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CMD 24-H5.45

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Written submission from Northwatch

Mémoire de Northwatch

In the Matter of the

À l'égard d'

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Application to extend the operation of Pickering Nuclear Generating Station Units 5 to 8 until December 31, 2026

Demande visant à prolonger l'exploitation des tranches 5 à 8 de la centrale nucléaire de Pickering jusqu'au 31 décembre 2026

Commission Public Hearing

Audience publique de la Commission

June 2024

Juin 2024

Canada

NORTHWATCH

April 29, 2024

Canadian Nuclear Safety Commission
280 Slater St
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Sent by email interventions@cnsc-ccsn.gc.ca **Ref. 2024-H-05**

Commission Members:

Re. **OPG Application for a License Amendment to Authorize Operation of Pickering NGS Units 5 to 8 beyond December 31, 2024**

On August 8, 2023 the Canadian Nuclear Safety Commission (CNSC) issued a public notice of its intention to conduct a public hearing on Ontario Power Generation's request for authorization to operate Pickering NGS Units 5 to 8 beyond December 31, 2024.[1]

The current operating licence for OPG's Pickering NGS units is valid until August 31, 2028. However, as detailed in the Commission's Record of Decision on the 2018 renewal of OPG's licence for the Pickering NGS, operating any of the units beyond December 31, 2024, would constitute a change in OPG's licensing basis. Therefore, OPG requires authorization from the Commission prior to engaging in commercial operations beyond 2024.

Ontario Power Generation (OPG) has applied to the Canadian Nuclear Safety Commission (CNSC) to amend the Power Reactor Operating Licence (PROL) of the Pickering Nuclear Generating Station (NGS) to operate units 5–8 to December 31, 2026, and up to 305,000 effective full power hours (EFPH). [2]

CNSC staff have recommended that the Commission:

- amend the licensing basis to authorize OPG to operate Pickering NGS units 5–8 to December 31, 2026, and up to a maximum of 305,000 EFPH for the pressure tubes of units 5–8
- amend the PROL to remove licence condition 15.3 related to pressure tube assessment and include a new licence condition 6.2 related to an enhanced fitness-for-service program for fuel channels in extended operation[3]

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.

[1] Notice of Public Hearing and Participant Funding issued August 8, 2023, Ref. 2024-H-05
[2] CMD 24-H5, 27 February 2024
[3] CMD 24-H5, 27 February 2024

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.[4]

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. [5]

On December 16, 2021, OPG informed the CNSC of its intent to operate units 5–8 to the end of 2025. On November 24, 2022, the Commission extended OPG’s application deadline under the licensing basis for licence conditions 15.1 and 15.4 to June. On December 12, 2022, OPG informed the CNSC of its updated intent to operate units 5–8 to September 30, 2026. On June 16, 2023, OPG submitted its application requesting authorization to operate Pickering NGS units 5–8 to December 31, 2026. [6]

In June 2023, OPG submitted a licence amendment application requesting Commission authorization to operate Pickering NGS units 5–8 until December 31, 2026 and to operate pressure tubes of these reactors for up to 305,000 equivalent full power hours (EFPH) (an increase from 295,000 EFPH). In the licence amendment application, OPG confirmed that Pickering NGS units 1 and 4 will be shut down by December 31, 2024. While OPG’s PROL remains valid until 2028, CNSC staff are recommending licence condition amendments related to an enhanced fitness-for-service program for fuel channels in extended operation.[7]

On January 30, 2024, the province of Ontario announced its support for the possible refurbishment of Pickering NGS units 5–8. CNSC staff have indicated that the possible future refurbishment of

[4] CMD 18-H6, page 1
[5] CMD 18-H6, page 1
[6] CMD 24-H5, page 6
[7] CMD 24-H5, page 1

Pickering NGS units 5–8, were OPG to formally request it, would be considered at a separate public hearing of the Commission.[8]

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 of 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. Previously, OPG had proposed deep burial of low and intermediate wastes in a repository less than one kilometre from the shore of Lake Huron; that proposal has been withdrawn.

