerns that provide ample reason for the Commission to reject the request to run the reactors to time and a half of their design life, there is a practical one: the irradiated fuel bay is out of time.

A Condition Assessment during the Periodic Safety Review determined that Pickering 5-8 IFB (Pickering B fuel bay) will read its end of life in 2035. Reaching this date assumes that numerous mitigation measures and monitoring regimes are maintained in place in order to minimize the impacts of continuing to operate this aging and leaking fuel bay. There appears to be little reasonable ground to expect there will be any extension.

[28] *CNSC Staff CMD: 18-H6 page 2*
[29] *OPG CMD 13-H2.1]*

Issues have been discussed earlier in this submission related to IFB capacity. It is clear that there is little to no flexibility in terms of storage space in the irradiated fuel bays. With an end of life for the IFB of 2035, the required minimum of ten years in wet storage prior to transfer to dry casks, and the one to two years required to defuel the reactor core at end of operations, the math clearly demonstrates that running the reactors out to 2024 is simply not an option.

REQUEST: Reject OPG's request to operate to 295,000 EFPH and to 2024.

REQUEST: Limit the license to a five year period, with a mid-term hold point; for that hold-point, have Ontario Power Generation produce a draft framework for their development of options for shut down and closure to be reviewed as a first stage in a strategic impact assessment of decommissioning and site remediation options for the Pickering Nuclear Generating Station.

CNSC Assessment of Safety Control Areas (SCAs)

As is the case with CNSC staff reports to the Commission on licensing matters, Northwatch finds the approach used by CNSC in reporting "Safety Control Areas" to be of limited value. This approach has been a subject of comment by Northwatch and discussion between Northwatch, Commission members and CNSC staff on previous occasions.[30]

Northwatch's assessment continues to be that the Safety and Control Areas (SCA) rankings do not serve as evidence of a nuclear facility's safe operations.

Environmental Protection

Northwatch has previously commented on the CNSC's "Independent Monitoring Program" for other facilities, and noted the shortcomings with the program design and reporting, including the selection of sampling locations and targets for monitoring.[31]

[30] See, for example Northwatch submissions" Regulatory Oversight Report for Nuclear Processing, Small Research Reactor and Class IB Accelerator Facilities: 2015" and submissions and and hearing transcripts for Darlington (2015-H-04) for Bruce Power (Ref. 2015-H-02) PROL reviews in 2015

[31] See, for example, Northwatch submissions on CMD 16-M43 and Ref. 2016-H-02

As was communicated to the Commission during the review of the Pickering Waste Management Facility in 2017, Northwatch has found the IEMP reporting for the Pickering facility to be problematic; for example:

- There are a very limited number of sample points
- Sampling results are presented for only a very limited number of potential contaminants
- The sample point locations appear to be other than locations where the greatest level of exposure would be measured
- The conclusions are not supported by sufficient sampling or data

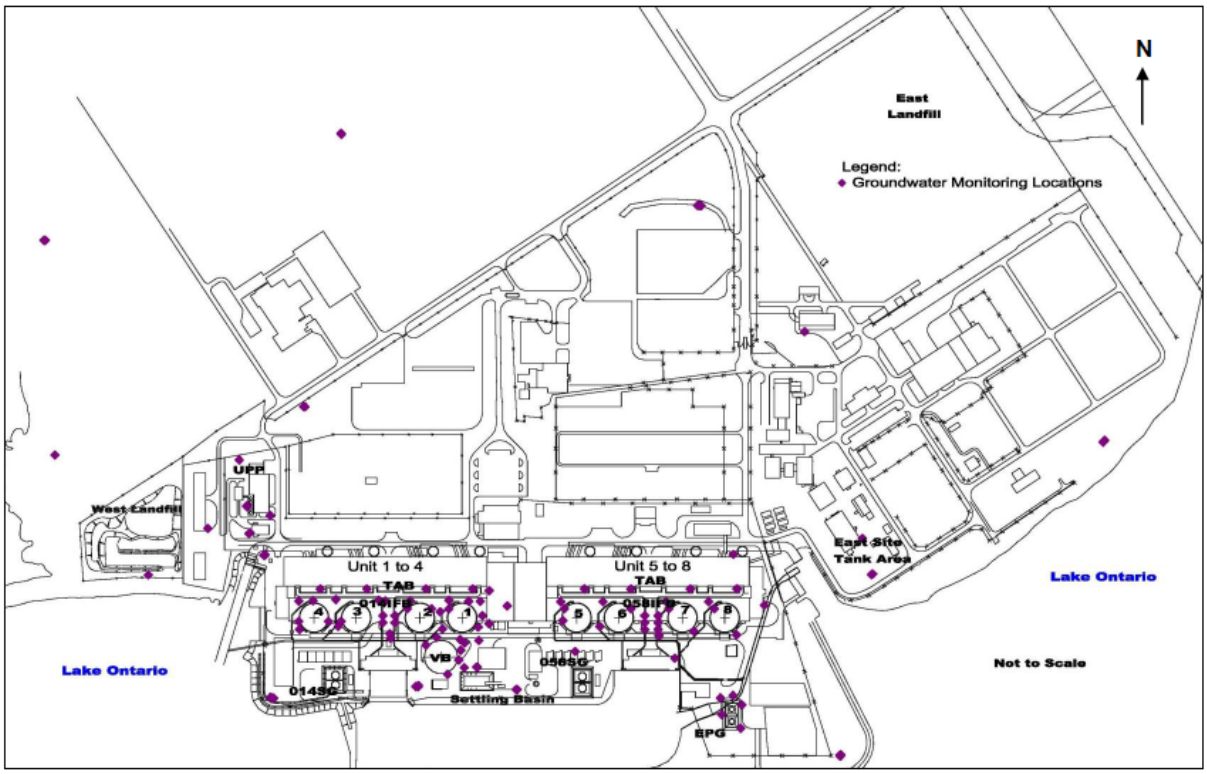
In the case of the Pickering nuclear site IEMP we raise the following specific concerns:

