

# **Radioactive Waste Policy: Irradiated Fuel Bays**

## **Northwatch Submission to Natural Resources Canada - 31 May 2021**

In November 2020 Natural Resources Canada announced a review of Canada's radioactive waste policy framework and launched a virtual hub with four discussions papers and a forum for posting comments online. A series of online sessions were held through direct arrangement – there were no engagement sessions announced on the radwastereview.ca web site and Northwatch is not aware of any opportunities for unaffiliated Canadians to be part of such sessions – and comments were invited by email.

The four discussion papers addressed waste minimization, waste storage, waste disposal, and decommissioning. Northwatch has posted summary comments identifying what was missing from each of these papers and responded to the questions posed in each paper through the online forum.

There are several subject areas which are central to the review and improvement of Canada's radioactive waste policy which were either not addressed in any of the four discussion papers, or were addressed only indirectly or in insufficient detail. This submission is one of a series prepared by Northwatch to provide input into the review and to propose additions to Canada's radioactive waste policy.

This submission is made by Northwatch in support of the following radioactive waste policy recommendations related to the performance of Irradiated Fuel Bays:

**POLICY RECOMMENDATION:** Under the principle of oversight and accountability Canada's radioactive waste policy should direct a third party approach to address operational safety concerns, such as fuel bay capacity and performance.

**POLICY RECOMMENDATION:** Under the principle of Transparency, openness and traceability Canada's radioactive waste policy should enable public access to information about nuclear facility operation, including and particularly information essential to assessing plant performance and safety compliance

**POLICY RECOMMENDATION:** Under the principle of Protection of human health and the environment Canada's radioactive waste policy should prioritize optimal performance of plant infrastructure, particularly when poor performance increases risk and/or release of radionuclides.

## **Irradiated Fuel Management**

Documents filed by Ontario Power Generation and the CNSC staff for the 2015 licence review for the Darlington Nuclear Generating Station raised concerns with respect to the irradiated fuel and its management during both "normal" operations and during refurbishment. Questions of concern include:

*Do the irradiated fuel bays have sufficient space for all contingencies during operation and refurbishment?*

- OPG states in the License Application<sup>1</sup> that “OPG is implementing actions to ensure that the Irradiated Fuel Bays will be ready from a heat removal and space standpoint prior to receiving a units full core discharge of fuel prior to the start of refurbishment” but no additional information is provided about what actions are being implemented
- Appendix 4 of the Application indicates that the “location maximum” quantity in the irradiated fuel bays is 402,180 fuel bundles, and the maximum quantity in all reactor cores is 24,960 fuel bundles.<sup>2</sup>
- According to the most recent inventory of radioactive wastes published by the Nuclear Waste Management Organization, as of June 2014 there were 336,327 fuel bundles in ‘wet’ storage at Darlington, and 129,747 bundles in “dry storage”<sup>3</sup>

If the numbers included in the 2013 OPG application and the 2014 NWMO inventory are reliable, they raise serious questions about capacity of the irradiated fuel bays at the DNGS to accommodate a range of contingencies, including transfer of the irradiated fuel from more than one reactor core in close succession, or return of irradiated fuel from one or more DSCs to the IFBs due to one of a range of potential failures.

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*Are the Irradiated Fuel Bays fit for service, including contingency use, during continued operation and refurbishment?*

- OPG states that the condition of the Darlington Irradiated Fuel Bays (IFB) was evaluated and found to be fit for service as part of the preparatory work for refurbishment and that IFB conditions will continue to be evaluated on a periodic basis to confirm they remain fit for service.<sup>4</sup>
- The Integrated Improvement Plan Item IIP-CC 064 indicated that repairs were required to the irradiated fuel bay, but did not provide details<sup>5</sup>
- The Integrated Improvement Plan Item IIP-CC 078 indicated that condition of the Heat Exchanger, which is part of the Irradiated Fuel Bay System, was in “poor” condition, and that repairs and part replacements were required<sup>6</sup>

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<sup>1</sup> Darlington Nuclear Generation Station Application for Licence Renewal, Ontario Power Generation, December 2013, NK38-CORR-00531-16490 P, page 115

<sup>2</sup> Darlington Nuclear Generation Station Application for Licence Renewal, Ontario Power Generation, December 2013, NK38-CORR-00531-16490 P, Page 144, APPENDIX 4, Summary of Nuclear Substances

<sup>3</sup> Nuclear Fuel Waste Projections in Canada – 2014 Update, NWMO TR-2014-16, December 2014

<sup>4</sup> Ontario Power Generation’s (OPG) 2015 Commission Member Document CMD-15-H8.1

<sup>5</sup> Darlington Nuclear Generating Station (NGS) Integrated Improvement Plan (IIP), page 30

<sup>6</sup> Darlington Nuclear Generating Station (NGS) Integrated Improvement Plan (IIP), page 31

Because of the limited and fragmented information available to Northwatch as a public participant in the license review process, we were unable to make a determination on this vital question about the fitness for service of the irradiated fuel bays, but are convinced by the seemingly contradictory statements and the gaps in available information that this is an issue that must be fully addressed as part of the Commission's review process.