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 two candidate site – the Teeswater site in southwestern Ontario and Revell site in northwestern Ontario - as possible burial locations for nuclear fuel waste.

Northwatch's key areas of focus in reactor licencing reviews are OPG's management of the irradiated fuel under the PROL license 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. In this review, Northwatch is particularly interested in how OPG has addressed the issue of aging and its effect or potential effect on the condition of the fuel waste.

For the record, Northwatch wishes to note that while listed among those to whom the CNSC awarded participant funding Northwatch will not be drawing on that award and is an unfunded participant.

[8] CMD 24-H5, page 6

Ontario Power Generation's Licence Application Review

The following comments on the Ontario Power Generation's application from Ontario Power Generation (OPG) to extend the operation of Pickering Nuclear Generating Station (NGS) Units 5 to 8 until December 31, 2026 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.

Impact of Aging on Fuel Waste Related Systems

As CNSC staff note in their CMD, as the reactor core ages, aging of various structures, systems, and components of the system and station have an impact on the overall safety case of the reactor.[9] CNSC staff reported that they have reviewed the updated 2022 Pickering NGS units 5–8 PSAs and found that the PSAs meet the intent of the submission requirements of REGDOC-2.4.2.[10] However, as noted elsewhere in this submission, Northwatch's review of the supporting documents found that the issues around aging of key components of the fuel waste management system, such as the irradiated fuel bay, were not addressed in the updated PSR-2B safety report. Hence we find CNSC's conclusions to be questionable.

CNSC staff state that they find OPG's integrated aging management program implemented at the Pickering NGS to be acceptable; Northwatch's review found it negligent with respect to fuel waste management. CNSC staff indicate they will continue monitor this program as part of the existing oversight strategy; Northwatch concludes that their oversight program include no directive or corrective actions, given the failure over the last five years to implement or corrective actions or catchup on the maintenance backlog.

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.[11] With the transfer of the irradiated fuel bundles into the

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[9] CMD 24-H5, page 30
[10] CMD 24-H5,Page 31
[11] See Northwatch 13-H2.123 Section on fuel defects; excerpts in Appendix 1

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 groundwater contamination, the full extent of which Ontario Power Generation has refused to disclose.[12]

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.[13]

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.

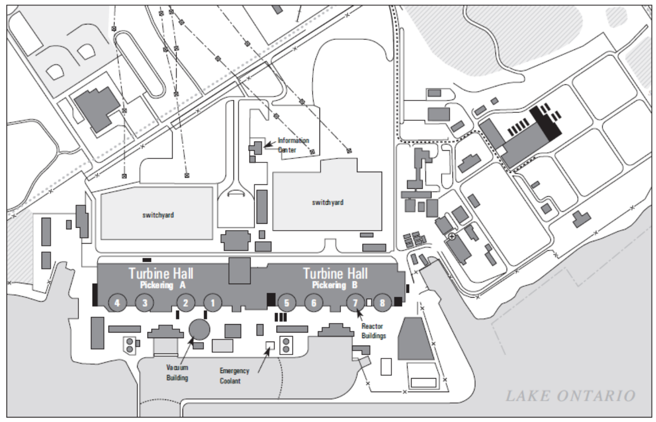

Figure 1 - Site map illustrates the main structures of the Pickering nuclear station

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[14] of one of the 2018 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 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

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

- 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 was a lack of clarity in the 2018 documentation 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. Similarly we were unable to find any indication in the Pickering NGS: Periodic Safety Review 2-B (PSR2-B) Global Assessment Report (GAR) or Pickering NGS: Periodic Safety Review 2-B (PSR2-B) Integrated Implementation Plan (IIP) that this issue had been addressed.[15]

The 2018 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.[16]