- There are very few surface water sampling locations, they are all on-shore, and none are immediately off-shore of the generating station and waste management facility
- There are no ground-water sampling locations / results included in the IEMP reporting
- There is a single sampling location for foodstuffs and it is approximately 14km northwest of the PNGS

Although not reported in the IEMP, OPG did disclose in documents relied upon by Northwatch during the 2017 licence review for the Pickering Waste Management Facility that the Pickering NGS site has a groundwater monitoring program in place. OPG described a 1999/2000 study was used as "background research to determine potential locations of contamination in order to accurately represent at-risk areas", but the limited number of groundwater monitoring locations is of concern.[32] In the 2017 review Northwatch noted the importance of groundwater data being publicly available.

For the current review of the Pickering Nuclear Generating Station power reactor operating license (PROL) Northwatch requested during a meeting with Ontario Power Generation that OPG OPG release groundwater monitoring results 2014-2017. OPG has reviewed and denied the request. OPG did restate to Northwatch that groundwater data for perimeter wells is available on the OPG website.[33]

[32] Page 63, Ontario Power Generation CMD:17-H5.1, 10 February 2017
[33] Email from OPG with subject line "Responses to Requests from Stakeholder Sessions", dated 2018-05-03



OPG CMD:17-H5.1_Figure 18: 2016 Groundwater Monitoring

During the 2017 licence review for the PWMF Northwatch supported the requirement that, by December 31, 2017, OPG was to conduct a gap analysis of their groundwater protection and monitoring programs, and prepare an implementation plan for meeting the requirements of CSA Standard N288.7, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*.[34] Northwatch had requested that the terms of reference for the groundwater protection gap analysis and a draft version of the resulting implementation plan for meeting the requirements of CSA Standard N288.7 be made available for public comment with a subsequent dispositioning of comments from public, government agency and First Nation commenters made public.

We have reviewed the CNSC and OPG CMDs, license application and draft license condition handbook, and find no report on this gap analysis of OPGs groundwater protection and monitoring programs or subsequent implementation plan.

[34] CNSC Staff CMD:17-H5, Page 68

There is passing mention in the CNSC staff CMD[35] that "OPG has committed to implement the … new and/or updated standards" including CSA N288.7-15 Groundwater Protection Programs, by December 30, 2020, but no followup for the directly related requirement of OPG to conduct a gap analysis and develop an implementation plan by December 2017.

The matter of groundwater protection and monitoring is extremely relevant to the review of OPG's application to renew the Pickering NGS operating license, and the absence of any reporting out on important groundwater related action items for a licensing review in the previous year is another flag that neither the management or the oversight of the Pickering site is conducted on an integrated basis.

REQUEST: The gap analysis that was to have been undertaken by OPG in 2017 of their groundwater protection and monitoring programs and the implementation plan they were to have prepared for meeting the requirements of CSA Standard N288.7, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* should be made immediately available, with a hold point on the relevant license condition be established to enable public comment prior to the license condition being finalized.

REQUEST: Groundwater monitoring data be made publicly available on at least an annual basis

[35] CNSC Staff CMD 18-H6 , Section 5.9.3.3 Proposed Improvements

4. Conclusions

Ontario Power Generation has failed to make the case for a ten year license, for an additional four years of operating the six reactors still in generating mode at the Pickering Nuclear Generating Station, or for deferring development of a detailed decommissioning plan for several decades.

As outlined in the preceding report and embedded recommendations, the Canadian Nuclear Safety Commission should deny OPG their ten year license, and instead grant them a five year license with strict timelines for preparation of a frameowork for the development and review of a strategic environmental assessment through which OPG will – in a participatory process - examine options for the prudent and precautionary shut down and phased decommissioning of the Pickering Nuclear Generating Station.

All of which is respectfully submitted on behalf of Northwatch on 7 May 2018.

Appendix 1

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Pickering Nuclear Generating Station Power Reactor Operating Licence Application August 2017

Review of Decommissioning Plans

An evaluation of Ontario Power Generation's (OPG's) state of readiness for the transition from preliminary decommissioning planning to actual decommissioning planning and eventual implementation of decommissioning plans, including identification of appropriate information measures and monitoring regimes.