Similarly, Northwatch's review of Bruce Power's licence application in 2018<sup>7</sup> raised concerns with respect to the management of irradiated fuel by Bruce Power, i.e. while in the irradiated fuel bays and prior to the irradiated fuel being transferred into dry storage containers with responsibility transferred to Ontario Power Generation. The concerns can be summarized as follows:

- Bruce Power provided inadequate information about the spent fuel and its management during the period between discharge from the reactor and transfer to dry storage
- What information was including in supporting documents raised concerns about the integrity of the irradiated fuel bays and the potential for adverse impacts on the environment as a result of IFB loss of integrity

While Northwatch was unable to locate a document which addressed issues related to the security and integrity of the irradiated fuel bays in a comprehensive manner, various documents identified several issues with the irradiate fuel bay which are cause for concern, including:

- There is a loss of integrity with the irradiated fuel bays; the document describes that "Leakage from the bays is monitored and when practicable stopped. When it cannot be eliminated, it is stabilized, and maintained at acceptable levels. It is collected by designed drainage systems and transferred to the liquid waste handling area"<sup>8</sup>
- It is unclear whether there is consistently sufficient capacity in the irradiated fuel bays to receive irradiated fuel from the reactors, should the reactors need to be fully unloaded in response to an unplanned event; for example, the Bruce A and B Global Assessment Report indicates that "The requirement for sufficient space to accommodate the entire reactor core inventory at all times is not reflected in the design and operating documentation The radioactive sources other than the reactor core are not addressed in Part 3 of the Safety Report."<sup>9</sup>
- It is unclear the degree to which ageing related degradation of the irradiated fuel bays is rigourously evaluated and whether the phenomena of ageing induced degradation of the irradiated fuel bays is sufficiently understood<sup>10</sup>

While there is some acknowledgement in various documents that Period Safety Reviews are to now include evaluations of the irradiated fuel bays, Northwatch was unable to find evidence of this having yet been undertaken, and – on the contrary – found some indications that the additional requirements for PSRs were not being met, such as the argument put forward that investigations at Darlington into whether work previously done to approximate single-unit

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<sup>7</sup> Ref. 2018-H-02

<sup>8</sup> K-421231-00202-R00 - Safety Factor 2 - Actual Condition of SSCs Page 58-59 of 90

<sup>9</sup> K-421231-00217-R02 Bruce A and B GAR IIP Page 49 of 321

<sup>10</sup> K-421231-00202-R00 - Safety Factor 2 - Actual Condition of SSCs Page 58-59 of 90

effects showed results that are consistent with the model outcomes for multi-unit accidents that because “the predictions from these two approaches are sufficiently well aligned such that further development of multi-unit models for Bruce A and Bruce B is not warranted”.<sup>11</sup>

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Also in 2018, Northwatch considered the irradiated fuel bay performance during the 2018 licence review for the Pickering Nuclear Generating station. Despite achieving the rather puzzling summation that “the Irradiated Fuel Bays and supporting equipment are generally in good condition” in the executive summary<sup>12</sup> 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 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.<sup>13</sup>

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<sup>11</sup> K-421231-00201-R00 - Safety Factor 1 - Plant Design Page B-142 of B-564 Page 4547 of 8060 of PSR

<sup>12</sup> PICKERING NGS PSR2 SAFETY FACTOR 2 REPORT – ACTUAL CONDITION OF STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY, March 2017, Page 6

<sup>13</sup> OPG Document No. P-REP-03680-00005 R01, PSR SF2, Section 4.1.4 REVIEW TASK #4 - SPENT FUEL STORAGE FACILITIES

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.

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<sup>14</sup>

One of the results of the above noted failures is the contamination of groundwater. As noted in the CNSC staff’s “Environmental Assessment Report”<sup>15</sup>, 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<sup>16</sup>

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

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<sup>14</sup> OPG Document No. P-REP-03680-00005 R01, PSR SF2, Section 4.1.4 REVIEW TASK #4 - SPENT FUEL STORAGE FACILITIES

<sup>15</sup> Environmental Assessment Report: Ontario Power Generation Inc. Pickering Nuclear Generating Station – PROL 48.00/2018 Licence Renewal, CNSC, March 2018

<sup>16</sup> For example, as reported in ONTARIO POWER GENERATION Environmental Emissions Data for Pickering Nuclear Q3 2017

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## **Aging Irradiated Fuel Bays**

To support our review of OPG’s Application for a License for Darlington NGS in 2015<sup>17</sup> Northwatch retained The WreathWood Group to assess the potential for risks and safety concerns associated with the irradiated fuel bays (IFBs) of DNGS that may arise from the extension of the operations by thirty years. The second area of focus for The WreathWood Group’s review was the effects of aging on structural integrity of the irradiated fuel bays.