Despite the seriousness of this issue, the 2023 Pickering NGS Periodic Safety Review 2-B (PSR2-B) provided no updates or reports on the state of the irradiated fuel bays or progress in addressing equipment deficiencies associated with the three irradiated fuel bays. The CNSC staff Commission Member Document also failed to provide any report on progress in addressing these previously reported operational failures.[17] In Ontario Power Generation's application they stated that "*upcoming projects include improvements to the Irradiated Fuel Bay (IFB) cooling and purification system, chemistry analyzer and stack monitor improvements, system performance monitoring data acquisition upgrades, investments in Fuel Handling (FH) reliability, and further investments in equipment reliability across a number of systems*" which might indicate that addressing these deficiencies is still on OPG's "to-do" list, but the account lack sufficient detail.[18]

The 2018 period safety review noted that leakage from IFB-B to the collection sumps has been increasing since 2007. Reportedly, the intended strategy was to maintain the water levels in the collection sumps below groundwater level so that any leakage is inward and not outward. Northwatch questioned this selection of strategies in the 2018 review, suggesting that a decade-old leak warranted direct attention, rather than makeshift management. There was no report of mitigative actions or of the status of this leakage included in the 2023 PSR2-B.[19]

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[15] Pickering NGS Periodic Safety Review 2-B (PSR2-B): Global Assessment Report, Kinectrics File No. K-20506/RP/0002 R02, OPG File No. P-REP-03680-00048 R000, April 28, 2023
[16] OPG Document No. P-REP-03680-00005 R01, PSR SF2, Section 4.1.4 REVIEW TASK #4 - SPENT FUEL STORAGE FACILITIES
[17] CNSC Staff CMD 24-H5
[18] Application to extend the operation of Pickering Nuclear Generating Station Units 5 to 8 until December 31, 2026, June 2023, 24-H5-1, page 94
[19] Pickering NGS Periodic Safety Review 2-B (PSR2-B): Global Assessment Report, Kinectrics File No. K-20506/RP/0002 R02, OPG File No. P-REP-03680-00048 R000, April 28, 2023

OPG also described in the 2018 PSR their "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 indicated at the time of the 2018 review. There was no report of whether this intention to mitigate these leaks was realized, and no report on the status of this leakage included in the 2023 PSR2-B. [20]

Irradiated Fuel Bay Capacity

The 2018 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." There was no discussion of fuel bay capacity in the 2023 Period Safety Review.

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 stated 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 fuel waste annual inventory reports, there were 399,703 irradiated fuel bundles in the Pickering irradiated fuel bays as of June 2017. According to the NWMO's most recent report, there were 376,162 irradiated fuel bundles in the Pickering irradiated fuel bays as of June 2022.[21]

Year	Fuel Waste in IFBs	Fuel Waste in DSCs	Total Fuel Waste
2022	376,162	469,327	845,489
2021	385,045	443,524	828,569
2020	392,386	417,345	809,731
2019	396,935	395,494	792,429
2018	400,597	372,738	773,335
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 2022.			

The 2018 PSR goes on to state that "there is sufficient bay space available provided movement to dry storage is performed in a timely manner". As noted above the 2023 PSR-2B did not address the issue of IFB capacity.

[20] Pickering NGS Periodic Safety Review 2-B (PSR2-B): Global Assessment Report, Kinectrics File No. K-20506/RP/0002 R02, OPG File No. P-REP-03680-00048 R000, April 28, 2023
[21] Nuclear Fuel Waste Projections in Canada – 2023 Update, NWMO-TR-2023-09 R001, December 2023

As was conveyed to the Commission during the 2017 license review for the Pickering Waste Management Facility and during the 2018 PROL review, 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. We acknowledge that there may have been incremental process in addressing this backlog in recent years but continue to hold the view that there is a system-wide malaise with respect to the pace of transfer of irradiated fuel from wet to dry storage.