Introduction

In 2015 world leaders adopted Agenda 2030 and its 17 Sustainable Development Goals (SDGs) at the United Nations. These goals represent a commitment by all countries to tackle some of the toughest global challenges including environmental sustainability. Sustainable development requires holistic approaches to economic, social, and environmental policies. But, engagement is also required from all sectors of society, and that needs vibrant, independent platforms for civil society. Goal 16 of the SDGs acknowledges this by calling for responsive, inclusive, participatory, and representative decision-making at all levels. (1)

As part of its commitments to the Open Government Partnership, the Government of Canada has promised that:

"*Canadians should have the information they need to meaningfully interact with and participate in their democracy. They should have the opportunity to make their voices heard on government policy and programs from the start. Canada should demonstrate leadership by championing open government principles and initiatives around the world*." (2)

Assessing the Preliminary Decommissioning Plan (PDP) against this commitment it can be seen that:

1. Meaningful interaction must mean more than just providing some information. Although OPG says it "*believes in open and transparent communication in a timely manner to maintain positive and supportive relationships and confidence of key stakeholders* … [and] *provides information to the public on its on-going facility activities, public and environmental impact, nuclear waste transportation program and consults with key stakeholders and the public on future planned activities, such as the L&ILW DGR and Repurposing Pickering.*" there does not appear to be any serious attempt by OPG to "*meaningfully interact*" with members of the public.

2. One way to fulfil the commitments made by the Canadian Government to the Open Government Partnership would be to introduce something similar to the concept of the Best Practicable Environment Option (BPEO) as detailed by the UK's Royal Commission on Environmental Pollution (1988). This is "*the outcome of a systematic consultative and decision making procedure which emphasises the protection and conservation of the*

environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term".[Emphasis added] (3)

3. The PDP could start this process by detailing the environmental principles upon which it is going to base the plan. Those principles detailed in Canadian Law include:

   (a) Sustainable Development;
   (b) The Precautionary Principle;
   (c) The Polluter Pays Principle;
   (d) Recognising the importance of biodiversity;
   (e) Pollution Prevention – a systematic and comprehensive approach to the challenge of identifying options to reduce or avoid the creation of pollution and waste. This could be paraphrased as "concentrate and contain – rather than dilute and disperse";
   (f) Adaptive management – a process of continuous learning anchored in the acceptance of uncertainty;
   (g) Environmental rights, intergenerational equity and public trust. (4)

In our view adhering to these principles means that an environmental radioactive waste management policy should include the following goals:

- A policy of 'dilute and disperse' as a form of radioactive waste management (i.e. discharges into the sea or atmosphere) should be rejected in favour of a policy of 'concentrate and contain' (i.e. store safely on-site);
- Any process or activity that involves new or additional radioactive discharges into the environment should be stopped, as this is potentially harmful to the human and natural environment;
- Wastes should ideally be managed on-site where produced (or as near as possible to the site) in a facility that allows monitoring and retrieval of the wastes;
- The unnecessary transport of radioactive and other hazardous wastes should be avoided;
- The idea that radioactive waste can be "disposed" of should be rejected in favour of a policy of continued management and monitoring.

Background

In August 2017, Ontario Power Generation (OPG) submitted a licence renewal application to the Canadian Nuclear Safety Commission (CNSC) requesting a 10 year licence extension for the Pickering Nuclear Generating Station (PNGS) covering the period between September 1st, 2018 and August 31st, 2028.

PNGS is the fourth oldest nuclear station in North America and one of the largest. It was originally designed to operate for 30 years, but it is now 47 years old. It is surrounded by more people (2.2 million within 30 km) than any other nuclear station on the continent. Pickering's operating costs per kWh, exclusive of fuel costs, are higher than those of any other nuclear station in North America. (5) It is probably one of the single largest sources of atmospheric tritium in the world. The consequences of a serious accident at Pickering would be much more severe due to its location in a dense urban area compared to what occurred in Fukushima, which is in a largely rural location. PNGS has had a chequered operational history with numerous performance issues. In 1997, four Pickering A reactors were shut down for repairs after a scathing safety review. In the end, only two units were eventually re-started (Units 1 and 4) with the other two "A" reactors mothballed. (6)

OPG now says that it wants the Pickering Plant to continue operating until 2024. This is a reversal of its earlier position that the plant should close no later than 2020. There is no question that the earlier deadline makes much more sense for both performance and safety reasons.

The current plan is to operate PNGS until the end of 2024. The licence term between 2024 and 2028 is intended to allow for activities such as removal of fuel and water.

This report will focus on post closure decommissioning. The aim is to evaluate OPG's preparedness for the transition from preliminary decommissioning planning to actual decommissioning planning and eventual implementation of decommissioning plans.

Note that in sections describing OPG's decommissioning plan this report uses the language as employed by OPG their preliminary decommissioning document. While terminology such as "disposal" is not appropriate, it appears in this report in the manner in which it appears in OPG's documents. Similarly, in some cases notions embodied by OPG in their PDP are presented here in a summary fashion but without changing the tone of OPG's language, such as in "Safe Storage"

The Preliminary Decommissioning Plan

The PDP says the plan "is an ongoing process" which "will evolve over time". Its objective is to demonstrate the technical and financial feasibility of decommissioning PNGS. The scope of the PDP does not include decommissioning the Pickering Waste Management Facility (PWMF). There is a separate PDP for this because it is licensed separately.

The licence application explains that PNGS plans to continue commercial operation and shut down all units by December 31, 2024. The Preliminary Decommissioning Plan assumes that PNGS A and PNGS B will be shut down in 2022 and 2024 respectively, and a deferred decommissioning strategy has been selected.