Simply put, The WreathWood Group reported that no evidence has been found in the documents listed in their reporting letter to show that any reassessment has been made of the structural integrity that might be expected in the period of the license extension despite the requirements of REGDOC-2.6.3. It is recognized that these requirements are cast in the light of “SSCs [structures, systems and components] of a reactor facility” there must be a similar requirement for fuel storage facilities (like IFBs) in order to meet the requirements of Paragraphs 12(1)(c) and (f) of the *General Nuclear Safety and Control Regulations* as described in REGDOC-2.6.3 relating to all licensed activities at a licensed site.

In addition, the DGNS Application for License Renewal, page 128, states:

- Response to potential loss of cooling capability in the IFBs has been enhanced and analysis has demonstrated that bay integrity will be maintained under elevated temperature conditions.
- Additional seismic assessments of the Darlington IFBs have been completed to confirm adequacy.

The WreathWood Group noted that there was no discussion about any consideration of any previous physical degradation of the IFBs because of the prior exposure to radiation effects from the fuel stored there.

In summary, the IFBs were not identified as being within the scope of the aging management program, nor is any mention made about DGNS having an aging management program specifically for the IFBs. There was no explanation of the extent to which any reanalysis of the IFB structural integrity has taken account of any aging effects of the IFBs. As a result, there is no basis for judging the integrity of the IFBs as the plant undergoes a further 30 years of operation.

The WreathWood Group concluded that, given the findings outlined in their reporting letter, the potential for failure due to aging appears not to be included in the aging management program (and therefore the potential for failure may increase) combined with the absence of any operator guidance for failure of the IFBs to keep the fuel cooled (or at least submerged) suggests the possibility of release problems in the future.

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<sup>17</sup> Northwatch review of OPG’s Application for a License for Darlington NGS for 2015-2028, 2015-H-04

Concerns about the effects of aging on the performance of the irradiated fuel bays are supported by observations with respect to the aging Pickering Nuclear Generating Station, now scheduled for shutdown.

As disclosed in the 2013 licence application for the Pickering Nuclear Generating Station, there were two other serious incidents at the Pickering NGS involving leaks of tritiated water to groundwater, both associated with the aging pumps and pools. According to the brief descriptions, tritium in groundwater in the *Units 5-8 Irradiated Fuel Bay B (058 IFB) area* was due to the bay sumps not operating as designed, allowing tritium to escape to groundwater, beginning in 2005 and first noted in 2007. Also in 2007, chronic leaks of active water to inactive *Unit 6 Reactor Building* foundation drainage sumps were identified as the cause of elevated tritium in groundwater.<sup>18</sup>

It is not clear if the two above noted incidents were as a result of station aging or were failures that should be attributed to more general failures in either design or maintenance, but it is reasonable to expect that incidents of this type are more likely to increase as the station goes beyond its design life. That having been the case with Pickering, it is a reasonable cause for concern with the Darlington Nuclear Generating Station as OPG proposed to extend its operations for up to thirty more years. The failure by OPG and CNSC staff to examine this potential for aging effects is unacceptable.

During the Pickering Licence review in 2018, despite achieving the rather puzzling summation that “the Irradiated Fuel Bays and supporting equipment are generally in good condition” in the executive summary<sup>19</sup> 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.

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<sup>18</sup> Attachment 3 to OPG Letter, G. Jager to M. Leblanc, “Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence”, CD# P-CORR-00531-03719, page 117

<sup>19</sup> PICKERING NGS PSR2 SAFETY FACTOR 2 REPORT – ACTUAL CONDITION OF STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY, March 2017, Page 6

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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.

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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<sup>21</sup>

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

As noted in the CNSC staff's "Environmental Assessment Report"<sup>22</sup>, 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 -

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<sup>22</sup> Environmental Assessment Report: Ontario Power Generation Inc. Pickering Nuclear Generating Station – PROL 48.00/2018 Licence Renewal, CNSC, March 2018



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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:

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- there are indications of tritium in the perimeter groundwater wells, so the claims of no off-site migration of tritium is difficult to accept<sup>23</sup>
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Prepared by Northwatch for submission to Natural Resources Canada as part of the Radioactive Waste Policy Review, May 2021

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<sup>23</sup> For example, as reported in ONTARIO POWER GENERATION Environmental Emissions Data for Pickering Nuclear Q3 2017