In addition to the advantages of dry storage over wet storage for sufficiently aged irradiated fuel waste from an overall safety perspective (i.e. the advantage of a passive system versus and active system) Northwatch was unable to conclude during the 2018 review that there will be sufficient capacity in the irradiated fuel bay going forward, even under "normal" operating conditions. Given the failure of OPG or CNSC staff to address these issues in documents produced to support the current review we are still 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 the 2018 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[22], 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,[23] 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.[24]*

[22] (P-REP-34400-00002) [66]
[23] (P-REP-34400-00003) [67]
[24] ***122*** *of* ***641*** *OPG Document No. P-REP-03680-00005 R01*

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 the brief section of one portion of the 2018 Periodic Safety Review report being the sole source of information available about this significant concern, and even more so by the complete absence of information in the 2023 Periodic Safety Review.

Irradiated Fuel Transfers

In general, the 2018 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 left 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 outlined 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"[25]; 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

[25] 4.1.4.5 SPENT FUEL HANDLING, 123 of 641 OPG Document No. P-REP-03680-00005 R01

These issues were not addressed or reported out in the 2023 documents, including the application, the CNSC staff CMD and the Periodic Safety Review. Therefore, they continue as live issues which require the attention and address of the Commission.

Radioactive Waste Management in OPG's Licence Application

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 and again in the PROL licence review in 2018, 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 their preliminary decommissioning plan that the irradiated fuel waste will be transferred off-site.[26]

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 STILL no operating geological repository for used fuel anywhere in the world although for more than 35 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.[27]

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.[28]

After 22 years of operation the Nuclear Waste Management Organization has still produced only "concept" reports to describe their proposed operations, which include transportation, processing and

[26] OPG CMD 17-H5.1 Submission from Ontario Power Generation Inc. re. PWMF, pages 85-96
[27] "Wasting the Future", Australia, 2006 http://www.energyscience.org.au/FS08%20Radioactive%20Waste.pdf
[28] "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

emplacement of the fuel waste in a deep geological repository as the starting steps in the much longer challenge: the containment of the irradiated fuel waste over very, very long time scales.

The challenging task of extracting the fuel waste from on-site dry storage containers remains undescribed by both the NMWO and Ontario Power Generation. We know from other investigations that the condition of the fuel waste inside the dry storage containers – some of it several decades old – is unknown. The transportation containers are untested and in the case of the fuel waste from non-OPG sites not yet designed beyond a preliminary concept released in a report in 2021.Similarly, the used fuel package plant remains at a conceptual stage of development, and the transfer systems and operational systems for the underground repository have been described only in very general terms.

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 not made the social case for geological disposal, despite a carefully crafted siting process designed to get the nuclear industry to their long sought after "yes" on the question of whether a geological repository was socially accepted.

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.[29]

What has been demonstrated in the contemporary context is that the NWMO's nine-step siting process has been extremely divisive at the local level in the potential host community of South Bruce and the proxy potential host community of Ignace. Widespread opposition has been observed along the transportation route and in downstream communities in northern Ontario, where the Revell candidate site (associated with the proxy host community of Ignace, located 45 kilometres southeast of the site and in a different watershed). The NWMO has stated that it will make its site selection in 2024 but will only proceed with an "informed and willing host community". No such "willingness"

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[29] 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

is evident in either of the communities being investigated, and certainly not in the “host” region of northern Ontario.

Interestingly, Ontario Power Generation excludes from the application to amend the Pickering operating license any discussion of the long-term management of the additional irradiated fuel waste that will be produced by extending operations at Pickering.

Ontario Power Generation acknowledged 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” 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.

Conclusions

Ontario Power Generation has failed to address issues related to safety and safe operations that are outstanding from the last PROL licensing review. Highly problematic is OPG’s failure – or refusal – to report on those outstanding issues.

Ontario Power Generation has also failed to demonstrate that Units 5-8 of the Pickering Nuclear Generating Station can be operated safely and without adverse effects, including effects related to and resulting from the irradiated fuel waste that will be generated.

Ontario Power Generation’s application to operate units 5–8 to December 31, 2026, and up to 305,000 effective full power hours should be denied.