After the units in PNGS are permanently shut down, OPG will defuel and dewater (remove the tritiated heavy water) the reactors and make all the necessary modifications to the Structures, Systems and Components (SSCs) to prepare for the subsequent Safe Storage Stage. Service systems no longer required to support the operation of the station will be removed. The aim is to safely transition from electricity generation to a Safe Storage State (SSS).Activities which are required to place the units in the safe storage state are described in the Stabilization Activity Plan (SAP).

Defuelling will be completed using existing fuelling machines and is expected to take a minimum of 6 months per unit to complete. All fuel removed from the units will be transferred to their respective Irradiated Fuel Bays (IFBs) for storage and monitoring.

Dewatering involves draining the heavy water from the moderator system and then flushing with light water flush to reduce residual contamination. The heat transport system will be drained with residual heavy water removed using a vacuum dry process. Heavy water removed from the reactor systems will be stored in a suitable storage facility.

For planning purposes, it is assumed that dismantling of the station won't start for 30 years after the start of Safe Storage. During this Safe Storage phase, the station will be monitored and maintained as deemed necessary while the radiation levels in the reactor systems decay. A Storage and Surveillance Plan (SSP) will be prepared to detail arrangements and activities that will be conducted in support of Safe Storage.

Work that will need to be carried out during the Safe Storage phase includes continuing to monitor spent fuel in the IFBs and transferring it to dry storage casks after a 10-year storage period; (the Pickering Waste Management Facility (PWMF) will need to continue receiving, packaging, processing and storing dry storage containers) storing upwards of 3,000 Mg of tritiated heavy water; spent resin storage and handling systems; removing intermediate level transitional waste generated prior to the stations entering Storage with Surveillance will also continue into Safe Storage.

Obviously the IFBs will remain in operation through the first part of the Safe Storage period until all the used fuel has been transferred to PWMF. Once all of the fuel (including all damaged fuel) has been removed from the IFBs, various work can be carried out such as draining the IFBs and disposing of the water in accordance with the applicable regulatory requirements; and removing ion exchange resins for disposal.

The PDP highlights the fact that a used fuel facility will not be available until 2043 at the earliest.

Planning for Dismantling & Demolition and Site Restoration

Towards the end of the Safe Storage stage, OPG will make detailed preparations for the dismantling of the remaining systems, structures, and the disposal of the waste. A transition plan will be developed for the orderly progression from Safe Storage to Dismantling & Demolition operations.

Dismantling & Demolition operations will be designed to accomplish the required tasks while maintaining all doses ALARA. The procedures will also address the continued protection of the health, safety, security of workers, the public and the environment.

This planning stage will include preparing plans for decontamination, dismantling and demolition, and disposal activities; preparing detailed procedures for the decontamination of Structures, Systems and Components (SSCs) and procurement of decontamination equipment, which may include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices, components for the scarification and spalling of concrete surfaces, chemical applicators, etc.; evaluating the options for the disposal of large radioactive components such as steam generators, calandria, etc.; developing and revising the emission monitoring program; developing a waste management plan; determining the transport and disposal container requirements for radioactive materials and hazardous wastes including the requirements for shielding and stabilization of the waste; assessing decontamination methods such as chemical cleaning, electro polishing, mechanical abrasion or melting which may be used to decontaminate scrap metal.

The PDP says that international experience suggests that scoping and characterization surveys should be performed as early as possible, prior to the start of Dismantling & Demolition.

Acceptable site radiological release criteria or clearance levels for decommissioning waste will be developed prior to Dismantling & Demolition.

Other work required to prepare for dismantling includes: completing a comprehensive site characterization survey to determine extent of site contamination and conducting radiation surveys of work areas and major components.

Detailed Decommissioning Plan

A Detailed Decommissioning Plan is expected to be ready approximately five years prior to the commencement of the Dismantling & Demolition operations – so not until around 2050. The DDP will present a complete description and schedule of work and an estimate of expected costs.

Nor will we know, until the DDP is published, the criteria (clearance levels) that will be used to determine if material is suitable for uncontrolled release from the site and the clearance levels that will be used to determine if the site itself is suitable for release from further regulatory control. An acceptable site radiological release criteria or clearance levels for decommissioning waste should be discussed and decided upon much sooner than that.

In Summary

The PDP assumes that PNGS A will close in 2022 and PNGS B will close in 2024, but no commitments are made. If the operating licence is granted, both dates could be much closer to 2028. This is unacceptable.

Despite the fact that IAEA Guidelines stipulate that the preferred decommissioning strategy should be immediate dismantling except in unusual circumstances, OPG has chosen to delay dismantling by 30 years. (See Annex A for more on this). However, the IAEA's preferred option is not available because there is no waste disposal option available.

Spent Fuel will continue to be stored in the Irradiated Fuel Bays for ten years and then transferred to the Pickering Waste Management Facility for dry storage. Eventually the spent fuel is expected to be moved to a used fuel management facility at some, as yet undecided location. This facility is not expected to be available until 2043 at the earliest, and, of course, there is no guarantee it will ever be available.

Decontamination, Dismantling & Demolition, and disposal activities will be planned towards the end of the 30 year Safe Storage period. The techniques mentioned could very likely lead to further dilution and dispersal of radioactive waste, as opposed to concentration and containment. Techniques for "decontamination" could include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices. Decommissioning is likely to generate large volumes of lower level radioactive wastes which could mean a high likelihood of pressure from the industry to introduce unacceptable waste management techniques, such as increasing the amount of wastes going to landfill.