Sincerely,

Brennain Lloyd
Northwatch Project Coordinator

Attachments: Appendix 1 – Fuel Defects
Appendix 2 – Extended Storage

Appendix 1

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

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[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

Appendix 2

SECURING THE FUTURE:

A Risk-Reduced Approach to Nuclear Fuel Waste Management

WORKING DRAFT FOR DISCUSSION

FEBRUARY 2024

NORTHWATCH

Revision #5

For more than four decades Canada and several other countries have invested considerable time and research effort into programs to investigate or support deep geological repositories[1] for the "disposal" of highly radioactive reactor fuel waste. To date, no country has actually licensed or implemented a nuclear fuel waste burial program and Canada has not yet secured a location or completed design of a repository.

Increasingly, discussion both in North America and internationally is shifting to an examination of options related to extending on-site storage[2] of nuclear fuel waste into the medium or long term, for periods ranging from 100 to 300 years or longer. 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
- Following the 9/11 terrorist attacks there are increased security concerns and – correspondingly – increased security benefits to moving the fuel wastes into more robust storage
- 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

The international failure of the geological repository programs, the continued scientific and technical uncertainties[3] surrounding the deep repository concept, the lack of social acceptance of nuclear waste burial, and the pressing need to improve the current on-site storage of high level nuclear fuel waste motivate this brief outline of a Canadian approach to securing high level nuclear waste into at least the medium term (100 to 300 years). The approach neither relies on nor rules out an eventual resolution of the technical and social obstacles to a deep geological repository or some other technical method not yet determined.

Placing Parameters

The containment and isolation of high-level radioactive waste is an intractable problem as long as wastes continue to be generated. The nuclear industry's go-to argument in defence of deep geological repositories as an end point for the long-term management of radioactive wastes is that society cannot be expected to continue uninterrupted on surface, referencing the risks of war, climate catastrophe and social collapse. However, as long as wastes continue to be generated, the most dangerous wastes must remain on surface, and at the reactor site. Irradiated fuel (nuclear fuel waste) must be water cooled in for the first 6-10 years in the irradiated fuel bay[4], and for at least thirty years above surface due to the heat generated by the irradiated fuel.[5]

Who makes the calculation as to when social collapse is going to occur? And who can accurately foresee that "moment" of collapse forty years into the future?

In practical terms, no sites can be closed, no nuclear generation stations decommissioned, and no relief found from the most radioactive and most vulnerable wastes being at greatest risk as long as wastes continue to be generated through the operation of nuclear generating stations.

Ending production is the essential first step in establishing a foundation for a successful long-term waste management plan. The following elements comprise a risk-reduced approach for the long term management of nuclear fuel waste. A similar or only slightly modified approach could be applied to the long-term management of so-called intermediate level wastes, all of which are highly radioactive and some with levels of radioactivity and hazard similar to irradiated fuel. However, the focus of this brief paper is irradiated fuel, also known as nuclear fuel waste or spent fuel, and categorized in Canada as "high level" radioactive waste.

Pre-Conditions

In addition to the above noted necessity of ceasing production, the following are necessary components to any effective radioactive or hazardous waste management system, including the one under discussion:

- Wastes must be appropriately categorized, commensurate with their hazards and management requirements
- Wastes must be fully characterized, including a radiological and chemical characterization
- Wastes must be inventoried, and these inventories must be peer reviewed by a multi-disciplinary team, and readily available to decision-makers, the public, and Indigenous peoples
- Wastes must be labeled and tracked, in a system which links the inventory with the location, characterization and containment method for each waste package
- Waste storage must be monitored, and performance of the storage systems measured for any releases
- Waste storage monitoring results must be recorded and must be readily available to decision-makers, the public, and Indigenous peoples

Prepared for the Future

In Canada, very little work has been done in the field of extending and making on-site storage of radioactive wastes more secure. A generalized report was prepared for Ontario Power Generation on behalf of Canadian nuclear fuel owners in 2003 which described conceptual designs for reactor-site extended storage facilities for used nuclear fuel[6]. 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[7], and others which provide detailed discussions of options to increase the robustness of a storage site or system.[8] Unfortunately, the corollary work has not yet been done for the Canadian / CANDU context.

In other jurisdictions, three features have been identified for a storage / management system which would make spent fuel storage more secure, particularly in terms of potential security threats, extreme weather events, or human error:

- Wastes are placed in a condition where the waste is passively safe, i.e. the system does not rely on electrical power, cooling water or active ongoing maintenance
- The facility is "hardened", by placing layers of concrete, steel, gravel or other materials – in various combinations – above and / or around the irradiated fuel waste storage structure
- The fuel waste storage facilities are dispersed, with the fuel storage structures distributed across the site, subject to site conditions, rather than being 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, extreme weather events, or terrorist attacks.

There are certain fundamental requirements of any reliable management system for radioactive wastes, regardless of the time frame. Whether the storage is intended for fifty years or for fifty thousand years, the following elements must be in place:

- The system must be developed with **monitoring** as a design fundamental; monitoring is required of the containment systems in order to detect any releases of radionuclides, including via the movement of water or gasses
- The system – including monitoring methods – must provide means to **measure** the performance of each of the barriers which form the containment system, and to be able to not only identify failures, but also anticipate failure by detecting material changes to any of the barriers or barrier materials (e.g. corrosion, embrittlement)
- The ability to access and **retrieve** waste packages or containers is key to being able to respond to any failures detected through the monitoring program and the measured performance of the system elements
- Waste packages and containers and the overall containment system – including layout, location and design – must support the **replacement, repair and/or re-encapsulation** of failed containers; an expectation that this will be required must be built into the system, rather than simply assigning this management step the status of a "contingency" which will be developed should the need arise. The system must assume that the need will arise, and have built into the system the ability to meet that need

In addition to meeting the very necessary and fundamental requirements outlined above, the system must align with sound principles of radioactive waste management, such as the "proximity principle" which directs that the waste is dealt with as close to its point of generation as is reasonably possible, plus key principles embedded in Canadian environmental decision-making, including risk and harm reduction, precautionary principle, and polluter play.

Perpetual Care

Radioactive wastes will require perpetual care. With the potential to cause harm to humans and the environment humans rely upon for hundreds of thousands of years, there is no easy solution and no quick way out. A sound approach to radioactive waste management – essentially, the containment of radioactive wastes such that they are kept separate and isolated from the environment – must be one of perpetual care.

Two mutually compatible approaches have been developed by civil society organizations which adopt the principles and responsibility for perpetual care. The first is described as Nuclear Guardianship,[9] and was developed in the U.S. in the 1990s and has evolved since its first release. The second is "Rolling Stewardship"[10], a concept also developed in the 1990s and more recently applied to radioactive waste management by the Canadian Coalition for Nuclear Responsibility.

Nuclear Guardianship is a citizen commitment to present and future generations to keep radioactive materials out of the biosphere.

Nuclear Guardianship requires:

- interim containment of radioactive materials in accessible, monitored storage, so that leaks can be repaired, and future technologies for reducing and containing their radioactivity can be applied;
- stringent limits on transport of radioactive materials, to avoid contaminating new sites, and to minimize spills and accidents;
- cessation of the production of nuclear weapons and nuclear energy;
- transmission to future generations of the knowledge necessary for their self-protection and ongoing guardianship through time.

The Concept of Rolling Stewardship

1. Humans can contain waste securely for decades at a time.
2. Recognizes a solution to the problem does not yet exist
3. Continual monitoring of waste is essential.
4. Retrieval is anticipated and actively planned for.
5. Periodic repackaging is an integral part of the process.
6. If leakage occurs timely corrective action will be taken.
7. Rolling Stewardship is based on persistence of memory.
8. Information is readily transmitted to the next generation .
9. Ongoing reminder that the problem remains to be solved.