There could also be pressure to lower standards for site remediation, in an attempt to reduce the volumes of waste generated and their associated disposal costs, and to release vacant land onto the market sooner than might otherwise be possible With significant quantities of potentially valuable metals arising from decommissioning, there could also be pressure to allow more recycling which would result in increases in discharges of liquid radioactive waste into the environment, as a consequence of the decontamination processes for metals.

The dilution and dispersal of radioactive contamination throughout the environment could result in increasing public exposures adding to the burden of radiological risk that is carried by society.

High levels of tritium are likely to continue being released into the atmosphere even after the reactors' closure. Tritium is likely to be oozing out of the concrete structures into the atmosphere. There is no acknowledgement of this in the PDP.

Towards a Democratically Accountable Decommissioning Plan

1. A democratically accountable decommissioning plan requires a plan for meaningful interaction with stakeholders and in particular the local population.

2. The first thing which a decommissioning plan developed by meaningful interaction with stakeholders is likely to decide is that a commitment should be made not to use decommissioning as an excuse to increase discharges of radioactivity into the environment.

3. Secondly stakeholders would need a clear indication of the inventory of radioactive waste, including spent fuel, firstly assuming PNGS is closed in 2018 as originally planned compared to an estimated inventory assuming PNGS continues to operate until 2024. OPG's application to operate PNGS longer that originally stated when there is no facility yet available to accept the spent fuel raises ethical questions which demand further discussion. For instance,

although the UK Government's Committee on Radioactive Waste Management (CoRWM) recommended geological disposal as the best available option it made clear that its "…*recommendations are directed to existing and committed waste arisings … the political and ethical issues raised by the creation of more wastes are quite different from those relating to committed – and therefore unavoidable –wastes*". (7) And in September 2007 CoRWM said: "*To justify creating new spent fuel from an ethical point of view, there must be a management solution that is ethically sound, not just least bad. … In short, a solution that is ethically acceptable for dealing with existing spent fuel is not necessarily a solution that would be ethically acceptable for dealing with new or changed materials*." (8)

4. In order to draw up a full inventory of radioactive waste there will need to be a complete scoping and site characterisation carried out. The PDP agrees that this should be performed as early as possible.

5. There should be a wide public debate about clearance levels before further plans are made for dismantling & demolition and site restoration. Options for controlled contaminated metals smelting as a means of volume reduction, and controlled reuse (e.g. within the radioactive waste management industry) could be discussed.

6. Similarly there should be a discussion about clearance levels for soil and methods of site remediation.

7. A plan for monitoring before, during and after decommissioning and dismantling will need to be agreed and implemented.

8. To meet the environmental principles detailed above further production of nuclear waste should be stopped as soon as possible. Practically speaking this means no new reactors and no refurbishments.

9. Existing waste should be concentrated and contained rather than diluted and dispersed. Stakeholders might want to know, for instance, if it is really necessary to flush the moderator system with light water – thus creating more tritiated water which will need to be managed.

10. Existing waste should be managed as close to the site of production as possible. Practically speaking this would involve storage of waste, in facilities which can contain the waste on the site where it is produced. It means no incineration of waste and no decontamination which involves discharges into the environment and no depositing of waste on landfills.

11. Particular attention will need to be paid to tritium emissions. All eight reactors are likely to continue emitting large quantities of tritium even after they have been closed down.

Conclusions

The Canadian public is being asked to support - with very little meaningful involvement in the decision-making process - a ten year licence extension for the Pickering Nuclear Generating Station which may close two of it reactors after four years and four after six years. There is still no certainty about what will happen to the extra spent fuel generated during this period. Once closed the reactors will be stored for 30years whilst the workforce which is capable of dismantling and demolishing the reactors is dispersed and the skills are lost. Meanwhile no decisions have been taken about releasing radioactive materials into the supply chain and yet the plans for carrying out decommissioning appear to include techniques which involve diluting and dispersing radioactivity throughout the environment.

OPG needs to be sent back to the drawing board. And the first thing it needs to plan is a meaningful stakeholder interaction process which it can work with to develop a new decommissioning plan.

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(3) See https://www.planningni.gov.uk/index/policy/planning_statements/pps11/pps11_introduction/pps11_waste_management_strategy/pps11_bpeo.htm
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(5) Clean Air Alliance 7th March 2016 http://www.cleanairalliance.org/pickering-highest-cost-nuclear-plant-in-north-america/
(6) See for example http://www.cleanairalliance.org/fukushima/
(7) Managing our Radioactive Waste Safely, CoRWM, July 2006. Para 26 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/294118/700_-_CoRWM_July_2006_Recommendations_to_Government_pdf.pdf
(8) Re-iteration of CoRWM's Position on Nuclear New Build, Gordon Mackerron September 2007. Page 3 http://webarchive.nationalarchives.gov.uk/20130717140311/http://corwm.decc.gov.uk/assets/corwm/pre-nov%202007%20doc%20archive/doc%20archive/tier%202%20(7)%20-%20implementation/tier%203%20-%20implementation%20advice/2162%202%20-%20corwm%20position%20on%20new%20build%20reiterated.pdf

Annexe: IAEA Decommissioning Standards

The Northwatch Written Submission on the Licence Application for a Nuclear Power Reactor Decommissioning Licence (PRDL) for the Gentilly-2 Nuclear Facility (1) reviewed the International Atomic Energy Agency (IAEA) Safety Standards Series No. GSR Part 6, Decommissioning of Facilities Using Radioactive Material. (2)

GSR Part 6 established internationally agreed requirements for the decommissioning of facilities on the basis of the IAEA's fundamental safety objective and fundamental safety principles. (3)

GSR Part 6 outlines the requirements for the different concerns that are involved in the decommissioning of a nuclear facility including:

- requirements for safety, for protection of workers and the public and for protection of the environment.
- responsibilities within the governmental, legal and regulatory framework associated with decommissioning.
- requirements for the management of decommissioning.
- requirements for selecting a decommissioning strategy.
- requirements for the financing of decommissioning.
- requirements for the planning for decommissioning that is done during the facility's lifetime.
- requirements to be followed when conducting decommissioning actions.
- requirements for determining when decommissioning has been completed, including the requirements for surveys to demonstrate the completion of decommissioning actions and the termination of authorization for decommissioning.

One specific requirement highlighted in the Northwatch Submission was the requirement that a final decommissioning plan must be undertaken for all facilities undergoing decommissioning and for which decommissioning is planned which is supported by a safety assessment addressing the planned

decommissioning actions and incidents, including accidents that may occur or situations that may arise during decommissioning.

Another specific requirement highlighted is that the government should establish and maintain a governmental, legal and regulatory framework within which all aspects of decommissioning, including management of the resulting radioactive waste, can be planned and carried out safely. This framework shall include a clear allocation of responsibilities, provision of independent regulatory functions, and requirements in respect of financial assurance for decommissioning.

The Northwatch report also looked at a report commissioned by the Canadian Nuclear Safety Commission (CNSC) on International Benchmarking on Decommissioning Strategies, (4) which compared the Canadian regulatory framework and standards in 2014 to the requirements of IAEA Safety Requirements, Decommissioning of Facilities Using Radioactive Material, WS-R-5, as well as other international jurisdictions. Since that time, WS-R-5 has been superseded by IAEA General Safety Requirements Part 6, GSR Part 6.

The report found that while many of the IAEA requirements were adequately reflected in the Canadian regulatory framework or commissioned standards, a number were not. It also said that the Canadian regulatory framework as it relates to the decommissioning of NPPs is similar to the regulatory system of most of the other countries that were reviewed (and particularly those of Finland, Italy, the UK and Sweden) in that these regimes primarily address planning for decommissioning, estimating the cost of decommissioning and assuring that funding will be available but do not extensively address the execution or completion of decommissioning.

CNSC does not provide any guidance on which particular decommissioning strategies may be acceptable or preferred, despite the fact that the IAEA's GSR Part 6 stipulates the preferred decommissioning strategy should be immediate dismantling except in unusual circumstances.

The Northwatch report recommends that:

"*…the Canadian regulatory regime should clarify the basis for its preferred decommissioning strategy in light of the IAEA recommendations The Canadian regulatory regime should provide guidance on the requirement to provide clear evidence for selecting a particular decommissioning strategy when all relevant factors are considered (for example, the absence of an approved off-site waste management facility).*"

GSR Part 6 also details what a final decommissioning plan and supporting documents should cover. The Northwatch report concludes that:

"*While the Canadian regulations and standards meet international standards for the content of a final decommissioning plan, they fall short of providing a schedule for its submission. International requirements suggest that the Canadian regulatory framework should require that a final decommissioning plan be submitted for approval prior to or within two years of permanent shutdown*."

Nor does the Canadian regulatory framework provide guidance on the duration for NPP decommissioning. Under these circumstances, the IAEA requirements for the approval of termination of decommissioning should be adopted. Approval should not be granted unless:-

1. The CNSC verifies that the licensee has demonstrated that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met, and

2. The public has been consulted before authorization for decommissioning is terminated and the site of the nuclear facility is released from regulatory control.

(1) Written Submission on the Licence Application for a Nuclear Power Reactor Decommissioning Licence (PRDL) for the Gentilly-2 Nuclear Facility Nuclear Power Plant Decommissioning International perspectives and comparisons of standards for post-closure safety case assessments by Rizwan Khan, J.D. for Northwatch
(2) IAEA, Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. GSR Part 6, IAEA, Vienna (2016). http://www-pub.iaea.org/MTCD/publications/PDF/Pub1652web-83896570.pdf
(3) Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006). http://www-pub.iaea.org/MTCD/publications/PDF/Pub1273_web.pdf
(4) Candesco, International Benchmarking on Decommissioning Strategies, RSP-0303, 2014 http://www.nuclearsafety.gc.ca/eng/pdfs/about/researchsupport/reportabstracts/RSP-0303-Final-Report-eng.pdf

Appendix 2

Nuclear Waste in Canada | Backgrounder

Planning for Extended Storage

In the late 1950s, the U.S. was one of the first jurisdictions to declare its intention to "solve" the problem of nuclear waste by what was referred to at the time as "land disposal", with the preferred option being to place it in salt mines. The "runner up" options were solidifying the wastes and placing it in "sheds" on arid line, or injecting liquid radioactive wastes 5,000 feet below the surface. Canada followed two decades later, with a three month study resulting in the identification of "geological disposal" as the preferred option, either in the Canadian Shield or salt formations.