Next Steps

This brief paper does not aspire to set out technical options or design details for extended on-site storage systems for CANDU fuel waste. Its purpose it to establish a framework for moving forward on improving the short and mid-term (100 to 300 years) security of nuclear fuel waste in Canada, including the parameters and pre-conditions set out above, and the principles of perpetual care. The next step is a peer review of this paper, followed by a technical review of early conceptual work done by Canadian utilities on options for extended on-site storage, with improving robustness and security as the primary objective

ENDNOTES

[1] Deep geological repository: The definition by the Canadian Nuclear Safety Commission is "A facility where radioactive waste is placed in a deep, stable geological formation (usually several hundred metres or more below the surface). The facility is engineered to isolate and contain radioactive waste to provide the long-term isolation of nuclear substances from the biosphere. Also called deep geologic repository."

[2] See for example, these two papers on extended on-site storage: 1) IAEA, "International Atomic Energy Agency (IAEA) Technical Meeting on Extending Spent Fuel Storage Beyond The Long Term", 22–24 October 2012, and 2)Nuclear Regulatory Commission, "Project Plan for the Regulatory Program Review to Support Extended Storage and Transportation of Spent Nuclear Fuel", June 2010

[3] Technical and design concerns with the deep geological repository concept include increased risk of releases and failures associated with damaged fuel, container failure including due to corrosion, risks associated with repackaging, transportation risk, opportunity for human error over the life expectancy of the repository, issues related to failures in the various engineered and geological barriers upon which the concept relies, including but not limited to those of gas generation, heat, microbial activity and synergistic effects. Related reports include "Rock Solid? A scientific review of geological disposal of high-level radioactive waste", Wallace, Helen, 2010

[4] See, for example, the description at http://nuclearsafety.gc.ca/eng/waste/high-level-waste/index.cfm

[5] See, for example, "Postclosure Safety Assessment of a Used Fuel Repository in Sedimentary Rock, Document Number: NWMO TR-2013-07", as posted at https://ceaa-acee.gc.ca/050/documents/p17520/117099E.pdf

[6] CANTech, "Conceptual Designs for Reactor-site Extended Storage Facility Alternatives for Used Nuclear Fuel Alternatives for the Pickering, Bruce and Darlington Reactor Sites Report of a Study carried out for Ontario Power Generation, New Brunswick Power, Hydro- Québec and Atomic Energy of Canada Limited, April 2003

[7] See, for example, 1) Mcconnell1, Paul*, Brady Hanson2, Moo Lee3, And Ken Sorenson1 1Transportation Manager, "Extended Dry Storage Of Used Nuclear Fuel, Technical Issues: A USA Perspective", US Department of Energy Fuel Cycle Technologies Program Received September 28, 2011, or 2) Rigby, Dr. Douglas B, "United States Nuclear Waste Technical Review Board Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel" December 2010

[8] See, for example, 1) 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, 2)* Alvarez, Robert "Improving Spent-Fuel Storage at Nuclear Reactors", Winter 2012, 3) Thompson, Gordon, "ROBUST STORAGE OF SPENT NUCLEAR FUEL: A Neglected Issue of Homeland Security" Institute for Resource and Security Studies, January 2003 or 4) "Storage of Spent Nuclear Fuel at the Pickering Site: Risks and Risk-Reducing Options", Institute for Resource and Security Studies for the Ontario Clean Air Alliance, 2018.

[9] Based on the pioneering work of eco-philosopher Joanna Macy, Nuclear Guardianship combines art, science, and remembrance to address the seemingly intractable human-caused problem of nuclear contamination with wisdom and creativity. Read more HERE

[10] Rolling Stewardship is an intergenerational waste management concept whereby each successive generation passes on the knowledge and provides the necessary resources to the next generation, so that nuclear wastes are never placed beyond human control and are never left unattended. Read more HERE and HERE