Another four decades have passed, and numerous countries have spent considerable time and research effort developing programs to investigate or support deep geological repositories for the "disposal" of highly radioactive reactor fuel waste, but to date no country has actually implemented a nuclear waste burial program.

Increasingly, discussion both in North America and internationally is shifting to an examination of options related to extending on-site storage of nuclear fuel waste into the long or very long term, for periods ranging from 100 to 300 years. There are three primary motivations for this shift:

- After several decades and a number of failed attempts, there is no geological repository on the near horizon
- Post 9/11 there are increased security concerns and – correspondingly – increased security benefits to moving the fuel wastes into more robust conditions
- Following the Fukushima crisis commencing in March 2011, there is growing awareness of the vulnerability of the spent fuel while being maintained in the Irradiated Fuel Bays

> "*Disposal in cavities mined in salt beds and salt domes is suggested as the possibility promising the most practical immediate solution of the problem. Disposal could be greatly simplified if the waste could be gotten into solid form of relatively insoluble character. In the future the injection of large volumes of dilute liquid waste into porous rock strata at depths in excess of 5,000 feet may become feasible.*"
> National Academy of Sciences - National Research Council Division of Earth Sciences Committee On Waste Disposal, Report on Disposal of Radioactive Waste on Land, U.S.A., 1957

In addition, in some situations, particularly in the U.S., pools are reaching capacity, and action must be taken in the short term to keep the waste secure over the short, medium and long term.

In the U.S., reactors are generally single units, whereas in Canada – and particularly Ontario – the practice of having multi-unit reactor stations has *de facto* created centralized storage, with up to eight reactors operating on a single property. That said, the precise location of the waste management facility within the nuclear generating station boundaries may not be the most appropriate for extended storage that may reasonably be expected to be in place for 100 to 300 years. This will be particularly evident in light of the features of robust storage as described below.

Moving to a program of long term at-reactor-site storage will present both opportunities and challenges. Challenges include shifting program momentum after so many decades of focus on illusory repository programs, and responding to reactor communities' expectations that the waste will be moved off-site, after decades of having been told that this would be the case. Technical challenges include having to potentially manage newer fuels with higher burn-ups, and maintaining technical capacity over the longer term in order to adequately maintain and - where necessary - upgrade or replace system components.

Notably, these technical challenges will be part of any management scenario. For Canada, an additional challenge is that there appears to have been very little attention given to CANDU spent-fuel management in the international programs. With 10% of reactors world-wide using the CANDU design, this is a gap that should be of concern to more than just Canada.

The opportunities include increased security benefits, avoiding the risk of off-site transfer and transportation, and receiving better returns on investment to make storage systems more robust.

A necessary first step in the evaluation of the extended on-site storage is the evaluation of how mature current technologies are in their ability to meet storage needs over a 200-300 year period. In addition, a review of the regulatory regime may be assist by determining the degree to which it can accommodate an extended on-site storage program or the degree to which it would need to be supplemented in order to provide regulatory oversight.

In Canada, very little work has been done in this area. A generalized report was prepared for Ontario Power Generation on behalf of Canadian nuclear fuel owners in 2003, discussing conceptual designs for reactor-site extended storage facility alternatives for used nuclear fuel. In comparison, there are numerous reports by U.S. agencies and organizations, some of which include very detailed technical discussions of aging of both fuel and storage system components, and others which provide detailed discussions of options to increase the robustness of a storage site or system. Unfortunately, the corollary work has not been done for the Canadian / CANDU context.

Three features make spent fuel storage more secure, in terms of potential security threats:

- Wastes are placed in a condition where it is passively safe, i.e. it does not rely on electrical power, cooling water or active ongoing maintenance
- The facility is "hardened", through layers of concrete, steel, gravel or other materials being placed – in various combinations – above and around the irradiated fuel waste
- The fuel wastes are dispersed, with the fuel spread more uniformly across the site rather than concentrated in a single area

The feature of passive safety is key in making the waste more secure from human or operational error or natural events. In some situations and designs, dispersal can also be advantageous in keeping the waste secure from human or operational error of natural events.

Inarguably, there are benefits to taking a planned approach to extending on site storage, rather than simply have "short term" or "interim" storage extend over the long term simply due to program failure.

Further Reading Related to Extended On-Site Storage

Alvarez, Robert, et al "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States", *Science and Global Security, 11:1–51, 2003*

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IAEA, "Further analysis of extended storage of spent fuel", Final report of a Co-ordinated Research Programme on the Behaviour of Spent Fuel Assemblies during Extended Storage (BEFAST-III) 1991-1996

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Rigby, Dr. Douglas B, "United States Nuclear Waste Technical Review Board Evaluation of the Technical Basis for Extended Dry Storage and ransportation of Used Nuclear Fuel" December 2010

Thompson, Gordon, "ROBUST STORAGE OF SPENT NUCLEAR FUEL: A Neglected Issue of Homeland Security" Institute for Resource and Security Studies, January 2003

Prepared for Northwatch, June 2013, Amended February 2017

Appendix 3

Fuel Defects - Effect of Reactor Aging in Post-Operational Periods[1]

In general, one of the most noteable points of interplay between the operational period of a nuclear generating station and the post-operational period is the legacy of radioactive wastes which were generated during operations but then must be managed into perpetuity.

In the case of an aging reactor station, such as the Pickering Nuclear Generating Station, there could be effects of aging that make this perpetual care even more challenging.

As outlined in Commission Member Documents[2] and Ontario Power Generation documents related to their application[3] and discussed in the Day One hearing[4] black deposits are being regularly observed on fuel discharged from Pickering A, with size and frequency of the deposits increasing over the last three years. OPG reported in December 2012 that they had discovered a fuel bundle with "significantly larger deposits than previously seen"[5]

CNSC have indicated that they have concerns regarding the black deposits, and have imposed a penalty of a 3% reduction from full power "to preserve the safety margins and until there is a better understanding of the cause and effects of the deposits". Staff also indicated that they are not sure of the underlying root cause and were not sure about the trends in the formation. They did not indicate why a 3% "penalty" was adequate, or the basis for applying the 3% penalty versus a larger reduction or a shutdown for investigation.

The deposits have been described by CNSC staff as being mostly magnetite and presumed to be corrosion products eroded from the outlet feeder pipes. Staff has also shared with Commission members during Day One a speculation that the deposits are due to limitations in the Pickering end units which led to "less than optimal" outage temperature control and indicated that the deposits could potentially impact the heat transfer properties of the fuel.

Ontario Power Generation's response has been in to increase the pH level and request that they be allowed to return to full power. OPG asserts that there is "no impact on cooling".[6]

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[1] Excerpted from 13-H2.123 Submission from Northwatch on Pickering PROL relicensing 2013
[2] CMD 13-H2, CMD 13-H2.B, CMD 13-H2.1B
[3] Reactor Components & Structures Life Cycle Management Plan, N-PLAN-01060-10003. 2012-09-12
[4] February 20th, 2013 – Transcript – Day One Hearing, pages 33-35, 53,56, 57, 174, 175, 176
[5] CMD 13-H2, page 38
[6] CMD 13-H2-1B, page

While CNSC staff reported in the Day One hearing that "there is no sign of under deposit corrosion" (page 34) the black deposits are acknowledged to be corrosion-related. Indeed, there are numerous references to aging-related corrosion throughout the documents related to the license review.

Of additional note is that the December 2012 S-99 Preliminary Report "Inspection Results Show a Thicker Black Deposit on a Slightly Bowed Fuel Element than Previously Seen" included a comment from the inspector that at least one of the elements was "slightly bowed out".

Analysis over several years has determined that the major effects of aging are on dry-out predictions as a result of Pressure Tube Creep, which leads to earlier onset of dryout. [7]

Taken singly or in combination, the above noted phenomena – corrosion deposits on the fuel sheath, a bowing out of the fuel structure, early onset of dryout – are all in evidence in the aging Pickering reactors, and have the potential to seriously reduce fuel integrity. And as

CNSC staff have acknowledged in CMDs prepared for this license review, fuel defects are a precursor to public dose. [8]

Fuel cladding has two primary purposes: to maintain the geometry of the fuel, and to act as a container. Fuel cladding is the first physical barrier between the irradiated fuel pellets and the environment. Changes that alter the physical structure and mechanical properties of a fuel bundle can cause damage. For example, oxidation of the cladding weakens its mechanical properties and decreases its thermal conductivity. In-reactor corrosion can also lead to embrittlement. Any of the just described phenomena can lead to damage or even failure of the fuel cladding.[9]

Over longer periods of time, even micro-defects in fuel bundles – which effectively become waste containers after removal from the reactor core – have increasingly more significant potential consequences. Long term storage – either dry storage on site or some form of centralized storage – rely on a multiple barrier approach. The weakening of the first barrier by any means – corrosion, dryout, temperature fluctuations – can potentially lead to cladding

[7] OPG Application Attachment 3, page 61
[8] CMD 13-H2.1B, page 1
[9] "Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel", United States Nuclear Waste Technical Review Board, December 2010

failure. This, in turn, may lead to or hasten the release of radioactive materials into the storage container or even, ultimately, into the environment.

CNSC staff assessment of the black deposits appears to be fully focused on the question of safety and safety margin during the operating period, i.e. the current period. We found no analysis by CNSC staff with respect to the bowing of the fuel element(s), which is also described in the December 2012 report on the largest of the observed black deposits.

The cause of the element deformation / bowing is likely to be thermally driven, with bowing generally attributed to uneven temperature distribution. Non-uniform heat transfer and generation leads to temperature gradients.[10] The bowing could cause stress-cracking in the element, which could in turn contribute to cladding failure.

While it is appropriate that safe operations be first and foremost in determining the response to situations such as the unexplained black deposits or the bowed fuel elements, the operating periods taken into account should not be limited to just the current operating period, but should include the very long term storage period that will of necessity follow. While the reactor may continue to operate without a severe incident in the present tense - although that is not by any means guaranteed – any phenomena which are likely or possibly going to adversely affect the duration and effectiveness of future efforts to isolate the wastes should be examined through a much longer time scale than the next few years that OPG had requested a license for extended operation of the Pickering reactors.

[10] J. Veeder, M.H. Schankula, Bowing of Pelletized Fuel Elements: Theory and In-Reactor Experiments, Nuclear Engineering and Design, 29, pp. 167-179, 1974